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Culinary Herbs

Ernest Small

Culinary Herbs

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Ernest Small

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Abstract

This book is a comprehensive reference guide to herb and spice plants that are cultivated in Canada and the northern half of the United States for the purpose of flavoring foods. Culinary herbs are of professional interest to the farmer, economist, pharmaceutical industry, flavoring and perfume extract industry, dietician, and teacher. They also offer delightful aroma, taste, and appearance to the home gardener, cook, and indeed all consumers. Culinary herbs have attracted the best imaginations in the history of civilization, and both folklore and science add a remarkably entertaining dimension. This work presents information in categories, allowing the reader to quickly find the type of information desired for particular purposes. Categories of information covered in considerable detail for 125 species include: nomenclature (botanical family, all recorded modern English and French names, scientific name and common synonyms), description and classification (including cultivars), uses (culinary, including a guide to recipe sources; industrial; ornamental), importance (nationally and internationally, including statistics where available), cultivation (soil, climate, reproduction, propagation, harvest, storage), chemistry, medicine, nutrition, human interest information, selected key literature, and a summary evaluation of problems and potential from an economic and agricultural viewpoint. All species discussed in detail are extensively illustrated, with over 400 drawings in the book. A color map of North America is included that shows climatic zones where each of the species can be cultivated. Brief information is presented on several hundred additional species of lesser importance to Canada and the northern U.S. Introductory chapters address such topics as: medicinal, chemical, and food aspects; germplasm; the culinary herb economy of North America; crop diversification; and the business of growing herbs.

Résumé

Cet ouvrage se veut un manuel de référence exhaustif sur les herbes et les plantes condimentaires cultivées au Canada et dans le nord des États-Unis pour aromatiser les aliments. Les herbes aromatiques constituent une culture d'importance pour les fermiers, les économistes, l'industrie pharmaceutique, l'industrie de l'aromatisation et de la parfumerie, les diététiciens et les enseignants. Bien stir, leur arôme enchanteur, leur goût et leur apparence en font aussi une denrée prisée des jardiniers, des cordons-bleus et des consommateurs. Les herbes aromatiques sont au centre de nombreuses croyances dans toutes les civilisations et, de fait, le folklore et la science enrichissent constamment leur réputation. L'information de cet ouvrage a été divisée en catégories afin de permettre au lecteur de trouver rapidement l'information dont il a besoin. Parmi les catégories d'information permettant de dresser le profil détaillé de 125 espèces, on note: la nomenclature (famille botanique, noms contemporains connus anglais et français, nom scientifique et synonymes courants), la description et la classification (y compris les cultivars), les usages (industriels, ornementaux et culinaires, avec sources de recettes à l'appui), l'importance (nationale et internationale, parfois étayée de statistiques), la culture (sol, climat, reproduction, multiplication, récolte, entreposage), les aspects chimiques, médicinaux, nutritionnels et sociaux, des références à de la documentation connexe, et une évaluation sommaire des enjeux et du potentiel économiques et agricoles. On retrouve dans l'ouvrage quelque 400 dessins au trait des grandes espèces. Est en outre incluse une carte en couleur de l'Amérique du Nord, sur laquelle sont illustrées les zones climatiques de culture de ces plantes. On y retrouve aussi de l'information générale sur plusieurs centaines d'autres espèces de moindre importance au Canada et dans le nord des États-Unis. Les chapitres d'introduction traitent de sujets tels que les aspects médicinaux, chimiques et alimentaires, le germoplasme, l'économie des herbes aromatiques en Amérique du Nord, la diversification des cultures et l'importance commerciale de la culture des herbes.

Preface

The purpose of this manual is to present general agricultural and economic information about plants that are grown as culinary herbs in the northern half of North America, including the familiar, unusual, and potential. The plants discussed are all cultivated, at least in home gardens, if not also as commercial crops. Generally they can be grown outdoors, either as annuals (in some cases requiring starting of seeds and seedlings indoors), or as perennials kept outdoors over winter, at least in areas with average minimum winter temperatures no colder than -15°C. Also included are several species that are or can be cultivated for culinary purposes as house plants. Several Canadian provinces and American states regularly issue production recommendations for the principal herb crops. This book is neither intended to provide such local recommendations, nor to be a guide to gardening; however, much of the information will be useful for both the commercial and home gardener.

The intended audience is broad and includes

• executives in government and the private sector who require a rapid overview of information on given culinary herb crops (e.g., for establishing, reviewing, and altering priorities for research)

• information service specialists in government (e.g., for answering inquiries on unfamiliar crops)

• farmers and research station personnel (e.g., for considering suitable crops for diversification in their region and soil type)

• teachers in educational institutions (e.g., for use as a reference text)

• staff in agri-food industries (e.g., for identifying regions where particular culinary herbs are grown).

Crop diversification is a principal current concern for North American agriculture, and culinary herbs are especially good candidates as new crops. New crops require research, development, production, and marketing. To make sound choices and decisions, knowledge and background information of the status of crops actually and potentially available are essential. Unfortunately, much of this information exists in widely scattered, often obscure locations. The present treatment provides an overview of information on culinary herbs which, it is hoped, will contribute to future development of the industry in North America.

The information in this book is encyclopedic, and naturally all categories will not be of interest to everyone. Chemistry, for example, will be of limited concern to most general readers, who may at least take solace in that this information is segregated. The categories of information are for the most part self-evident; however, three require comment. Notable varieties are mentioned (in "**Cultivation Notes**, Example Cultivars") simply to indicate some popular forms; their inclusion should not necessarily be interpreted as a recommendation of these over those not mentioned. Under **Recipe Sources** references where recipes can be obtained are included, particularly for marketing purposes, because consumer acceptance of food plants, especially unfamiliar ones, depends heavily on such information, and recipes for many of the unfamiliar herbs included in this book are very difficult to locate. Striking "human interest" information is highlighted in "**Additional Notes**, Curiosities," since man does not live by bread alone, and just as herbs serve to spice up food, there is a remarkably spicy quality to much of the history and science of herbs. Learning about some of this fascinating history and science can increase our respect for the wondrous qualities of our universe. In the words of Alfred North Whitehead [cited in Andrews (1986)]:

> *...When you understand all about the sun and all about the atmosphere and all about the rotation of the earth, you may still miss the radiance of the sunset.*

Every reasonable effort has been made to acquire reliable data and information, and to cite sources for this information. However, it is inevitable in a work of this scope that some past errors recorded in the literature will be reproduced, and that some new errors will be introduced. I shall appreciate errors and inadequacies of presentation being brought to my attention.

Medicinal Warning

The traditional medical and folk uses and modern medicinal values of the culinary herbs described here are given for informational purposes only. Medicinal use of herbs should be carried out only under the care of a well-informed, qualified physician. Please note that some herbs included in this book are poisonous, and others may cause toxic reactions in susceptible individuals. Although most, if not all culinary herbs are pharmacologically active, for many herbs limited health information is available, and safe levels of consumption are poorly understood. Culinary herbs are meant to be used in small amounts at any meal, and sparingly in the total diet. Remember, a little goes a long way!

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Reviewers

The following reviewed drafts of the chapters shown, or provided extensive information on the aspects indicated. "Personal communications" in the book are mostly from those listed. All reviewers mentioned have expertise in some or all of the material reviewed, and their criticism greatly improved the accuracy and presentation of this book. Errors of fact and interpretation that remain are solely the responsibility of the author.

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Richards, A.J., University of Newcastle upon Tyne, U.K.: *Taraxacum*.

Rogers, M.A., Editor, Herb Growing and Marketing Network, Silver Spring, PA, USA: Key Sources of Information on Culinary Herbs, Crop diversification and the business of growing herbs.

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Soule, J.A., Washington State University, Pullman, WA, USA: *Tagetes*.

Stearn, W.T., Kew Gardens, Richmond, Surry, England, U.K.: *Allium*, Plant classification and plant names.

Svoboda, K.P. The Scottish Agricultural College, Auchincruive, Ayr, U.K.: *Satureja*.

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Wilson, F.D., U.S. Department of Agriculture, Agriculture Research Service, Western Cotton Research Labratory, Phoenix, AZ, USA: *Hibiscus*.

Wilson, H.D., Texas A&M University, College Station, TX, USA: *Chenopodium*.

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Yamaguchi, M., University of California, Davis, CA, USA: *Cryptotaenia*.

Yetter, T.C., Cumberland College, Williamsburg, KY, USA: *Pycnanthemum*.

Introduction

What is a Culinary Herb?

As humans, we seem destined to fight over words, and edible plants are no exception. The Roman emperor Diocletian (245-313) in 301 issued an edict in which he defined mustard as a "food" and not a "condiment" (Toussaint-Samat 1992). In fact, mustard plants are both, providing vegetables (from the root, leaves, stem, and flowers) and the familiar flavoring (from the seeds) we use on various meats and other dishes. As noted below, there really isn't a universal meaning for the word herb or for the phrase culinary herb, but nevertheless these terms are useful.

Herbalists (those who collect, grow or use herbs for various purposes, but especially medicinally) have the broadest definition of "herb:" any plant valued for its medicinal properties, flavor, or scent (Elbert and Elbert 1974). Simmons (1969) defined herbs as "plants that are useful to man for flavor, for fragrance, for medicinal purposes, for magic, for charms and incantations, and for fun." Mercer (1994) described a herb as "any plant used for flavor, fragrance, dye, medicine or cosmetics, currently or historically." Tyler (1994) pointed out that the term herb has a specific, restricted meaning in medicine, and he defined herbs as "crude drugs of vegetable origin utilized for the treatment of disease states, often of a chronic nature, or to attain or maintain a condition of improved health."

Botanists usually use the word herb in a technical sense: to denote soft-stemmed plants, as apposed to woody plants. Indeed, in the discussions of culinary herbs in this book, the word is often used in this sense to contrast soft-stemmed plants from perennial shrubs and trees. However, as is traditionally done, woody plants are included within the scope of the phrase "culinary herb." Thus this book includes some "herbs" that develop woody bases as they mature, and are sometimes called "subshrubs" (most notably rosemary; also many others, such as holy basil, garden thyme, sage, marjoram and country borage), perennial shrubs (lemon verbena and roses), plants that are sometimes shrubs and sometimes trees (bay laurel, juniper, and myrtle), and trees (sugar maple).

No distinction is made in this book between culinary herbs and "spices." Those who do have tried to define the difference in various ways. For example, one way has been to define herbs as plants that can be grown in temperate climates, while spices can be grown only in the tropics. Another way is to distinguish spices as being more "pungent" or "aromatic," i.e., having more volatile oil flavoring and aroma constituents. Attempts have also been made to distinguish herbs and spices by plant organ, i.e., whether from seeds, fruits, flowers, leaves, stems, bark, or roots. Purseglove et al. (1981) restricted the term spice "to hard or hardened parts of plants, usually originating in the tropics and mostly used in a pulverized state, which impart an agreeable flavor and aroma to food and drink." For commercial purposes, it may be important to distinguish herbs and spices. For example, trade legislation may apply to a plant product called a spice, but not to herbs. Pharmacopoeias (officially recognized books describing drugs, chemicals and medicinal preparations) and legislation often attempt to present rather precise definitions of herbs.

The American Spice Trade Assssociation defines spice as "any dried plant product used primarily for seasoning purposes" (Buzzanell et al. 1995). This very broad definition includes tropical aromatics such as pepper, cinnamon and cloves; leafy temperate-zone herbs such as oregano, basil and sage; "spice seeds" such as sesame, mustard, and caraway; and even dehydrated vegetables used as spices, such as onions.

According to Tucker (1986) "a culinary herb is defined in the popular sense as a plant which can be usually grown in temperate regions and is used (or has been used) in minor quantities to flavor foods and beverages."

For purposes of this book, the following definition is offered: **a culinary herb is an edible plant, consumed in small quantities, to provide substantial flavor and usually also aroma**.

Note that culinary herbs are defined here as plants that are eaten in small quantities. This distinction is difficult, not just because of vast differences in personal preferences among individuals, but also because culinary traditions among ethnic groups often result in a plant being used liberally as a vegetable by some, but sparingly as a condiment by others.

Extracts from plants often serve the same purposes as herbs and spices, however defined. Essential oils and oleoresins may include the aroma and flavor ingredients of culinary herbs, and often also are useful in medicine and for various industrial purposes. Information is provided on plant extracts for the culinary herbs discussed in detail in this book, but it should be kept in mind that flavoring extracts can be obtained from plants other than culinary herbs, such as fruits and vegetables.

A number of other terms related to culinary herbs are used in broad senses in this book. "Potherbs" are plants used in cooking, and may include vegetables as well as culinary herbs. "Condiments" are materials used for flavoring food, and include culinary herbs, animal-derived

flavoring ingredients such as fish sauces, mineral-based materials such as table salt, and synthetic chemicals such as monosodium glutamate, the so-called "third spice" (Arctander 1960). Arctander (1960) defines a condiment as a combination of several spices and/or strong herbs, but he himself points out that vinegar is considered a condiment, so that this term is rather flexible. Arctander calls flavorings like sugar, salt and vinegar "seasonings," a term which is used here as a synonym of condiment.

Herb or Erb?

> A simple four-letter word, h-e-r-b has been the cause of much discussion as to its pronounciation. In America one is often considered uncultured if he pronounces the *h*; in England he is apt to be branded a cockney if he drops the *h*.
>
> Until 1475 the word was *erb*, both in spelling and in pronounciation. It came to England from the Latin *herba*, through the Old French *herbe* or *erbe*. At the beginning of the 16th century, the Latin *h* was re-attached to the word, but it remained mute until 1800. Since then pronunciation of the *h* has come into use; *herb* is correct in England. American usage still clings to the historical *erb*. Take your choice. When in London, say *herb*, when in New York say *erb*; When in Rome.....
> Anon. 1982*a*
>
> Now I shall be compelled to disappoint any who want to know which is "correct," '*erb* or *herb*... Correctness, is and alway has been, solely a matter of general agreement in cultivated habits of speaking... The pronunciation of the word *herb* is a clear case of divided cultivated usage. Those who prefer '*erb* can rightly feel proud of preserving a well-founded tradition; those who prefer an unmistakably well-aspirated *herb* can justly feel that they are at least not old-fashioned. But I hope that both parties agree in liking herbs.
> Kenyon 1953

In Canada, pronunciation is mixed, many following the British style, which will be evident in the Canadian editing of this book wherever *a herb* or *a herbal tea* is mentioned (and not *an herb* or *an herbal tea*). New Englanders also tend to follow the British standard (McNair 1978). According to Elbert and Elbert (1974), "Most Americans have been taught to say 'erb, much as the cockney says 'enry - a classical example of reversed English. Recently those in the know here have been copying the English pronunciation... In the long ran, we suppose, the English way will prevail."

The Historical Importance of Culinary Herbs

Flowering plants provide us with indispensable commodities such as food, fuel, materials for our buildings, and clothes. Of the 250 000 "higher" (or flowering) plant species, about 25 000 have been cultivated for various purposes (Small 1993). About 7 000 have been employed for food, and several times that number have edible parts (Small 1995). The plant world is clearly a gold mine. Indeed, the gifts of the Three Wise Men included not just gold, but the herbs frankincense (*Boswellia carterii* Birdw.) and myrrh (from *Commiphora* trees, not *Myrrhis odorata* treated in this book). The extraordinary value of herbs in history has several explanations.

First, as will be discussed later, herbs are incredibly rich in medicinal compounds, and mankind has known this for a very long time. There is even a little evidence that, as much as 60 000 years ago, Neanderthal man valued herbs as medicinal agents (Solecki and Shanidar 1975). The antiquity of the use of herbs can be deduced from the oral traditions and legends transmitted by the shamans or medicine men of Eurasia and the Americas. By tradition, Shen Nung, the legendary first emperor of China, was a herbalist, who taught people what plants to use. This interpretation fits with the illustrations of plants scratched on the sheep scapulae or "oracle bones" found at ancient sites in North China. Ancient herbalist traditions are also known in the New World, as evidenced by depictions of plants on birch bark scrolls prepared by indigenous North Americans (e.g., Duke 1986). The ancient civilizations of Sumer, Assyria, Egypt, Greece, China, and Rome all prepared written "herbals," manuals identifying plants with medicinal properties, on clay, stone, bronze, papyrus or parchment.

Some herbal medicines worked very well. About 2400 years ago the Greek physician Hippocrates (460?-377 B.C.), the "Father of Medicine," recommended chewing willow bark to counter fever and pain, advice that should have worked because, as is now appreciated, willow bark contains salicylates, the chemical basis of aspirin. Many more examples of modem science discovering a rational chemical basis for herbs that were used medicinally in former times will be found throughout this book. Duke (1985) noted that it has been estimated that at least 25 percent of drugs used by modem-day physicians came into being by way of folk medicine. Of the order of 10 billion dollars a year is spent in North America for prescription drugs in which the active principles come from plants (Chandler 1985*a*). Even an irrational belief in the healing powers of herbs could be therapeutic (the so-called placebo effect, whereby if you think something works, it

does). In the past, many herbs were considered aphrodisiac, and no doubt the belief was often sufficient.

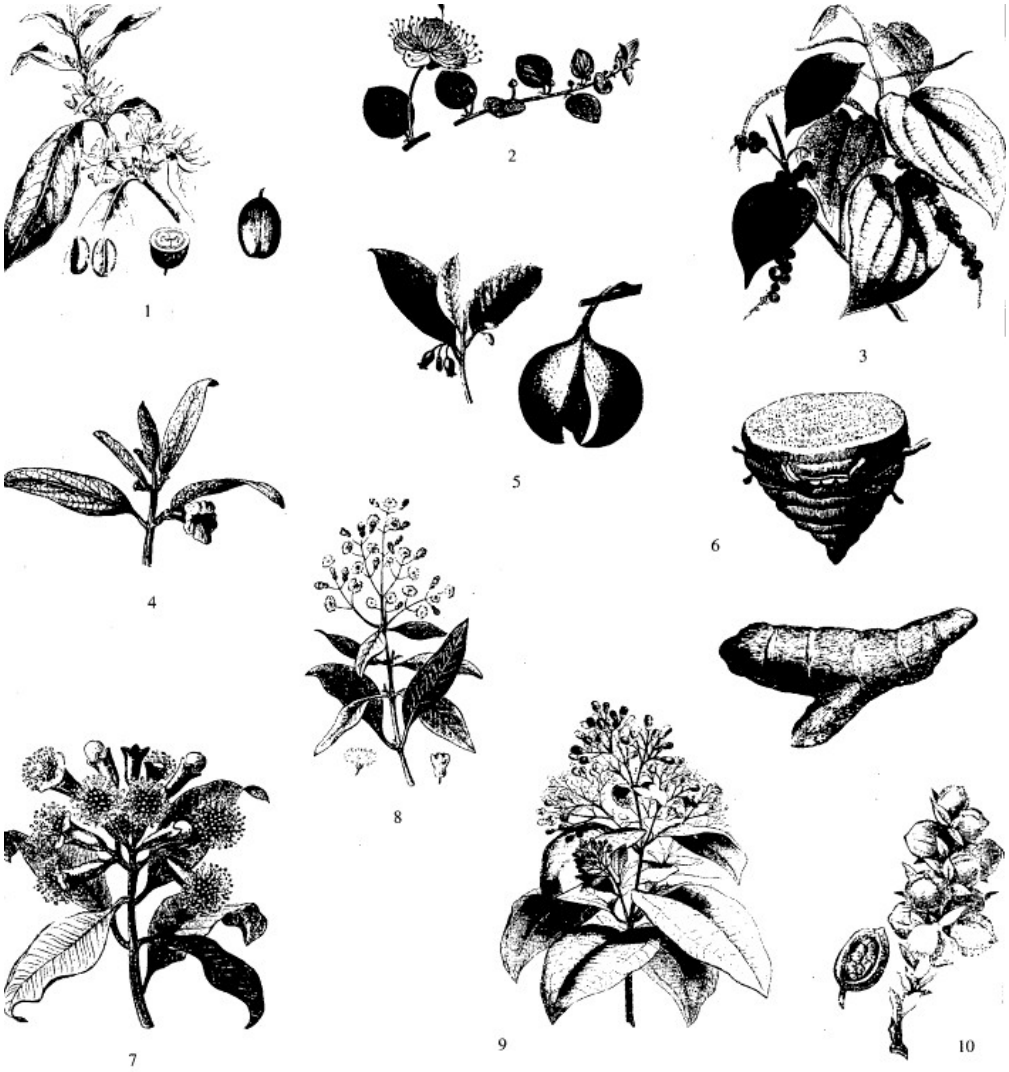
A second reason why herbs were esteemed in past times is related to the lack of refrigeration. It was difficult to keep food from spoiling, and herbs offered a means of masking off-flavors. Aside from simply hiding the effects of putrefaction of food, many plants containing volatile oils and other compounds in their leaves, seeds or roots inhibit organisms of decay, acting as preservatives and fumigants. In temperate countries, where livestock was killed in the autumn and meat was kept overwinter, both sugar and such exotic spices as pepper and cloves were particularly valuable additions to the traditional drying, smoking, pickling or salting, at least in the wealthier households. Similarly, with limited sanitation, perfumes from herbs could be used to conceal the odors produced by "unwashed humanity" as the old saying goes. This was recognized centuries ago by the ancient north Europeans who lacked the more pungent herbs, but spread evergreen branches, hay, or straw on the floors of their houses to freshen up the atmosphere.

Of course, the flavoring of food, the chief reason for using culinary herbs today, has always been important. Even in temperate regions, where most herbs have little pungency compared to those of Mediterranean or tropical climates, herbs added interest to an otherwise bland and monotonous diet, whether of cereals, roots, or a little meat or fish. One can mention particularly onions, leeks, parsley, knot-grass, bell peppers, celery, mustard greens and dill. Similarly, the more flavorful or pungent herbs and spices, among them garlic, coriander, cumin, ginger, lemon grass, chile peppers and curry leaves, have long been a part of the diets of peoples living in warmer climates. Contrariwise, a few of the more exotic spices that attracted foreigners were virtually ignored by the local inhabitants until they saw how valuable they were to others. Cloves, for example, are absent from most Indonesian and Chinese cooking, although they turn up as a tobacco flavoring in Java; and there is no evidence that the native West Indians used allspice. Arabs and Europeans, on the other hand, were quick to adopt both.

Military conquests, trade and migrations led to the spread of previously unknown aromatic culinary herbs from warmer climates into the temperate world. Many, like those illustrated in Figs. 1-10, arrived far from their places of origin, and were so exotic that some came to be treated almost like precious stones. Bay leaves, thyme, tarragon and other herbs with aromatic leaves came early from the Mediterranean into northern Europe, possibly with the Celts as they moved west from Turkey, or somewhat later with the Romans. Coriander, mustard, and garlic appear to have left their homelands in the eastern Mediterranean and western Asia shortly after the Greeks under Alexander the Great completed their conquests of the Middle East, Persia and northern India in the third century before our era. Northern India, in turn, adopted the turmeric, black pepper, cardamom and sugar found in the southern part of the continent and Ceylon (Sri Lanka); and when the Romans subsequently conquered the Greeks, they took over the eastern trade routes and established new routes of their own to the west. Cinnamon, cloves and other spices that had reached ports in Roman Syria, Egypt, or Turkey from India or through Hindu traders came into Roman cookery at that time; while spices such as frankincense, myrrh and gum resins that had been coming down the Nile and along the Red Sea since pharaonic and biblical times, had long since become known in the Middle East and eastern Mediterranean.

A similar process was taking place in other parts of the world. China adopted ginger root, galingale, cassia bark, sugar cane, cinnamon, black pepper, camphor, cloves, and eventually chile peppers, along with the equally valuable edible birds' nests, sea slugs and rhinoceros horn, as the empire expanded from the northeast into the south within reach of Hindu, Arab, and Malay trading vessels, and southwest towards the Indochinese peninsula and Burma (Myanmar). In the Americas, the hot peppers and cacao of the tropical lowlands of the Amazon Basin became the favorite culinary herbs of the colder sub-tropical highlands in Mexico (Diaz del Castillo 1966). Similar regional trade routes had been bringing herbs such as asafoetida, rhubarb and saffron along with numerous new fruits and vegetables by way of Iran into China along the Silk Route since the beginning of our era, and tea was one of the Chinese products that moved the other way (Laufer 1919). A more complex network of small traders operating in the Indian Ocean between Madagascar and eastern Indonesia brought an exchange of aromatics such as cinnamon, cloves, cardamom, camphor and resins throughout the archipelago, as Hindus, Buddhists, and Moslems succeeded one another in that region (Sopher 1977). The Moslems, who arrived in eastern Asia in the ninth and tenth centuries, were probably responsible for the appearance of cloves in Zanzibar and Mombasa before the Portuguese arrived there, and would have contributed to the spread of Indonesian spices in the Middle East and Europe.

Arab merchants had earlier carried eastern products from closer to home through North Africa on their way to conquer Spain in the 8th century. Among the most valuable were the saffron crocus and sugar cane, both of which were planted in Spain or on the Balearic Islands. Saffron and sugar subsequently became highly sought-after



Figs. 1-10.

Some principal tropical and subtropical Old World culinary herbs [all from Harter (1988), except caper, which is from Vilmorin-Andrieux et C^{ie} (1883)]. 1. Coffee (Coffea arabica L.; the "beans" are the pulpy fruits with their seeds). 2, Caper (Capparis spinosa L.; "capers" are the flower buds). 3. Black pepper (Piper nigrum L.; the fruits are used to make pepper). 4. Sesame (Sesamum indicum L.; the seeds constitute the spice). 5. Nutmeg (Myristica fragrans Houtt.; the seed yields nutmeg, while the fleshy covering of the seed yields mace). 6. Turmeric (Curcuma longa L.; the spice is obtained from the rhizome). 7. Clove (Syzgium aromaticum (L.) Merrill & Perry; "cloves" are the dried flower buds). 8. Allspice (Pimenta dioica (L.) Merrill; allspice is the dried, unripe fruit). 9. Cinnamon (Cinnamomum zeylandicum Bl.; the bark yields cinnamon). 10. Cardamom (Elettaria cardamomum (L.) Maton; the seeds constitute the spice).

products in western Europe (Braudel 1975). After the Arabs were conquered by the Visigoths in the 10th century, they expanded their territories and influence in North Africa, bringing Islam and new trade goods wherever they went. They also developed a sea route down the coast of Morocco, and land routes across the Sudan, where Arab traders associated with African traders operating on the Upper Nile, Niger, Senegal and other river routes (Levtzion and Hopkins 1981). This trade brought in malaguetta pepper, carob beans, and eventually African varieties of chiles and black pepper, as well as gold, ivory, cotton, dyes, and slaves (Lopez and Raymond 1955). Coffee from East Africa also came north at that time, and was subsequently spread throughout the Ottoman Empire by the Turks. Numerous eastern spices were therefore in wide use in the Middle East, and had already entered the Mediterranean trade, by the time of the Crusades when West met East at the crossroads of the trade routes.

Although many spices remained scarce and very expensive, this was relative. In all areas, plants introduced from neighboring regions could often be grown locally, or were not so rare or hard to obtain that they became luxuries and out of reach of the ordinary people. The spices from the south are found in the everyday curries of all parts of India; ginger is ubiquitous in Chinese cookery from north to south; an English or northern French cook will grow a little thyme, marjoram or oregano in a pot in the kitchen or in a sheltered corner of the garden to add to a stew or poultry stuffing; the chile pepper has been an essential part of everyday cooking, not only throughout its tropical American homeland, but also in the parts of tropical Africa, Asia, and even central Europe to which it was introduced; and it is difficult to find a Middle Eastern recipe that does not use at least one of three different kinds of pepper.

Early Europeans generally had very little idea of the geography of the parts of the world where exotic products had originated. Africa west or south of the Nile was virtually unknown, and Asia more or less stopped at western India. Both the Greeks and the Romans tried for centuries to solve the mystery, and even produced geographies based on tales by merchants and shipwrecked sailors, with names and purported locations that have challenged historical geographers (e.g., Chittick 1981). Even as late as the 15th century, Europeans from Italy to Portugal were looking for a mysterious Indian emperor called Prester John in such unlikely places as Senegal and Abyssinia. The Chinese remained equally vague, and in both cases, the reasons were similar. Both relied on numerous intermediaries for their long-distance trade, and neither had ships capable of crossing open seas prior to the 14th century. Most of the early trade was carried on by small coastal and river traders long before the era of the great sea-going empires. These small vessels were part of a relay system or entrepot trade in which goods were transferred or exchanged at intermediate ports, and few had a monopoly on the original sources of supply. Much of this trade was local, to get such staples as cereals, lumber, iron or fish to the next port; and only the most valuable items - spices, precious metals, jewels, ivory, or silks - would be transshipped through several intermediaries to distant markets.

Relay trading systems existed all over the world. They included Egyptians going up and down the Nile or along the Red Sea to Yemen and Ethiopia; Vikings plying the Baltic and the Volga River to the Black Sea and Istanbul where such northern goods as grain, wool, furs, hemp and amber were exchanged for luxury goods of the Byzantine and Turkish empires; Malay sea nomads coasting around the mainland and islands of the south Indian Ocean, the Straits of Malacca, and the South China Sea; Gujeratis sailing around the Persian Gulf and meeting up with Persian, Arab, or Egyptian traders at Hormuz or Red Sea ports; Arawaks trading maize, fruits, cacao beans, honey, incense resins and peppers along the Amazon river system and Caribbean Basin; African Krumen trading on the coasts and up the Niger and Senegal Rivers; and Greeks, Romans, Arabs, Genoese or Venetians going up and down the Mediterranean, up the Rhine or Danube, or occasionally venturing beyond the Pillars of Hercules and along the Atlantic coasts of Europe and Africa with both local and imported wares.

There were occasional accidental ventures into the high seas, as witness early European shipwrecks, but the first real changes in the pattern of coasting trade took place in the southern seas. The changes began with one-directional voyages into the Pacific by the ancestors of the Polynesians at distant unknown dates, and by the time that Hindus came to Southeast Asia in the fifth century, Malays and Indonesians had figured out how to use monsoon winds and the lodestone as well as the stars to travel back and forth through previously uncharted waters. The Chinese reported an active trade there in foodstuffs, spices, and textiles at that time. Hindus, Arabs, Persians, and Turks picked up the navigation skills of the Malays and Indonesians, and were soon crossing the Indian Ocean on regular trading ventures. There were even rumors that Arabs and Africans were crossing the South Atlantic. Gradually, those navigation skills were adopted and surpassed in southern Europe, and changed the history of the spice trade.

The early trade in spices and other luxuries brought increasing wealth to every nation involved in it, but nowhere was this more the case than in western Europe after the advance of Islam was stopped there in the 12th century.

Returning crusaders and others of the ruling classes and the church who had acquired a taste for eastern luxuries from their Moslem enemies did not give up those tastes afterwards. They ushered in an era of soaring cathedrals, great castles, and feudal estates all over western Europe. Aristocrats and bishops dressed in the finest silks and velvets, and knights had jewelled cloak pins and sword hilts; church furnishings were made of gold, silver or ivory, encrusted with exotic jewels; manuscripts were embellished with gold and paints derived from Canary Island orchella or Central Asian lapis lazuli; and in the kitchens of the upper classes, cinnamon, cloves, ginger and pepper became the most popular seasonings (Toussaint-Samat 1992). Without that accumulated wealth, the arts of the Renaissance period that began in the late 15th century would never have attracted the great church and secular patronage that allowed them to flourish. The converse of all this was unprecedented poverty among those whose labor had to pay for the luxuries, from feudal serfs and slaves in Europe to the slaves who cultivated the spices and manned the ships in the east.

Control of the Mediterranean trade shifted during the Middle Ages from the old Greek and Roman ports to new city states where larger and faster ships were being built, capable of evading coastal pirates in the Mediterranean, and of going out into the Atlantic (Braudel 1972). Genoa was in the lead for a time, but Venice with its links to the east soon became the most powerful and wealthy city in Europe. Venetian merchants were famous for their far-reaching trading ventures. Marco Polo and his family got as far as China in the 13th century. Although somewhat vague in his geography, Polo was the first European to report on sources of spices in southern Asia between southwestern China and India. Other Venetian merchants got as far as the Canary Islands in the early 14th century, and established trade in resins and dyes from the Atlantic region (Lopez and Raymond 1955). In the 1440's, the Venetian merchant Cadamosto took wares from Venice to trade on the first Portuguese expedition along the Atlantic to the Senegal River, obviously with prior knowledge that this would be worthwhile (Crone 1937).

Although new rivals were appearing in Lisbon, Paris. and London, Venice kept its dominance over the spice and other luxury trades for almost two centuries until the fall of Constantinople (Istanbul) to the Turks in 1453. This cut off Europe's direct access to the spices and other luxuries of the east and their prices began to rise. The Venetians tried to find other ways of getting supplies, and their merchants were among various adventurers who tried to bypass the Moslems in the late 15th century, and get to India by way of Abyssinia (Hammond 1963). However, by that date, the Portuguese were getting ready to outsmart their rivals, and were on their way to opening up a new sea route to India.

After many excursions into the North Atlantic, and the discovery of the Azores and Madeira, the Portuguese were building the best ships in Europe. They had captured Ceuta in Morocco in 1415, and were making their way down the African coast towards the Cape of Good Hope. They had been getting information from various sources about Indian Ocean trade, and foreign passengers like the Venetian merchant Cadamosto must have provided them with a great deal of geographical information. Their most famous passenger, Columbus, came from Genoa, the city with the most advanced knowledge of maritime mapping and navigation aids. The Portuguese therefore had a head start in the search for the "Spice Islands" when Diaz rounded the Cape of Good Hope in 1488 and entered the Indian Ocean.

The Portuguese maintained their lead in Asia for almost 150 years after the spring of 1498 when Da Gama sailed up the east coast of Africa and crossed the Indian Ocean to Calcutta. Their superior ships controlled the high seas and they established forts and enclaves from Mozambique, Goa, and Ceylon to Malacca, Timor, and Macao between 1502 and 1519. In 1511 they reached the southern Moluccas, and subsequently gained control of the rest of the "Spice Islands." After the conquest of Calcutta in 1512, the first shiploads of pepper set off for Europe, followed shortly after by cloves and other spices from eastern Indonesia. Jesuit missions were established with varying success all over Asia, although the closed societies of China and Japan were never penetrated very deeply. Many traders also got involved in the profitable local coasting trade between Malacca and eastern ports after they found that cooperation with local rulers got them further than trying to fight them. Combined with income from the gold, ivory, slaves and malaguetta pepper of West Africa, Portugal initially became extremely wealthy. It did not last long because the country became overextended, lacking the population and resources to sustain an empire covering half the globe. Nevertheless, the Portuguese initially got what Columbus had set out to find, and what European rivals set out to take away from them - the spices of the East.

Right at the start of the search for eastern spices by sea routes, the Europeans began to carve up the tropical world among them, a process that did not end until most of the colonies achieved independence after World War II. This began with the Treaty of Tordesillas of 1494, under which Spain was granted all land discovered west of 46° 37' W, and Portugal all land to the east. Portugal got an added

bonus out of this when Cabral landed in Brazil in 1505, and it turned out to be east of the line. Sugar became the main source of wealth in Brazil, rivalling spices in value.

Spain came to Asia a few years later. Part of the incentive for Magellan's famous voyage for Spain in 1519-22 was to see whether the "Spice Islands" lay in the right longitude to be claimed for Spain. In the end, Spain gave up the Moluccas, but conquered the Philippines where ginger and a few other spices were grown. However, products from the Philippines were mainly shipped to China in exchange for the much more valuable silks and porcelain that were sold in Europe or in the American colonies. Spain remained a marginal player in the eastern spice trade. In its American colonies, the major spice plant, the chile pepper, was not an important trade item, but vanilla and cacao fetched very high prices, supplementing the even greater sources of wealth in such goods as silver and precious stones.

Compared to what followed, the rivalry between Spain and Portugal for control of the spice trade was mild, and both settled down happily to profits from other goods in their colonies, and most profitable of all, from the slave trade. Despite attempts to keep the sources of their wealth secret, the Portuguese were forced to rely on foreign manpower for their ships. This meant that information went north with the numerous French, English, Dutch and Baltic crews on the expeditions. The balance of naval power was again shifting, and cut-throat behavior became the rule as the rest of the tropical world was carved up among the Europeans. By the mid-16th century, English and other pirates were taking shiploads of spices, silks, and other goods, and setting up rival colonies wherever Portuguese or Spanish control was weak, whether in the West Indies, West Africa, or southern Asia.

After the defeat of the Spanish Armada in 1588, the English became the leading Atlantic power, and even tried to find a route to Asia through northern North America to by-pass their rivals. By the beginning of the 17th century, the English and French were active in the South Indian Ocean, and had set up rival trading companies in India, where Portuguese control was limited to the west coast ports where they had disrupted the Arab trade. The French occupied several Indian Ocean islands, and took away Spain's monopoly on vanilla by establishing plantations there. The British won out over the French in India, and in the late 18th century, gained political control over several states. Within the next few decades, the rest of India, Ceylon, Burma, and the Malay States came under British control. They not only established monopolies in pepper, cinnamon, cardamom, turmeric and ginger, but also gained immense wealth from their tea plantations. Indirectly, the tea cost them the loss of their American colonies. The British were also in the forefront of European attempts to control China, and were instrumental in the spread of that most dangerous of culinary herbs, the opium poppy.

The Dutch also set up a trading company in India, and gained political control in South Africa, the East Indies, and the Caribbean during the 17th century. They had taken Malacca, Ceylon, and most of Indonesia, including the Moluccas, by the mid-17th century and proceeded to create monopolies on a scale far exceeding that of the Portuguese. In order to keep up the prices of cloves and nutmegs, they cut down many of the trees and set up new plantations away from control by Malay rulers. Native populations were virtually enslaved to produce goods like coffee, tea, sugar, pepper, and cinnamon for the European markets. The Dutch were the only Europeans allowed to carry on a restricted trade with Japan for almost 2 centuries after the Portuguese were expelled in the 17th century. The Dutch also planted sugar and cacao in the Caribbean; and precious metals and stones added to their wealth in South Africa and Ceylon. At home, Dutch arts and crafts reached new heights with the rise of a large, wealthy merchant class, and they brought Chinese and Japanese influences into European art along with shiploads of spices. The Dutch lost Malacca and Ceylon and, temporarily, Java and Sumatra to the British in the early 19th century, but regained control of most of Indonesia except North Borneo in 1824, and continued to profit from its spices, coffee, cacao and other products until after World War II.

Americans became major players in the Asian trade during the 19th century. They persuaded Japan to reopen trading links with the west in the 1870's, and also got involved in the conflicts to open up trade with China. They captured the Philippines from Spain during the Spanish-American war in 1898. However, by that time, the era of monopolies was coming to an end. Wars and revolution in Europe had disrupted trade and markets, destroyed wealth, and ended the dominance of the upper classes. In France and other countries, there was a return to native seasonings in a rejection of the excesses of fallen aristocracies. As colonial powers desperately tried to secure their own supplies of spices and other luxury goods by growing them in their own colonies, markets became flooded and prices fell. Sometimes harvests were destroyed to shore up prices, but this too would backfire as people stopped buying, or found substitutes like the beet sugar that replaced cane sugar in much of Europe. At the same time, those forced to plant and harvest the crops were rising against their colonial masters. Market economics was coming into play, and the Americans, with a large population and buying power not found anywhere else, could determine the fate of the

spice trade by their economic, rather than their political or naval power. Spices no longer were costly luxuries upon which empires could be built; and within a few decades even their transportation ceased to be a risky adventure of several months on the high seas.

New factors have also come into play. The trend away from exotic spices that occurred after the French Revolution has reappeared today among health food enthusiasts who promote the use of native culinary herbs. However, one suspects that for most ordinary people, this has always been the case. One has only to look at the prize dishes of Europeans, whether a saffron-flavored paella in Spain, roast beef with horseradish and mustard in England, chicken with thyme and marjoram in France, or salmon with dill in Sweden. And now that many of the producers of the exotic spices have migrated to the west, one need only go to an ethnic restaurant to find an Indian curry, an Indonesian ricetafel, or a Mexican salsa. Finally, as refrigeration and food technology have advanced, culinary spices are no longer in great demand for food preservation; and modern medicine has reduced their role as medicinal herbs. Their value now lies mostly in their taste and aroma, and most of us can at least afford to put a pepper shaker on the table.

Selected References

Lopez and Raymond (1955); Magalhaes-Godinho (1969); Parry (1969); Divine (1973); Purseglove et al. (1981); Spice Trade Asssociation (1985); Toussaint-Samat (1992).

Importance of plant families as sources of the 85 genera of culinary herbs discussed in detail in this book

Family	Number of genera discussed in detail in this book	Percentage of genera discussed in detail in this book
Labiatae	21	24.7
Umbelliferae	14	16.5
Compositae	9	10.6
Cruciferae	7	8.2
Rosaceae	3	3.5
Polygonaceae	3	3.5
Boraginaceae	2	2.4
Leguminosae	2	2.4
Verbenaceae	2	2.4
Families with one genus providing herbs	22	25.9

The Families of Culinary Herbs

The following table gives an analysis of the 85 genera of herbs treated in detail in this book. The great majority of plants used as culinary herbs in north temperate regions belong to four families (Labiatae, Umbelliferae, Compositae, Cruciferae), which provide 51 of the 85 genera (60%).examined in detail in this book. As many as 300 families of flowering plants are recognized, so that it is clear that some families have characteristics that preadapt them for use as culinary herbs.

Species in the mint family (Labiatae or Lamiaceae) have square stems, opposite, simple leaves (i.e., not divided into leaflets), and two-lipped flowers (with two or four stamens) placed in the axils (crotches) of the leaves, sometimes singly, but usually several together, forming rings or whorls. After fertilisation, mainly by bees, four small fruits or nutlets (often termed "seeds") are produced. The leaves are generally sprinkled with tiny glands that contain a volatile oil, which is responsible for the fragrance and piquancy of the plant.

Species in the carrot family (Umbelliferae or Apiaceae) have small, generally white or pink, sometimes yellow flowers in flat-topped clusters called umbels. In an umbel the stalks of a group of flowers arise from one point, like the ribs of an umbrella, and umbels may themselves be grouped in the same fashion into a compound umbel. The stems are cylindrical, usually hollow, and the leaves are generally alternately placed on the stem, and are often compound (i.e., divided into leaflets which themselves may be subdivided, like the foliage of many ferns, into very

fine segments). The base of each leaf stalk broadens out into a sheath which clasps the stem. The fruits are made up of two seedlike, dry portions called mericarps (literally "half-fruits") each with a single seed. These mericarps are usually called seeds, and usually separate on ripening. Each of these mericarps has five longitudinal prominent ribs, and several smaller ribs. Between the ribs are numerous oil ducts. Although aromatic oil is also found in other parts of the plants, the concentration in the "seeds" is generally very high, and this is why seeds are so often the edible part of umbelliferous culinary herbs.

Species in the sunflower family (Compositae or Asteraceae) usually have tiny flowers clustered into daisy-like flower heads that most people refer to as individual flowers. The fruits are small, dry and hard, often with plumes of hairs to aid in wind dispersal, as in the dandelion.

The mustard family (Cruciferae or Brassicaceae) has flowers with four petals forming a square cross, and six stamens of which four are long and two are short.

The above analysis of culinary herbs is biased towards representation in north temperate areas. An analysis of tropical culinary herbs would reveal that other families are also important. For example, the tropical ginger family (Zingiberaceae) has several spice plants, including ginger (*Zingiber officinale*, treated in this book), turmeric (*Curcuma domestica* Val.), cardamom (*Elettaria cardamomum* Maton) and spices belonging to the genera *Aframomum, Amomum, Kaempferia, Languas* (*Alpinia*), and *Phaeomeria* (*Nicolaia*).

Use of Plant Parts as Culinary Herbs

A few herbs discussed in this book are culinarily useful only for an extracted product (sweet sap from sugar maple, sweet chemicals from stevia). Most herbs are eaten directly, usually to flavor other foods. Plant organs used include roots, stems, leaves, flowers, fruits, and seeds.

Commonly, more than one plant organ of some species is eaten. These include Alexanders (roots, stems, leaves, and seeds are all consumed), angelica (roots, stems, leaves, and seeds), comfrey (roots, leaves, stems and flowers; the plant is now known to have poisonous properties), lovage (roots, stems, leaves), mitsuba (roots, leaves and seeds), the nasturtiums (leaves, flowers, seeds, and fruits), perilla (leaves, flowers and seeds), sweet cicely (stems, leaves and unripe seeds), and vap ca (roots, leaves and fruits).

Most plants, however, are primarily useful for food purposes for just one plant organ. In the following two sections, the use of flowers and seedlings are given special attention. The remaining parts of a plant used as culinary herbs are discussed below.

Underground parts. Roots and rhizomes (which are stems) of biennial and perennial plants are often food storage organs, that allow the plants to overwinter and grow again in the spring. Many root vegetables are of this nature. A few of the herbs discussed in this book have underground parts that are sometimes eaten like vegetables, although these species are primarily useful for above-ground parts; these include: angelica, caraway, chervil, chicory, comfrey (not recommended), hop, and lovage. Turnip-rooted forms of celery and parsley and the roots of some forms of brown mustard are of considerable economic significance as vegetables (Munro and Small 1997).

Storage organs used as culinary herbs are different: they are usually not eaten alone (their taste is too concentrated), and they are usually characterized by uniquely-tasting chemicals. Ginger, ginseng, horseradish, and licorice are good examples. This may be the result of the plants evolving the chemicals to dissuade herbivores from eating them (that humans are attracted to these very chemicals is an accident; virtually all plant species evolved before there were humans). Other roots that have proved very useful as culinary herbs because of the presence of flavorful chemicals are those of chicory and dandelion, both used as coffee substitutes.

Leaves (mostly leaf blades); generally twigs as well. The majority of culinary herbs are useful because of their foliage. Leaves of the following culinary herbs are usually or at least often eaten directly (as in salads): ambrosia, anise hyssop, the basils, bergamot, chervil, chives, cilantro, country borage, the cresses, dandelion, dill, fennel, garlic chives, great burner, Korean mint, leaf celery, lemon balm, lemon bergamot, lovage, Mexican marigold mint, Mexican oregano, Mexican tea, marjoram, the true oreganoes (species of *Origanum*), parsley, rau om, rau ram, rosemary, rue (not recommended), sage, salad burnet, the various species known as savory, scurvy grass, the sorrels, sweet cicely, tarragon, the thymes, yap ca, Vietnamese balm, and wild bergamot.

Rather than being eaten directly, the leaves of many other culinary herbs are used in the home primarily as flavoring for beverages, or for flavoring purposes in cooking. These include: agrimony, bay laurel, betony, the calamints, catnip, citronella grass, costmary, horehound, hyssop, the fragrant-leaved geraniums, lemon grass, lemon verbena, the mints, mountain mint, myrtle, and woodruff.

Leaf stalks. Rhubarb and mitsuba are eaten particularly for their leafstalks. The leaf stalks of Alexanders are also commonly eaten. The leaf stalks of celery-leaved forms of parsley are the part of the plant primarily consumed.

Sterns. Angelica is perhaps the best known of the herbs whose stems are eaten. The stems of Alexanders are also often eaten.

Bulbs. Garlic and many other species of *Allium* have most of their edible tissues in a condensed stem axis consisting of both stem and leaf tissues. Lemon grass is similar.

Fruits. As pointed out above, aromatic oil is concentrated in the "seeds" (half-fruits, really) of the many culinary herbs of the carrot family (Umbelliferae) discussed in this book, and this is why they are so often the edible part of umbelliferae culinary herbs. Important umbelliferous "seeds" include anise, caraway, celery, coriander, cumin, dill and fennel. Hop is another kind of dry fruit used as a herb. The chile peppers and juniper provide fleshy fruits that are used as herbs.

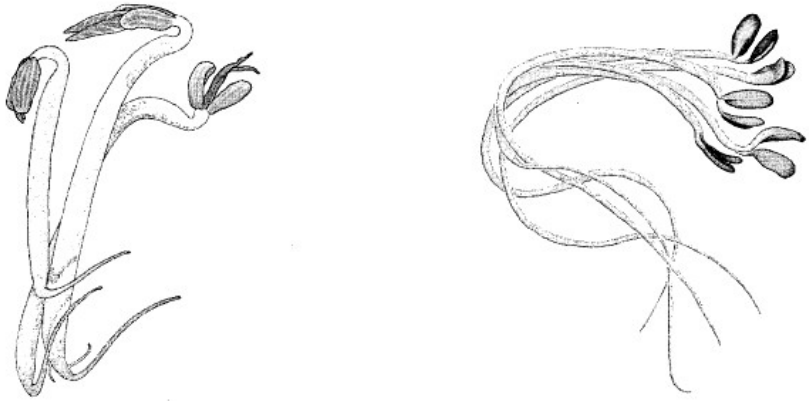
Seeds. The mustards (brown and white) are grown mainly for their seeds, from which mustard is manufactured. The seeds of black cumin, fenugreek, and opium poppy are also used for flavoring foods.

Aerial bulbils. This rather unique category is represented by Egyptian onion and some of the other species of *Allium* mentioned in this book.

Edible Sprouts

Warnings

(1) Some leguminous seed sprouts (notably broad beans) contain toxins that may be harmful if large amounts are consumed raw. (2) Seeds sold for garden sowing are often chemically treated with toxic chemicals to avoid diseases, and seed sprouts produced from them should not be eaten. (3) Never attempt to eat seeds or sprouted seeds of unknown identity; many seeds are deadly poisonous.



Figs. 11 and 12.
Edible sprouts of mung bean (Fig. 11, left) and alfalfa (Fig. 12, right). Prepared by M. Jomphe.

Sprouting seeds for food use, once considered more appropriate for livestock than for humans, is an ancient practice that is increasing in popularity. Seeds are highly nutritious because they contain stored food for the young plants into which they will develop. (However, to deter herbivores, many seeds also contain toxic chemicals.) Recently germinated seeds are often even more nutritious from the point of view of humans because the stored chemicals are often transformed into more edible and palatable substances. Sprouts are a valuable food because of their generally high content of vitamins, minerals, carbohydrates, and proteins. Most sprouted seeds traditionally consumed can be eaten raw. For legumes with toxic constituents, cooking greatly lessens toxicity, and it is preferable to serve these boiled, steamed, stir-fried or added to soups.

Alfalfa sprouts are very popular. Nevertheless, some have contended that the content of various anti-nutritional factors is sufficiently high that the consumption of both alfalfa sprouts and alfalfa tea should be limited (Brody 1987; Rinzler 1990; Tyler 1993). Canavanine in the seeds has been alleged to be associated with lupus (lupus erythematosus, a disease characterized by skin lesions, arthritis, wasting, fever, and other symptoms), causing recurrence in people in which the disease had become dormant (Foster and Duke 1990). Certain saponins in alfalfa sprouts have also been alleged to have detrimental effects (Small et al. 1990). On the other hand, these same alfalfa saponins reduce levels of blood serum cholesterol in animals, and this may be desirable for people, since elevated cholesterol levels clog arteries and can lead to heart attacks (Small et al. 1990).

Species commonly employed to provide edible seed sprouts

(* = species treated in this book; ** = species treated in Munro and Small (1997); (L) = legume)

Common name	Latin name	Main culinary use
Alfalfa** (L)	*Medicago sativa* L.	Livestock fodder
Adzuki bean** (L)	*Vigna angularis* (Willd.)	
	Ohwi & Ohashi	Vegetable
Barley	*Hordeum vulgare* L.	Cereal
Broad bean** (L)	*Vicia faba* L.	Vegetable
Brussels sprouts**	*Brassica oleracea* L.	
	var. *gemmifera* DC.	Vegetable
Buckwheat	*Fagopyrum esculentum* Moench	Grain (false cereal)
Cabbage**	*Brassica oleracea* L. var. *capitata* L.	Vegetable
Cabbage, Chinese**	*Brassica oleracea* L.	
	subsp. *pekinensis*	
	(Lour.) Hanelt	Vegetable
Cauliflower**	*Brassica oleacea* L.	
	var. *botrytis* L.	Vegetable
Cress, garden**	*Lepidium sativum* L.	Vegetable
Fenugreek* (L)	*Trigonella foenum-graecum* L.	Grown for edible seeds
Garbanzo bean (chick pea) (L)	*Cicer arietinum* L.	Grown for edible seeds
Kale**	*Brassica oleracea* L.	
	var. *viridis* L.	Vegetable
Leek**	*Allium ampeloprasum* L.	Vegetable
Lentil** (L)	*Lens culinaris* Medic.	Vegetable
Lima bean** (L)	*Phaseolus lunatus* L.	Vegetable
Mung bean** (L)	*Vigna radiata* (L.) R. Wilcz.	Vegetable
Mustard, spinach**	*Brassica perviridis* (Bailey) Bailey	Vegetable
Mustard, Oriental**	*Brassica* species	Vegetables
Mustard, yellow*	*Sinapis alba* L.	Culinary herb
Onion**	*Allium cepa* L.	Vegetable
Pea** (L)	*Pisum sativum* L.	Vegetable
Perilla*	*Perilla frutescens* (L.) Britton	Culinary herb
Radish**	*Raphanus sativus* L.	Vegetable
Rape, salad**	*Brassica nigra* (L.) Koch.	Vegetable
Rice	*Oryza sativa* L.	Cereal
Rye	*Secale cereale* L.	Cereal
Soybean** (L)	*Glycine max* (L.) Merrill	Oilseed
Triticale	x*Triticosecale*	
	(hybrids of wheat species and rye)	Cereal
Water pepper*	*Polygonum hydropiper* L.	Culinary herb
Wheat	*Triticum aestivum* L.	Cereal

Three families of plants provide most of the species used for edible sprouts. The pea family (Leguminosae) furnishes adzuki beans, alfalfa, broad bean, fenugreek, garbanzo beans, lentil, mung beans (used by the Chinese for as long as 5000 years), peas, and soja (soya) beans. The mustard family (Cruciferae) supplies a variety of cabbage and mustard species (of the genera *Brassica* and *Sinapis*), radish, and the cresses. Cress and mustard combinations have long been considered especially desirable. Finally, some cereals of the grass family (Gramineae) make good sprouts, including barley, rice, rye, triticale, and wheat. Malted barley, used for brewing various alcoholic beverages, starts off as germinating barley seeds. Although made from young wheat (*Triticum aestivum* L.) plants that have become green by being grown in the light until about 10 cm high, rather than from wheat sprouts that have been protected from light, so-called "wheat grass" beverages may also be mentioned. These have recently become popular

in health food bars. [Botanists call certain wild relatives of wheat, such as found in the genus *Agropyron*, wheat grass. The name has been taken up by health food enthusiasts for the grass-like shoots of young wheat plants.]

Sprouted seeds are generally grown in the dark, as the blanched seedlings produced are crisper and better-tasting. Considerable research has been carried out for the species that are marketed commercially, with respect to type of container, temperature, and other conditions that are best. Information and references concerning commercial production of sprouts of mung bean, alfalfa and other species are provided in Munro and Small (1997). From the consumer's viewpoint, the simplest method of obtaining sprouts is to buy them in a supermarket. Seeds suitable for home sprouting can also often be purchased from stores. Anyone can produce sprouts simply by soaking viable dried seeds. Kits designed for sprouting seeds can be purchased, or a large, wide-mouthed jar covered with a fine mesh covering, such as muslin or cheesecloth, can be used. An elastic can be used to hold the cloth onto the jar. The porous covering allows air to circulate among the seeds. Seeds should first be rinsed at least twice with water, and placed in the jar, leaving enough room for the seeds to expand ten times in volume. The seeds and seedlings should be kept moist, but simply soaking the seeds can be detrimental (although some recommend initially soaking the seeds overnight). A good way of keeping the seeds and seedling moist without drowning them is to rinse them with water two or three times a day, draining the water away through the porous covering of the jar. The jar should be kept in the dark, but in an area with some air circulation. If mould develops at any time, discard the sprouts. Temperatures are usually best between 12 and 25°C. Sprouting is slower at the cooler temperatures but for many species tastier sprouts are produced. Blanchard (1975) provides extensive information for preparing and consuming seed sprouts. For a longer list of species that have been used for seed sprouts than given below, see Facciola (1990).

Shepard (1979) provides the following advice for preparing mung bean sprouts, the most popular of the sprouts (the same technique can be used for soybeans and lentils). Soak beans overnight in warm water, drain, and place in jar set on its side in a warm dark place. Rinse soybeans four or five times a day (others once or twice). Rinse completely or beans will ferment. In 2 or 3 days the jar should fill with sprouts, which may be stored in a refrigerator for up to a week.

Selected References

Blanchard (1975); Larkcom (1984); Huxley et al. (1992).

Fig. 13.
Edible flowers add elegance to a meal. Prepared by B. Brookes.

Edible Flowers

Warning

The flowers of many species are poisonous. Sometimes an edible species has related species with poisonous flowers (note Creekmore 1966, Creasy 1990, and the examples below). Unless absolutely certain of identification, flowers should not be eaten. Common names can be misleading, and if relied on could lead to consumption of poisonous material. Avoid plants that have been sprayed with pesticides and fertilizers. Avoid plants growing on roadsides where they could be affected by pollution, and in situations where they could have been exposed to herbicides. Ornamental plants bought in stores have likely been treated with chemicals; it is best not to eat flowers from florists, nurseries, or garden centers. Those suffering from hayfever may react to the pollen present in flowers, or indeed to other constituents. Consumption of edible flowers should be limited, and a little experimental nibbling to test one's reactions is advisable, particularly if suffering from hay fever, asthma or allergies. Of course, such tests should be with the flowers of one species at a time, in small quantities over a long period of time. The safest way to obtain edible flowers is to buy packaged containers of flowers clearly marked as edible flowers in a supermarket. However, since supplies are limited and the restaurant trade uses most of the available harvest, home-grown plants are usually the only option. These should of course be grown as "organically" as possible, without the use of pesticides, or the use of surface-coating fertilizers in the garden that could be retained by the flowers. The safest way to obtain seeds to be grown into plants harvested for their edible flowers is to buy them through firms and seed catalogues offering seeds for the purpose.

Eating flowers has often been viewed with suspicion, since most people do not consider flowers edible. By law in British Columbia, flowers that are put on a plate with food

must be edible (Barash 1993). The extended warning above will probably frighten away many potential users, which is probably desirable since the hazards of eating unknown or misidentified flowers can not be ignored. Actually, flowers have long been used as food - for example broccoli (although not usually understood to represent floral tissue), daylily flowers in Chinese recipes, squash blossoms in Italian cooking, and rose petals in sweet dishes in Victorian England. However, in this century it was not until the 1980's that flowers attracted much attention as objects of culinary art. The elegance, sophistication, fun, and (as explained later) the commercial potential offered by edible flowers are reasons for increased attention to them. Food, beauty, sex, love, a feast for the eyes and nose - all are exemplified by flowers. Combine this allure with taste and the enchantment of flowers doubles.

In this book; several species discussed are principally of culinary interest for their flowers (or floral parts): borage, French marigold, pot marigold, English lavender, German chamomile, Roman chamomile, roselle, saffron, and violet. Hops are also frequently called edible flowers, although technically the flavorful parts of a hop cone are mostly derived from non-floral tissue. The flowers of several other species are commonly eaten, as well as other parts of the plant: chicory, dandelion, geraniums, nasturtiums, and roses. The flowers of some vegetables also provide excellent culinary fare, particularly those of okra, pumpkins and squashes, and some chrysanthemums.

Not all of the flowers listed below are outstandingly pleasant in taste. Culinary flowers, after all, owe much of their appeal to emotion, and may simply serve as an attractive garnish, or to add color to a tossed salad. Sugar-coated flowers allow designer chefs the opportunity of creating fashionable and memorable meals, without particular concern about how the flowers taste. It is preferable to eat only the petals of daisy-like flowers and large flowers, as other parts of the flower are usually bitter.

Generally, flowers should be collected in the morning, after dew has evaporated. Young flowers from vigorous plants, before they have produced many fruits, are usually best. For fresh consumption, the flowers should be kept moist at refrigerator temperatures until used. Although flowers can be kept refrigerated for a few days, they should be used as soon as possible. Usually flowers should be added at the end of food preparation to preserve their appearance. When added to a salad, the salad should be tossed and dressed first. Petals readily absorb salad oil, and this is minimized by added the flowers or petals last. A plate of flowers can be served with the dressing in a separate container, so that their beautiful appearance will be maintained until the last moment.

The following list of species with edible flowers has been compiled from the selected references listed below. Elder [some elderberries are poisonous and Barash (1993) recommends not even eating elder flowers or berries of edible species unless cooked or processed], grape hyacinth, gladiolus, and some other species are sometimes listed in edible-flower guides, but are not included here because of probability that similar-looking but poisonous species will be collected. As several of the following species are rarely used as sources of edible flowers, information on their safety is limited. Often, some cultivars of a species are palatable and others are not; for some of the herbs discussed in this book, information on cultivars with palatable flowers is given. Crowhurst (1973) provides a more extensive list than the following, including a number of wild species, trees and ornamental shrubs (and coltsfoot and wormwood, for which information is presented in this book that the plants are poisonous). Facciola (1990) presents a very extensive list of flowers of the world, both wild and cultivated, that have been used as food. As he includes the poisonous *Tanacetum vulgare* L., Facciola's list should not be taken as an endorsement to consume the flowers mentioned. Belsinger (1991) provides a list of 50 edible flower species that she considers to be both safe to eat and tasty. All are included below, except species of elder, gladiolus, and grape hyacinth (for the reason given above); *Tagetes tenuifolia* and pineapple sage (discussed in this book); and red clover, lemon, orange, and yucca.

Edible flowers commonly encountered in gardens and around homes

(* = species treated in this book; ** = species treated in Munro and Small (1997); C = culinary herb, E = source of commercial extracts, O = ornamental, V = vegetable, W = weed in North America).

Common name	Latin name	Notes
Alexanders*	*Smyrnium olusatrum* L.	C
Agrimony*	*Agrimonia eupatoria* L.	C, W
Anchusa	*Anchusa azurea* Mill.	O, W
Anise hyssop*	*Agastache foeniculum* (Pursh) Kuntze	C
Apple	*Malus* species	O
Balm, lemon*	*Melissa officinalis* L.	C, E, O, W
Basil*	*Ocimum basilicum* L.	C, E
Begonia	*Begonia tuberhybrida* Voss	
Bergamot*	*Monarda didyma* L.	C, E, O, W
Betony*	*Stachys officinalis* (L.) Trevisan	C
Borage*	*Borago officinalis* L.	C, E, O, W
Bugloss	*Anchusa officinalis* L.	C, O, W
Burner, salad*	*Sanguisorba minor* Scop.	C, W
Carnation (pinks)	*Dianthus caryophyllus* L.,	O
	D. plumarius L.	O, W
Catnip*	*Nepeta cataria* L.	C, E, W
Chamomile, German*	*Matricaria recutita* L.	C, E, O, W
Chamomile, Roman*	*Chamaemelum nobile* (L.) All.	C, E, O, W
Chervil*	*Anthriscus cerefolium* (L.) Hoffm.	C, E, W
Chicory*	*Cichorium intybus* L.	C, E, V
Chives*	*Allium schoenoprasum* L.	C, W
Chives, garlic*	*Allium tuberosum* Rottl. ex Spreng.	C
Chop suey green**	*Chrysanthemum coronarium* L.	O, V
Chrysanthemum	*Chrysanthemum* species	O
Cicely, sweet*	*Myrrhis odorata* (L.) Scop.	C, E
Clary*	*Salvia sclarea* L.	C, E, O
Coriander*	*Coriandrum sativum* L.	C, E
Cornflower	*Centaurea cyanus* L.	O, W
Costmary*, [1]	*Tanacetum balsamita* L.	C, O, W
Cottage pink	*Dianthus plumarius* L.	O, W
Cowslip	*Primula veris* L.	O, W
Daisy, English	*Bellis perennis* L.	O, W
Dandelion*	*Taraxacum* Weber	V, W
Dill*	*Anethum graveolens* L.	C, E, W
Fennel*	*Foeniculum vulgare* Mill.	C, E, W
Garlic*	*Allium sativum* L.	C, E
Geranium, fragrant*	*Pelargonium* fragrant-leaved species	C, E, O
Hibiscus	*Hibiscus rosa-sinensis* L.	O
Hollyhock	*Alcea rosea* L.	O
Honeysuckle	*Lonicera* species	
Hyssop*	*Hyssopus officinalis* L.	C, E, W
Lavender*	*Lavandula* species	O, E
Lilac	*Syringa vulgaris* L.	O, E
Lily, day[2]	*Hemerocallis* species	O
Lovage*	*Levisticum officinale* Koch	C, E, W
Mallow	*Malva* species	O, W(some)
Mallow, marsh	*Althaea officinalis* L.	E, O, W

(Table continued on next page)

Edible flowers commonly encountered in gardens and around homes (continued)

Common name	Latin name	Notes
Marigold, French*	*Tagetes patula* L.	C, O
Marigold, Mexican mint*	*Tagetes lucida* Cav.	C, W
Marigold, pot*	*Calendula officinalis* L.	C, O
Marjoram, wild or common*	*Origanum vulgate* L. subsp. *vulgate*	C, E, W
Mint*	*Mentha* species	C, O, W
Mustard, brown*	*Brassicajuncea* (L.) Czern.	C, V, W
Mustard, yellow*	*Sinapis alba* L.	C, V, W
Nasturtium*	*Tropaeolum majus* L.	C, O
Nasturtium, dwarf	*T. minus* L.	C, O
Okra**	*Abelmoschus esculentus* L.	V
Pansy	*Viola wittrockiana* Gams.	O
Pea**, [3] [See warning!]	*Pisum sativum* L.	V
Perilla*	*Perilla frutescens* (L.) Britton	C, E, O, W
Plum	*Prunus domestica* L.	
Poppies*	*Papaver* species	
Primrose, English	*Primula vulgaris* Huds.	O
Pumpkins and squashes**	*Cucurbita argyrosperma* Huber,	V
	C. maxima Duch.,	V
	C. moschata Duch. ex Poir.,	V
	C. pepo L.	V
Rocket**	*Eruca vesicaria* (L.) Cav.	V, W
Rose*	*Rosa* species	C, E, O
Rosemary*	*Rosmarinus officinalis* L.	C, E, O
Saffron*	*Crocus sativus* L.	C, E
Sage*	*Salvia officinalis* L.	C, E
Sage, clary*	*Salvia sclarea* L.	C, E, O
Salsify**	*Tragopogon porrifolius* L.	V, W
Salsify, black**	*Scorzonera hispanica* L.	V
Savory, summer*	*Satureja hortensis* L.	C, E, W
Savory, winter*	*Satureja montana* L.	C, E
Scarlet runner bean**	*Phaseolus coccineus* L.	O, V
Sorrel, French*	*Rumex scutatus* L.	C
Sorrel, garden*	*Rumex acetosa* L.	C, W
Stock	*Matthiola* species	O
Sunflower	*Helianthus annuus* L.	O, V, W
Sweet William	*Dianthus barbatus* L.	O, W
Thyme*	*Thymus* species	C, E
Tulip	*Tulipa* species	
Violet, sweet*	*Viola odorata* L.	C, E, O, W
Woodruff, sweet*	*Galium odoratum* (L.) Scop.	C

[1] Flowers of another species of *Tanacetum*, tansy (*T. vulgare*), are poisonous (Creasy 1990; also see *Tanacetum* genus notes).

[2] Some "lilies," such as lily of the valley (*Convallaria majalis* L.) can be poisonous, and correct identification is essential. Tiger lily (*Lilium lancifolium* Thunb.) is sometimes recommended as an edible flower. However, Creekmore (1966) stated that "the pollen from tiger lilies - lilies are notorious for the great amount of pollen they produce and scatter from their anthers at any disturbance - has poisoned some people, causing drowsiness, purging and vomiting."

[3] Do not confuse pea with sweet pea (*Lathyrus odoratus* L.), which is poisonous (Creasy 1988).

Selected References

Crowhurst (1973); Smith (1973); Weinberg (1978); Clifton (1984); Larkcom (1984); Hutson (1987); Leggatt (1987); Bremness (1988); Creasy (1988, 1990); Facciola (1990); Handwerker (1990); Richardson (1990); Belsinger (1991); Pailler (1993); Barash (1993).

Preservation of Culinary Herb Germplasm

Crop varieties today are the result of selection for desirable characteristics, such as high yield, disease resistance, and tolerance to climatic conditions. For several reasons it is necessary to continue to select new varieties. The most important reason is that, by natural selection, diseases and pests continue to find ways of overcoming the resistance bred into crops. As well, there is market competition between those who produce different crops, and even among those who raise the same species. New ways of cultivating, harvesting, marketing, and using crops may mean that a variety that was suitable in the past is no longer satisfactory. Sometimes poisonous chemicals, or particularly useful chemicals come to light, and in this case it is desirable to select out better chemical races.

Of all of the factors that bear on the breeding of new and better crops, the most important is genetic resources. "Germplasm" is the word now commonly used to denote the genetic variation available. In the case of plants, germplasm resources primarily includes seeds representing plants from various regions, both wild and cultivated, but also living, growing collections of species that must be propagated vegetatively, and sometimes also very specialized collections such as preserved pollen grains and tissue cultures. The term gene bank refers to the special collections, largely of cultivated plants, that various countries maintain. Increasingly it is being realized that wild relatives of crops maintained in nature are critical for the future, but because of habitat destruction considerable important germplasm seems destined to survive only in gene banks.

An analysis of the contents of gene banks reveals that membership is rather exclusive (Small 1995). Most plants aren't admitted unless they have demonstrable economic value, and the number of collections of given species is heavily related to how important they are in agriculture, forestry, and to a lesser extent in industry and medicine. Culinary herbs are dwarfed in numbers of collections by comparison with the cereals, for which the world has amassed hundreds of thousands of seed collections in seed banks.

The largest and most important gene bank in the world is the United States Department of Agriculture National Plant Germplasm System. This maintains perhaps 400 000 collections of seeds of agronomic and horticultural crops at sites throughout the U.S. These samples are used by plant breeders, horticulturists, pathologists, taxonomists, entomologists, and other researchers in many nations to improve crops. The herb and spice resources have been analysed by Widrlechner (1989). Most of the collections are represented by fewer than 10 accessions. By far the largest collection is of the chile peppers (*Capsicum*), with over 2000 collections. The next largest collections are the mints (*Mentha* species), celery, opium poppy, parsley, and fenugreek, all with more than 100 collections.

Canada's central germplasm bank (at Saskatoon) is known as the Plant Gene Resources of Canada. This is a part of the federal agriculture department, Agriculture and Agri-Food Canada. As of 1997 there were over 100 000 collections of seeds. However, a total of only 206 collections, representing only 18 species, belong to the culinary herbs discussed in detail in this book. The only large collections are of brown mustard (with 81) and white mustard (with 43).

In addition to germplasm banks, the collections of individuals growing herbs as a small business or hobby may represent the largest reservoir of plant diversity in North America (Craker 1989). Herbal gardens are also important for the preservation of germplasm. The National Herb Arboretum in Washington, D.C. has a particularly extensive collection.

Selected References

Widrlechner (1989).

Herbs, Chemistry, and Nutrition

The flavors and medicinal qualities of culinary herbs are due to chemicals in the plants. As well, chemical extracts from herbs, culinary and otherwise, often have industrial uses, such as in making perfumes, paints and lubricants. Plants synthesize many chemical compounds called primary metabolites that are critical to their existence. These include proteins, fats, and carbohydrates that serve a variety of purposes indispensable for sustenance and reproduction, not only for the plants themselves, but also for animals that feed on the plants. Plants also synthesize a dazzling array of additional components, called secondary metabolites, whose function has been debated [See Deans and Waterman (1993) for a review of various hypotheses]. Some secondary metabolites may be like waste products, not useful to the plant. Some may be like vestigial organs such as our appendix, that may have served a purpose in ancestral organisms, but no longer do. Some secondary compounds act as attractants to insects that pollinate the flowers. Many secondary metabolites are "antibiotic" in a broad sense, protecting the plants against fungi, bacteria, animals, and even other plants. Every plant species contains chemicals that can affect some animals negatively, strongly supporting the interpretation that secondary metabolites play a vital role in combatting diseases and herbivores. "Plants have been a rich source of medicines because they produce a host of bioactive molecules, most of which probably evolved as chemical defenses against predation or infection" (Cox and Balick 1994). Many animals too have evolved chemical defences, but on the whole the plant kingdom far surpasses the animal kingdom in this respect. This is the reason why so many plants have medicinal uses, and so few animals do. The diversity of secondary metabolites of plants also explains why so many plants compared to animals are useful as flavoring ingredients (despite the existence of perhaps 100 animal species for every plant species).

By studying the chemistry of plants it is sometimes possible to devise syntheses for natural products. For example, an artificial vanilla mixture, comprising several chemical compounds, can now be used as a substitute for vanilla extract from the beans of *Vanilla planifolia* Andr. Because vanilla is perhaps the world's third most expensive spice (after saffron and cardamon), synthetic vanilla flavoring has captured much of the market - as much as 90% in the U.S. (Norman 1990). Chemists have not yet learned, however, how to reproduce the unique flavor of most plants, which is generally not due to a single chemical, but to a subtle mixture. The thousands of kinds of

Fig. 14.
Vanilla plant *(Vanilla planifolia Andr.)*, from Halter (1988). The beans of this tropical orchid furnish the vanilla of commerce.

wine that are available testify to just how variable plant-based food products can be in aroma and flavor. Moreover, the taste of culinary plants is not necessarily determined by the chemicals in plants in a simple way. Chemical compounds lacking flavor often modify the detection of flavor in other compounds by our taste buds, and interactions of taste factors in plants may be quite extensive. Also, compounds occurring naturally in plants, such as antioxidants that inhibit the oxidation of substances sensitive to destruction upon exposure to air, are important to preservation of taste and aroma.

Essential Oils

Most of the flavor and aroma ingredients of culinary herbs are found in essential oil. This term is derived from "quintessence," implying that the oil contains the essential characteristic aroma and flavor of the herb. About 2 000 of the 250 000 species of flowering plants are known to contain essential oil, many of these in the plant families Labiatae, Rutaceae, Lauraceae, Myrtaceae, Umbelliferae, Compositae, and some Coniferae (Launert 1981). These families provide most of the culinary herbs discussed in this book. Essential oils are complex mixtures of volatile constituents, and so are often called volatile oils. They are colorless when fresh. They usually constitute mixtures of hydrocarbons or oxygenated derivatives of hydrocarbons, and include such chemically important groups as terpenes or sesquiterpenes, alcohols, esters, aldehydes, ketones, phenols, ethers and peroxides.

Volatile oils are usually responsible for the unique aromas of individual herb species. The distinctiveness results from the specific, complex mixture of chemical compounds, and from the differences in the volatility and quantity of the compounds. The compounds that vaporize most rapidly often dominate the aroma of a herb.

Volatile oils are also often responsible for the medicinal properties of herbs. Volatile oils may be bacteriostatic (inhibiting the growth of bacteria), anti-inflammatory (counteracting inflammation), antispasmodic (preventing or relieving spasms or convulsions), sedative (reducing excitement and irritability), carminative (expelling gas from the alimentary canal so as to relieve colic or griping), appetizing (appealing to the appetite), rubefacient (producing redness of the skin by external application), and expectorant (promoting discharge of mucus from the respiratory tract) (Launert 1981).

Plants synthesize chemicals in their cells, and essential oils may be found in all plant organs, including the root, stem, bark, leaves, flowers, fruits, and seeds. Often, essential oils are manufactured in particular tissues or organs of plants, or are concentrated into "lysigenous passages" by breakdown of cell walls in certain tissues. Moreover, families of plants often have characteristic places where they synthesize much of their essential oil. In the mint family, most species synthesize essential oil in glandular hairs. In the carrot family most species concentrate their oil in oil tubes, especially in the seeds.

Both plant material with volatile oil and extracted volatile oil are used as flavoring agents, and in pharmaceuticals, perfumes, cosmetics, and other products. Over $200 million worth of essential oil is imported annually into the U.S. (Additional information on the commercial value of essential oil is given below in the chapter on the culinary herb economy of North America). Volatile oils are usually obtained commercially by distillation, that is, heating and recooling mixtures to separate the components through differences in volatility. Steam distillation is used for fresh plant material (steam is passed through the harvested plants, picks up the oil, and the volatile oil is subsequently condensed and collected). Water distillation is usually employed with dried plants (the material is placed in heated water until the volatile components vaporize, a mixture of oil and water is condensed to a liquid, the oil floats and is separated). Volatile oils that decompose with heat are usually collected by mechanical expression. Volatile oils used by the perfume industry are frequently extracted with solvents, avoiding high temperatures that may alter the chemical constituents. Indeed, artifacts are sometimes present as a result of the distillation process, so that the distilled essential oil may be somewhat different from the natural volatile oil of the plant. Even in the living plant, components of essential oils may be the result of hydrolysis (breakdown) of other chemicals.

Pungent Principles, Bitter Principles

While essential oil usually contains most or all of the chemicals responsible for aroma, some non-volatile flavor contributors, such as "pungent principles" and "bitter principles," are also important. For example, gingerols in ginger and capsaicinoids in chile pepper are usually not present in the volatile oils from these plants. Pungent and bitter principles are very varied chemicals, not really defined by their chemical structure and properties, but by their effects on people. Such chemicals have the ability to stimulate the production of digestive juices, and may also affect secretion in the gall bladder and peristalsis (the involuntary waves of muscular contraction in the intestine that force contents forward). These chemicals are important as appetizers and in promoting digestion and metabolic functions.

Pungent principles are present in prepared oleoresins. The term oleoresin is sometimes used to designate natural viscous plant exudates, but prepared oleoresins are the solid or semi-solid residues obtained by solvent extraction of plant material, followed by evaporation of the solvent. Oleoresins may contain both the volatile oil and the pungent principles of herbs. Food processors often prefer oleoresins to raw herbal material because the extracts may offer advantages from the points of view of consistency of quality, freedom from micro-organisms, uniform dispersion in products to which they are added, and easy handling and storage.

Other Classes of Chemicals Important in Herbs

Chemistry is one of the aspects for which information is given for each of the herbs discussed in detail in this book. The presentation of chemistry is limited to the most pertinent details related to economic importance, taste, odor, and safety, while giving key references where more information can be obtained. In addition to essential oils discussed above, numerous other classes of chemical compounds are mentioned in this book (some of these are present in essential oils). Some of the more important classes of chemicals are as follows (for additional information, see Purseglove et al. 1981, Robinson 1988, Craker 1990).

The **terpenoids** include numerous compounds differing in physical and chemical properties. These are constructed of groups of five carbon atoms, called isoprene units, which can be linked together. Those with multiples of two (i.e., 10 carbon atoms) are quite volatile and are

often responsible for the dominant aroma of herbs. For example, the aroma of mints is largely due to terpenoids with ten carbon atoms. Terpenoids with multiples of three units (i.e., with 15 carbon atoms) are less volatile, but often modify the dominant aroma of plants; this is the case, for example, in sage, basil, and oregano. Some larger, nonvolatile terpenoids contribute to taste, some very sweet, others very bitter.

To the chemist, **aromatic compounds** are those related structurally to benzene, which is made up of a ring of six carbon atoms. Such compounds may or may not be aromatic in the usual sense of having a distinctive odor. Some aromatic (in the chemical sense) compounds are odorless, and many constituents of plants that are aromatic in the popular sense are not aromatic in the chemical sense. Smaller aromatic compounds are volatile and odoriferous, and are often responsible for some or all of the aroma of herbs, for example apiole of parsley. Larger, non-volatile aromatic molecules are often antioxidants, inhibiting the destruction of substances upon exposure to air.

Tannins are a group of aromatic compounds in the chemical sense. Tannins are generally widespread among plants, although some families, such as the Cruciferae and Papaveraceae, lack them (Starý and Jirásek 1973). The word tannin derives from the use of constituents of the bark of oak and hemlock trees, and other species, to tan leather. Tannins are responsible for the sensation of astringency of certain foods, such as tea. The puckering of the mouth resulting from tannins is different from the sensation produced by plant acids. Tannins are defensive compounds that counteract bacteria and fungi by complexing with their proteins (McGee 1984). They have been used since prehistory to tan animal hides into tough leather by complexing with the proteins on the surface of the leather. The sensation of astringency is the result of the "tanning" of proteins on the mucous membranes of the mouth, and in the saliva, resulting in reduction of lubrication and a contraction of the surface tissues (McGee 1984). The safety of regularly consuming condensed catechin-based tannins, the main components of fresh Chinese tea leaves, has been questioned; however, it is believed that drinking tea with milk renders the tannin inactive through the binding action of milk proteins (Morton 1979; Kapadia et al. 1983). Moreover, while "many of the polyphenols [tannins are polyphenols] are considered anti-nutrients because they reduce the amount of proteins that are digestible by animals," "the phenols from tea have recently been found to have many healthful biological functions such as being anti-carcinogenic, anti-microbial, and possibly effective against AIDS" (Li et al. 1994). Because of their astringent properties, many of the tannin-containing herbs described in this book have been used medicinally to treat minor burns and wounds, hemorrhoids, and diarrhea. According to Launert (1981), the antibiotic effect of tannins is due to their precipitating protein, thereby depriving bacteria of nutrition.

Figs. 15 and 16.
Chinese tea *(Camellia sinensis (L.) Kuntze)*, flowering plant (Fig. 15, left) and tea plantation (Fig. 16, right), from Harter (1988). Common tea is the most significant source of tannins in the diet of most people.

Acids result in a sour taste. Principal organic acids include malic acid, citric acid, oxalic acid and tartaric acid. Several of the herbs treated are notably acidic, including garden sorrel, French sorrel, and roselle. The pH of the sap of some plants, such as the sorrel species (of the genus *Rumex*) can be as low as 2. Oxalic acid, mostly responsible for the acidity of the sorrels, is the only organic acid of plants toxic to livestock under natural conditions, the toxicity due not to the acidity *per se* but to the reactions of the oxalate ion (Kingsbury 1964). The above-mentioned organic acids may have a mildly laxative effect (Starý and Jirásek 1973).

Steroids are closely related to the terpenoids, and are produced by both plants and animals (terpenoids are Synthesized mostly in plants). Cholesterol is the best known steroid. The most interesting steroids are those produced in animals by the adrenal and sex glands, particularly the sex hormones. Fenugreek, discussed in detail in this book, is an example of a plant commercially useful for providing the precursors of sex hormones, and having sufficient of these to arouse concern about overdosing by consuming too much. The foxglove plant (*Digitalis purpurea* L.), has high concentrations of steroids, used in the drug digitalis for the treatment of heart dysfunctions. As noted below, cases of mistaking this plant for an edible herb have led to fatalities. Indeed, some steroids are responsible for the strong toxicity of some poisonous plants.

Alkaloids (literally "alkali-like") are plant-produced compounds that contain nitrogen, but aside from this are rather difficult to define. This hasn't prevented chemists from recognizing several thousand different alkaloids. The name comes from the behavior in usually forming salts with acids, like inorganic alkalies, which are true "bases." Alkaloids generally have a ringlike configuration, with single or multiple rings, and contain nitrogen. Alkaloids may be present in 5-10% (Kingsbury 1964) or up to 20% (Blackwell 1990) of plant species. Generally alkaloids are bitter, and often they are very toxic (e.g., strychnine), and so plants with noticeable concentrations of akaloids are usually not among our culinary herbs. The alkaloid piperine is responsible for the burning taste of black pepper. The alkaloid caffeine is widely distributed in plants, but usually in low concentrations (prepared coffee with 1-2% caffeine and Chinese (common) tea with 1-4% are exceptions). Most herbal teas have little or no caffeine. Comfrey contains pyrrolizidine alkaloids, which are carcinogenic, and so in the discussion of this herb it is strongly recommended that it not be consumed. Some alkaloids are valuable medicines. Quinine is a well-known antimalarial alkaloid. The alkaloids of the opium poppy, which is dealt with in some detail in this book, are among the most valuable of pain relievers.

Food Value of Herbs

Culinary herbs are plants used in small quantities to produce large changes in flavor. Almost by definition, therefore, culinary herbs have limited or no food value. Indeed, recommendations are provided for many of the herbs that they be used sparingly, precluding their providing significant nutrients. Nevertheless, a few herbs, such as chile pepper, garlic and coriander, are used in large amounts in some cultures or by some individuals, and could contribute significant nutrients. Murphy et al. (1978) stated that the nutrient content of spices and herbs is sometimes significant. Some herbs are known as outstanding sources of vitamin C, and roses and scurvy grass (to a much lesser extent horseradish), discussed in this book, have been very important historically in preventing scurvy. For many herbs, information on culinary value is limited. Nevertheless, for all herbs discussed in this book, notable content of vitamins and minerals, occasionally also of protein or other dietary constituents, is pointed out. Generally information is not furnished on protein, carbohydrates, and fats as too little is supplied in culinary herbs at normal consumption levels to be of much importance.

In the following table, the major vitamins important to man are identified (after Lust 1974, Lewis and Elvin-Lewis 1977, and Brody 1987). Vitamin A is not found in plants, but is manufactured in animals (including humans) from · pigments (carotene) that are common in plants. Vitamins K and most B vitamins may be synthesized by intestinal bacteria; vitamin D is formed by the action of ultraviolet on the skin. Niacin from plant foods is transformed to niacinamide for use (animal foods contain niacinamide).

Major vitamins important to man.

Vitamin	Common sources	Importance
A_1 (retinol) A_2 (dehydroretinol)	Butter, eggs, carotene ("provitamin A") and cryptoxanthin in plants; fish oils	Essential for night vision, good bones & teeth, growth, proper digestion, production of red & white corpuscles, & for lactation
B_1 (thiamine = thiamin)	Yeast, meat, whole grains, eggs, milk green vegetables	Essential to production of energy through carbohydrate breakdown; necessary for nerve function; prevents beriberi
B_2 (riboflavin)	Yeast, liver, kidney, cheese, eggs, ham, milk, beef, spinach	Essential for cell growth; for enzymatic reactions for metabolizing proteins, fats & carbohydrates; helps maintains healthy skin, eyes, mucous membranes
B_3 (niacin, nicotinamide, nicotinic acid)	Yeast, beef, lamb, salmon, peanuts, whole grains, soybean, spinach	An essential component of some enzymes producing energy and tissue respiration; prevents pellagra
B_6 (pyridoxine, pyridoxol, pyridoxamine)	Liver, yeast	Associated with enzymes in various metabolic pathways, particularly for brain & nervous system functions
B_{12} (cobolamin)	Liver, kidney, milk products	Participates in nucleic acid synthesis; deficiency produces anemia, neurological disorders
Biotin	Widely in food, in kidney, yeast	Involved in several metabolic processes, including synthesis of fatty acids (never observed to be lacking in humans)
C (ascorbic acid)	Citrus fruits, berries, greens, cabbages, peppers	Needed for normal cell functioning, for formation of healthy collagen, bones, teeth, cartilage, skin, capillary walls; promotes effective use of other nutrients
D (calciferol)	Eggs, fortified milk, liver oils	Absorption and use of calcium and phosphorus; necessary for healthy bones, teeth
E(-tocopherol)	In many foods, including green vegetables, vegetable oils	Protects red blood cells, vitamin A, and unsaturated fatty acids from oxidative destruction; maintains healthy membranes, fertility
Folic acid (folate, folic acid)	Liver, kidney, yeast	Nucleoprotein synthesis; necessary in mitosis; deficiencies produce anemia, digestive problems, fetal abnormalities
K (menadione)	Widely in food, including green vegetables, tomatoes, orange peel	Participates in synthesis of prothrombin in liver for normal blood clotting; maintains bone metabolism
Pantothenic acid	Widely in food, liver, kidney, yeast, wheat, bran, peas	Necessary for cellular metabolism (never observed to be lacking in humans)

Except for table salt, which supplies chlorine and sodium, minerals are acquired through food. Because of over-consumption of salt, sodium is rarely deficient in human diets today. Murphy et al. (1978) found that sodium levels in some of the herbs discussed in this book, including celery seed, cumin, coriander leaf (cilantro), dill weed, and especially parsley flakes, were very high, so much so that their use might be unwise in therapeutic diets in which sodium is highly restricted. The following table lists minerals for which information is provided for at least some of the herbs treated in this book (after Lust 1974, McGee 1984), but is not a complete list of minerals needed by the human body.

Minerals commonly of nutritional concern in man for which information is provided for some of the herbs treated in this book.

Mineral	Common sources	Importance
Calcium	Plants, dairy products, seafoods	Necessary for healthy bones, teeth, for clotting of blood, functioning of nerve tissue and muscles, for enzymatic processes; controls movement of fluids through cell walls
Iodine	Iodized salt, seafood, vegetables or animals raised near seacoast (inadequate soil levels decrease amounts in plants & animals)	A component of thyroid hormone; deficiency leads to goiter; in pregnancy, deficiency can cause mental retardation, muscular and skeletal malfunctions in child
Iron	Both in plant and animal tissue	Essential to form oxygen-carrying hemoglobin in red blood cells; involved in muscle functioning and enzyme reactions for energy production
Magnesium	Occurs in both plant and animal tissue	Essential enzyme activator, probably involved in formation and maintenance of body protein
Phosphorus	Occurs widely in plant and animal tissue	Involved in production of energy for body, a constituent of bones & teeth, necessary for functions of brain, nerves, muscles, enzyme formation
Potassium	Abundant in plant and animal tissue	Promotes certain enzyme reactions, acts with sodium to maintain normal pH levels and balance between fluids inside and outside cells
Sodium	Common in plant and animal tissues	Regulates volume of body fluids; in balance with potassium, maintains balance between fluids inside and outside cells; necessary for nerve and muscle functioning
Zinc	Animal foods	Component of enzymes involved in energy production and digestion of protein; required for normal function of several metal-protein complexes

Herbs, Medicine, and Safety

The story is told of Jivaka, the student of the great Punarvasu Atreya, founder of India's first medical school about 1200 B.C. (Castleman 1991). To acquire what was essentially his doctor's certificate, Jivaka was assigned the task of searching the countryside and collecting all the medically useless plants. When he returned empty-handed, explaining in exasperation that he was unable to find a single plant without healing power, Atreya replied in satisfaction that his student now had the knowledge to be a physician. To those who are knowledgeable about the enormous range of chemicals in plants, it does not seem at all unreasonable that in a sense every plant does have medicinal value. A list of over 20 000 medicinal plants has been published (see details in Deans and Svoboda 1990). The question of chief concern for those interested in using herbs for culinary purposes is not whether or not there is something good present (almost surely there is); it is whether there is something significantly bad.

Plants have been used in treating human diseases for thousands of years. Many plant-derived medicines continue to be used today; others are being investigated for their pharmacological potential. The unusual chemistry of pharmacologically useful plants is associated with unusual abilities to alter human metabolism. All substances that are medicinal can also be poisonous, and so the questions of safety and medicinal use are closely related.

Before leaving this section, it is interesting to note that there is a well-established association of medicine with herbs that has nothing to do with the medicinal value inherent in herbs. Herbs with volatile oils, such as anise, clove, fennel and mint, have traditionally been used as flavorings in medicine to mask the underlying odor and/or taste of medicinal ingredients, and hence make preparations acceptable for consumption (Deans and Svoboda 1990). The expression "a little sugar makes the medicine go down" is reflective of this, since sugar cane, the main source of sugar, is a culinary herb.

Natural Plant Toxins in Food

Given current concerns over the presence of agricultural toxins in food plants, it is startling to learn that "we are ingesting in our diet at least 10 000 times more by weight of natural pesticides than of man-made pesticide residues" (Ames et al. 1987). Natural "toxic chemicals" that plants manufacture to protect themselves against microorganisms, insects and animal predators make up about 5-10% of the dry weight of plants that we consume (Ames et al. 1987). There are poisonous compounds in our major food plants and food products, for example carotatoxin in carrot (note following paragraph), goitrogens (that block iodine absorption) in cabbage, oxalic acid (which can cause kidney problems) in spinach, solanine (a poison) in potatoes, a cyanogenic glycoside (that yields cyanide) in lima beans, hydrazine compounds (some of which cause tumors in mice) in the common mushroom of commerce, dicarbonyl aldehyde methylglyoxal (a potent mutagen produced by fermentation) in prepared coffee, and diacetyl (a mutagen) in wine.

While many of the thousands of chemicals in plants can be poisonous, their concentrations are for the most part too low to be of concern. Generally one would have to consume prodigious amounts of a given plant species to suffer ill effects. A famous example was provided by Basil Brown, an English health food enthusiast who in 10 days in 1974 drank about 45 L (10 imperial gallons) of carrot juice, thereby consuming about 10 000 times the recommended requirement of vitamin A. At the end of the 10 days his skin was bright yellow, and he was dead of severe liver damage (McGee 1984).

There may be reason for particular concern, however, about the chemistry of culinary herbs. While vegetables, grains, and fruits are important chiefly because they supply energy (calories), minerals and vitamins to the diet of humans, culinary herbs are primarily attractive because of their aroma and taste, in other words their chemistry. In fact "culinary herbs may be defined as plants whose green parts, ripe seeds, or tender roots have an aromatic flavor and fragrance due to a volatile oil, or to some other chemical substance peculiar to the individual species" (Grieve 1933). The high concentrations of certain chemicals, to say nothing of all of the other compounds present, is the reason for concern about safety. All herbs that have useful medicinal properties are not edible; however, all culinary herbs have pronounced medicinal properties. It is not just an amazing coincidence that all culinary herbs (in contrast to most vegetables and fruits, for example) have long been used in medicine.

"So what?," one may ask, since in consuming vegetables, grains, fruits, nuts, and other plant products we are equally exposing ourselves to thousands of chemicals. However, for the most part the plants that we eat in large quantities have undergone hundreds if not thousands of years of intensive selection of non-toxic forms. By contrast, culinary herbs are generally not much different from their wild progenitors, and many are simply wild plants that have been brought into our gardens. True, one eats

much smaller amounts of culinary herbs, but chemicals or their effects can be cumulative in the body and long-term consumption, in theory at least, could be harmful.

Herbal Medicine vs. Western Medicine

In modem western society relatively few physicians practice what has been termed "herbal medicine," by which is meant the use of raw herbs and relatively unrefined extracts in order to cure diseases. The 20th (1980) edition of the *United States Pharmacopoeia* lists over 2000 drug products, of which only about 200 (5%) are derived in part or entirely from higher plants, and indeed only from a total of about 20 different plant species (Youngken 1983). Duke (1993) estimated that only about 10% of the leading legal drags today contain phytochemicals still extracted directly from higher plants. However, some qualified physicians do use herbs to a great extent in their practice; many para-medical practitioners advocate the use of herbs to promote or maintain health (in the knowledge that recommending herbs to cure medical conditions might constitute the unlicensed practise of medicine); and an astonishing array of raw herbal preparations, extracts, and mixtures are marketed by health food stores, ethnic market outlets, and mail-order firms. Sherry and Koontz (1979) suggested that there are about 12 000 licensed homeopaths and naturopaths routinely using herbal medicines in the U.S. (Homeopaths treat diseases especially by administering minute doses of remedies that in healthy persons produce symptoms of the disease treated; naturopaths treat diseases especially by using natural medicinal substances and physical means.) If this weren't enough to suggest that there is merit to herbal medicine, one only has to recall that perhaps 90% of the world's population, in third-world countries, relies completely on raw herbs and unrefined extracts as medicines (Duke 1985). Commercial herbal medicinal preparations, on a world-wide basis, have been estimated to be worth about $8.4 billion (U.S.) (Foster 1995). It has been estimated that about 13 000 species of plants have been used for at least a century as traditional medicines by various cultures around the world (Tyler 1993*b*). In the western world, increasing distrust of chemical preservatives and taste enhancers in foods, and of chemical residues in food that result from the use of herbicides, pesticides, and fertilizers, have stimulated a desire for "natural" or "organic" foods, all of which make the use of herbs to promote health seem desirable. And, the use of herbal beverages has seemed a healthful way of avoiding high-calorie preparations like chocolate and high-caffeine tea and coffee. Is the majority wrong?

First, it is misleading to contrast herbal medicines and other medicines. True, synthetic chemicals have increasingly entered the marketplace, but often these "new" drags are inspired by study of the chemistry and pharmacology of natural plant drags. In any event, numerous medicines in use today are extracted from plants. Perhaps 50-60% of pharmaceutical drags are either of natural origin or obtained through use of natural products as starting points in their synthesis (Verlet 1990; Balandrin et al. 1993). The commercial value of biologically active compounds from plant sources has been estimated to be over $20 billion (U.S.) annually worldwide (Deans and Svoboda 1990). Higher plants have given rise to about 120 commercialdrags and account for about 25% of all prescriptions issued in North America (Cox and Balick 1994). Extracts from many of the herbs discussed in this book are used in modem medicine.

Second, contrasting medical practices in third-world countries and the west is like comparing apples and oranges. Herbal medicine as presently practised in third world countries is affordable and available to most people, and one should not underestimate the curative potential of medicines that people believe in. The world's most popular and extensively used drug is ginseng (crude preparations from roots of species of *Panax*), and it is clear that ginseng contains potent pharmacological constituents, and that consumers of ginseng derive psychological comfort from using the drug. (It is less evident that metabolism is altered for the good, as explained in the discussion of the ginseng species in this book.) It perhaps needs to be said that the western bias of most people in the West probably prevents them from appreciating the different philosophy upon which third-world herbal medicine is based. Traditional, non-Western medicine is followed not just in China but in Japan, Korea, Indochina, Singapore, India and other parts of Asia - essentially a third of the world's population. More than a thousand species of plants have been used in Chinese medicine (Widrlechner and Foster 1991). In defending traditional Chinese medicine, Young (1983) wrote:

> The medicinal agents used for healing are primarily natural products rather than synthetic chemicals. These natural products are derived not only from herbaceous and arboreous plants, but also from animal and mineral sources. The Chinese physician tailors the treatment to fit the individual patient's condition as well as the nature of the disease. The prescriptions usually contain many medicinal substances to produce synergistic action, or to neutralize negative interactions, or to mask the bitter taste of the crude

(meaning unprocessed or natural) drugs. Chinese medicine uses complex mixtures of drugs for a slower, but more complete, healing process. Traditional Chinese medicine employs drugs of low toxicity. The drugs do not produce a quick symptomatic effect, but rather work to increase the natural resistance and recuperative powers of the patient. This is the fundamental difference between Chinese medicine and the symptom-attacking single drug approach used in Western medicine.

In the hands of experts, as is commonly the case in some third-world countries, many herbal preparations undoubtedly are useful medicines. However, a great advantage of western medicine in its use of highly refined pharmaceuticals is the precision with which dosage can be regulated and effects can be predicted and monitored. Xiao (1989) noted that in 1985 China adopted a principle decreeing that traditional Chinese medicine and Western medicine would have equality in the health system of the nation, so that traditional herbal physicians are accepting the best of Western medicine. By the same token, undoubtedly western medicine has a great deal to learn from third-word herbal physicians, but until it is clear which preparations are effective, and are at least equal in effectiveness to western pharmaceuticals, this writer prefers to put his faith in modern western medicine.

In parts of Europe, especially in Germany, herbal medicine is much more popular than is the case in North America. "Phytomedicines" have been defined as therapeutic agents derived from plants or parts of plants, or preparations made from them, but not isolated chemically pure substances, such as menthol from peppermint (Foster 1995). Examples of widely used products include garlic, ginseng and chamomile. Some 67 000 different herbal products are available in Germany (Foster 1995). In Canada, and especially in the U.S., the regulatory climate is much less receptive to phytomedicines (Tyler 1993*b*). Foster (1995) predicted that with appropriate research and regulation, "herbal medicine will regain its rightful status as an important and integral aspect of classical medicine."

The Danger of Personal use of Herbs as Medicine

As noted above, societies everywhere depended heavily on herbal medicines, and much of the world continues to use herbs medicinally. Much of this use has been as "folk medicine," the herbs used medicinally without the advice of doctors. In North America and elsewhere, there has been a growing popular movement toward the return of using herbs medicinally without the guidance of doctors. Numerous "health food" stores and popular self-help books are fuelling this movement. Even "herbal drinks," flavored with such herbs as tarragon and ginseng and suggestive of health benefits, have been introduced in the market as competitors to mineral water and soft drinks (Perkin 1993).

The problems of self-medication are manifold. First is the question of medical competence: maintaining health and curing diseases of the human body are so obviously important that one wants the help of the best medical professionals, guided by thorough scientific knowledge. Second, what works for the majority may not work for you, as humans vary greatly in their responses to plant constituents, and what may be harmless or even beneficial to most will harm others. Third is the question of dosage. Natural (unrefined) plant materials and crude plant extracts and mixtures can vary widely in the concentration of active principles, and may be rather unpredictable in terms of interactions of the principles.

Although information is provided in this book on many historical medicinal uses of herbs, most of these are now considered unsuitable, and some are even considered dangerous. Where potential pharmacological values of plants is mentioned, it should be understood that these require further research. It is often the case for uncommon, less-domesticated food plants, that their consumption should be limited because harmful constituents may be present. Moreover, just as prescription medicines can have different effects on individuals, so can some plants, and what is safe for some individuals may be toxic for others. Accordingly, **the reader should rely on qualified medical advice** *before* using the information provided here for medical or pharmacological applications. In this book folk medical uses of culinary herbs are pointed out, while repeatedly urging the reader not to attempt self-medication. By contrast, most popular books on herbs that are currently marketed in bookstores either simply recommend various herbs for their medicinal qualifies, or give a rather unenthusiastic warning of the medical hazards (perhaps at the urging of publishers fearing lawsuits), all the while emphasizing the health-giving aspects of the herbs in question. As pointed out by Tyler (1984), much of popular herbal literature can only be classified as "advocacy literature," with almost every herb "good" for almost everything.

The use of herbal teas requires particular comment, since the distinction between medicinal and culinary use is often imperceptible. Herbal teas have become particularly popular since the back-to-the-earth and natural food movements gained impetus in the 1960's, and even more so with the desire to avoid caffeine and high-calorie

beverages. Over 100 species have been used to brew tea or tea-like beverages, and the safety of many of these is open to question (Morton 1975*a*). Comfrey (*Symphytum officinale*, discussed in this book), lobelia (*Lobella* species) and sassafras (*Sassafras albidum* (Nutt.) Nees) are examples of plants that were (sometimes still are) used for teas but are extremely hazardous to health (Snider 1991). Several decades ago sassafras oil was also a common constituent of root beers, until it was learned that it causes cancer in rats. While no sensible person would use these plants as beverages today, it simply isn't clear what other species have unrevealed dangers. Large herbal tea manufacturers are extremely conservative and are unlikely to risk placing dangerous plants in their herbal teas, but natural food stores that blend their own teas can be problematical since the safety of the majority of plants that have been marketed as teas simply has not been ascertained adequately (Snider 1991). By far, the greatest risk is associated with those who, for want of a better phrase, might be termed "herbal enthusiasts," who typically grow their own herbs, and self-medicate with teas.

Mechanical Injury

In addition to the toxicity of chemicals detailed below, another source of injuries is mechanical. The best (or worst) example is bay leaves, often used to flavor dishes, but if not removed before serving may cause injuries to the mouth and alimentary canal because of the sharp leaf edges. Some herbs (like borage) have irritating hairs, especially if mature rather than young leaves are consumed, and sometimes, as in the case of rose hips, it is best to filter out plant debris before using the material in food.

Classes of Injurious Chemicals in Herbs

Tyler (1984) and Blackwell (1990) summarize the classes of chemicals that have proven dangerous in medicinal, and indeed many culinary herbs. Examples of problems that can arise, based mostly on plants treated in this book, include:

Toxins. This is a heterogenous class of poisonous chemicals that alter metabolism in different ways. As long as consumption is limited, problems usually do not develop. Saffron is reported to contain a poison of the central nervous system and kidneys that can prove fatal, but nevertheless is considered safe in recommended rates in recipes. Pulegone in pennyroyal (and in the essential oil of many culinary herbs) is toxic to the liver and lungs. Thujone in wormwood (mentioned in this book as a medicinal, not a culinary herb) is highly neurotoxic. Canavanine is a toxic, non-protein amino acid, present in the seeds of many leguminous plants, such as alfalfa. It protects seedlings against insects, and even against competing weeds (Miersch et al. 1994), but as noted earlier in the discussion of edible sprouts, its presence in alfalfa sprouts is undesirable.

Carcinogens. These are cancer-causing agents, such as the pyrrolizidine alkaloids, in comfrey (which as will be noted, should not be consumed as a culinary herb), and in borage, although in much lower concentrations in the latter. Furocoumarins in angelica have been shown to be carcinogenic in laboratory animals. Estragole in tarragon and basil, allyl isothiocyanate in brown mustard, and psoralens in celery are also carcinogens, but occur in sufficiently limited concentrations (in the plants) that they are not of concern (essential oils extracted from the plants may have dangerous levels of carcinogens). Ames et al. (1987) make the following points about cancer: (1) at least 70% of human cancer could in principle be prevented if the main risk and antirisk factors could be identified; (2) only a few dozen of the thousands of potentially toxic natural plant chemicals that are regularly consumed (albeit generally in small amounts) have been adequately tested for their carcinogenic potential; (3) interest in carcinogenic natural products has been limited until recently, and likely many more natural plant chemicals will be found to be carcinogens; if tested; (4) it is important to keep relative risk in mind, as even tap water (and well water) have been shown to have a measurable (but very small) risk of producing cancer.

Photosensitizers. Some plant species may cause susceptible individuals to develop a rash in the presence of sunlight, referred to as *photophytodermatitis*. Remarkably, an animal or human protected from sunburn by ordinary glass (which filters out untraviolet light) will still be photosensitized, and develop the rash. Why should this occur only in sunlight? The substance capable of reacting to sunlight is usually a plant. pigment, obtained by consuming the plant, and such pigments are by their nature photoreceptive. (In hepatogenic photosensitivity, the light-receptive substances may be break-down products of the liver.) The phenomenon of photosensitization has been known at least since the first century A.D., but the causative agents were not understood until the present century, when they were identified as psoralens or linear furanocoumarins, which are activated most strongly by near-ultraviolet radiation (Zobel and Brown 1991). Photosensitizing plants are often in the Umbelliferae (notably angelica) and Rutaceae (notably rue), but as will be pointed out throughout the text, species in other families of plants may also cause the condition. Celery is a special case of clinical interest, as the plant is stimulated by infection with fungal

pathogens to produce the sensitizing chemicals, which are absent from the uninfected plant. Celery with "pink rot" has caused outbreaks of photophytodermatitis among commercial celery handlers (Zobel and Brown 1991).

Allergens. For virtually every plant there are individuals who will develop allergenic reactions from external or internal use. People who are susceptible to hayfever caused by pollen may well also have allergenic reactions to the flowering tops of herbs, such as Roman or German chamomile, which contain pollen.

Hormone-like effects. Too much licorice produces pseudo-aldosteronism, characterized by sodium and water retention, potassium depletion, hypertension, and even heart failure. Concern has been expressed that sufficient estrogen is present in fenugreek that overconsumption could result in toxicity.

Abortifacients. Rue, which should not be consumed, is a culinary herb that has been used historically as an abortifacient. *Lippia dulcis* is another example of a herb discussed in this book that has been used as an abortifacient. Parsley seeds and juniper berries, and more particularly the oil obtained from them, should also be avoided by expectant mothers. Stevia has been used to control fertility, but as a contraceptive rather than an abortifacient.

Irritants. White and brown mustard, discussed in this book, contain mustard-oil glycosides, called glucosinolates. The glucosinolates release mustard oils (thiocyanates or isothiocyanates) during digestion. Sulfur-containing mustard oils contribute to the taste of the mustards and horseradish, but can be severe irritants of the lining of the digestive tract if consumed in large quantities. Chile peppers contain the irritant capsaicin, discussed in some detail in this book.

Cathartics. Many of the culinary herbs treated in this book have laxative properties, but this will generally not be a problem as very limited amounts are normally consumed. Excessive consumption of herbal teas can lead to habituation and development of the so-called laxative habit.

Teratogens. These are compounds, commonly alkaloids, typically from the lily and tomato families, that produce birth defects. Nicotine in tobacco is a teratogen. So are green potato sprouts. Caffeine in the culinary herbs coffee and tea is definitely a teratogen, and women who are or may become pregnant are urged to avoid or limit consumption of foods and drags containing caffeine (Tyler 1993).

Mutagens. Furocoumarins in angelica have been shown to be mutagenic, i.e., a compound that induces genetic changes. The acridones in rue may also be mutagenic. Allyl isothiocyanate, a component of horseradish, has produced chromosomal changes in hamster cells. Many mutations are harmful, and mutagens are considered very dangerous.

Hallucinogens and narcotics. The opium poppy is the most well known example of a narcotic plant, although as discussed in this text the seeds, used as a culinary herb, are practically devoid of narcotic alkaloids. Seeds of several plants of the carrot family contain minute quantities of a hallucinogen. Fennel oil is a narcotic that can cause epileptiform madness and hallucination. The oils of dill, anise and parsley have similar properties, apparently due to a chemical transformation (amination) *in vivo* (in the living body, after ingestion) resulting in the production of hallucinogenic amphetamines.

The presence of such a witch's brew of hazardous chemicals in herbs, including culinary herbs, is frightening, perhaps even shocking, but should not deter the consumption of most of them, so long as they are eaten sparingly. The fact is that serious cases of poisoning from using herbs are rare, and for the most part have resulted from mistakenly consuming a highly poisonous plant, allergies, very high consumption of a particular herb, or use of a traditionally consumed herb such as comfrey that research may or may not have revealed is simply dangerous. The purpose in frankly laying out in this book the downside of consuming herbs has been to emphasize the dangers of using herbs as medicines, and to give commonsense guidelines for using herbs as food.

Recommendations are given below on medicinal use of herbs (extracted from National Council Against Health Fraud 1995), and on culinary use.

Recommendations of The [American] National Council Against Health Fraud (NCAHF) on Over-the-Counter Herbal Remedies (National Council Against Health Fraud 1995).

1) Do not assume that herbal remedies are safe simply because they are natural. Herbal remedies contain substances that can have powerful effects upon the mind and/or body. Use even greater cautions than when taking standard medications.

2) Be cautious about taking medicinal herbs if you are pregnant or attempting to become pregnant.

3) Be cautious about taking medicinal herbs if you are breast feeding a baby; herbal drugs in the body may be transferred to breast milk.

4) Do not give herbs to infants or children.

5) Do not take large quantities of any herbal preparation.

6) Do not take any medicinal herb on a prolonged daily basis.

7) Buy only preparations that identify plants on the label and state contraindications for use.

8) Become familiar with the names of potentially dangerous herbs and be cautious about their use.

9) If you are taking medications, do not use medicinal herbs without checking with your doctor.

10) Do not trust your health to unqualified practitioners who use unregulated titles such as "Herbalist," "Herb Doctor," "Master Herbalist," "Herbologist," "Natural Health Counselor," or the like.

11) Beware of exaggerated claims for the benefits of herbal remedies.

12) Insist that herbal marketers meet basic consumer protection standards of labeling, safety and efficacy.

Recommendations for Culinary Use

1) BE SUSPICIOUS OF THE SAFETY OF ALL CULINARY HERBS, even if obtained from a store, even if said to be safe in a book (including this one). The less well known a herb is, the more one should be careful.

2) NEVER CONSUME A CULINARY HERB UNLESS ABSOLUTELY CERTAIN OF ITS IDENTITY OR OF THE RELIABILITY OF ITS SOURCE.

3) IF YOU HAVE EXPERIENCED ALLERGIES FROM PLANTS, LEARN ABOUT WHAT RELATED PLANTS COULD CAUSE PROBLEMS.

4) TAKE ONLY A SMALL QUANTITY THE FIRST TIME YOU TRY A NEW HERB.

5) MODERATION: not too much at one time, not too much over time, and remember "variety is the spice of life."

6) KEEPUPTO DATE ON MEDICINAL KNOWLEDGE OF HERBS. The dangers of consuming some species have recently come to light, and almost certainly future research will lead to cautions regarding other species.

7) STORE HERBS SAFELY. Herbs or flowers that are cut and saved for a long period by keeping their stems in water may become contaminated if microbes grow in the water; storage in sealed plastic bags encourages condensation which may lead to fungal or bacterial growth.

8) BE ADVENTUROUS IN USING CULINARY HERBS. The above recommendations should not keep you from testing the many pleasant possibilities that herbs often Culinary herbs are generally healthful, nutritious, delicious, and an indispensable part of a sensible diet.

Selected References

Kingsbury (1964); Larkin (1983); Tyler (1984); Ames et al. (1987); Blackwell (1990); Snider (1991); Tyler (1993).

Climatic Zones Where Herbs can be Grown

This chapter presents a map of Canada and the U.S. based on minimum winter temperatures, showing the coldest climatic zone where the perennial herbs discussed in this book can be grown. Also presented is a table that estimates the most northward zone tolerated by the perennial herbs, and also shows the species that can be grown as annuals and so are not limited by winter temperatures. Plant hardiness and the limitations of plant hardiness maps are discussed below.

Plants, indeed all creatures have evolved adaptations that suit them to surviving in their natural habitats. Cultivated plants have been taken out of their natural habitats and, to add injury to this insult, have often been deprived of some of their natural resistance to environmental conditions as a result of man altering their genetic makeup by selective breeding. Different categories of stress limit whether or not a plant will survive in a given situation. *Biotic* stresses include competition from other plants (such as weeds), herbivores (especially insects), and pathogens (fungi, bacteria, and other harmful microorganisms). *Edaphic* stresses refers to factors of the soil, such as excessive or insufficient amounts of needed nutrients. *Climatic* stresses include temperature, humidity, wind, photoperiod (duration of light, especially important for induction of flowering), and light intensity. Water availability for most plants is determined by a combination of climatic and edaphic conditions, but for many cultivated plants irrigation is artificially provided. Any one, or a combination of factors, can limit whether or not a given species (or even a particular cultivar of a species) will grow well in a given geographical region. For cultivated plants, biotic and edaphic factors can be controlled. Climatic factors can be controlled by growing plants under glass, but this is too expensive most of the time, so that in practice climatic factors are most important in determining whether or not a plant can be grown in a give region.

Some climatic factors can be controlled for outdoor plants, at least to some extent. Many plants that are perennials can be grown as annuals, thus avoiding cold weather that the plants may not be able to survive. Plants that require a long, warm growing season may often be grown in short-season areas if started indoors well in advance of being transplanted outdoors. The microclimate (the climate in the immediate vicinity) of outdoor plants can be modified to some extent. Shade can be provided to plants that do not tolerate full sun. Protection from cold drying winds can result from shelter belts, hedges, or a cosy location. In the winter, above-ground parts of susceptible plants such as evergreens can be covered. Mulches of leaves or other materials can be used to cover some perennials that survive underground during the winter, lowering the possibility of frost injury from deep freezing of the ground. By growing plants near reflective stone walls open to the sun the temperature near the plants can be raised. Planting close to house foundations, where some heat is lost through the walls and produces warmer soil, can make the difference between success and failure with marginally hardy plants. Southern exposure is sometimes desirable to increase temperature. On the other hand, northern exposure may be useful to prevent deadly freeze-thaw cycles in the spring. Radiation frosts are a constant danger in "frost pockets," low-lying places that are situated where they receive cold-air drainage. Many cultivated plants can be "hardened off" by appropriate cultural treatment, and so will withstand colder temperatures than they would otherwise. Withholding fertilizer in the fall, to prevent the development of tender growth, is one technique. Some plants seem to become hardier as they mature.

While much can be done to help outdoor plants survive the cold season, minimum winter temperature can only be controlled to a limited extent, and is the most important determinant of whether or not a perennial species will survive in a given region. The concept of "hardiness zones" is based mostly on minimum winter temperatures. Hardiness zone maps are based exclusively or mostly on winter isotherms (lines on a map connecting places with the same mean temperature at a give time). The most widely used hardiness zone map for North America is that of the U.S. Department of Agriculture (Cathey 1990). This includes Alaska, Canada, Mexico, and Hawaii, and has 11 zones, each divided into A and B zones 5 Fahrenheit degrees wide. It is based exclusively on mean minimum winter temperatures. A simplified version, created for this book, is given here. (Because the zones have been redrawn for simplicity, local areas that deviate substantially (especially in mountainous areas) may not accurately reflect the original map.)To obtain an *estimate* of the coldest zone a given species can be grown, find the species by its scientific name, as listed in the alphabetical sequence in the table. In most cases, several estimates are presented of the coldest areas the herbs can tolerate, and these sometimes deviate significantly. These differing figures reflect the various experiences of the individuals who made the estimates. It may well be that genetic differences in cold tolerance among the cultivars grown substantially accounts for the differences in estimated cold tolerance.

The concept of a hardiness zone map has been criticized: "climatic zones are not hardiness zones: they are meteorological patterns" (Huxley et al. 1992). As explained above, hardiness is complex. A plant's survival in a given region depends not just on climatic variables, but on edaphic and biotic factors. A single factor such as minimum winter temperature is unlikely to be sufficient alone to predict hardiness limits.

A plant hardiness zone map for Canada was published in 1967, republished in a revised (but out-of-print) edition (Ouellet and Sherk 1973), and republished in Currie (1994). This was based about 80% on minimum winter temperatures, but also on length of frost-free period, rainfall, mean maximum winter temperatures, snow cover, and wind strength, with the zone lines adjusted by surveying the hardiness of 175 indicator plants (Currie 1994). The Canadian map provides finer resolution for climatic regions of Canada than does the U.S. map. However, little information is available for the Canadian climatic ratings of most of the species discussed in this book. The Canadian map is preferable for finding the climatic zones in Canada where species can be grown, provided the information is available. Information is available for many woody species and for some herbaceous species. Of those discussed in this book, Canadian climatic zone information is available as follows: Sherk and Buckley (1968; this contains a reprint of the map), for common juniper, dog rose, Turkestan rose, and rosemary; Cole (1979) for sugar maple; Buckley (1980) for sugar maple, dog rose, Turkestan rose, and common juniper; du Coffre (1992) for angelica, catnip, chives, garlic chives, great burnet, hyssop, lemon bergamot, sweet cicely, sweet violet, tarragon, and woodruff; Ashley and Ashley (1992) for chives, garlic, garlic chives, and horseradish; and Oliver (1993) for American ginseng.

The hardiness zone listings given in this book for the species are open to several sources of error. Zones merge gradually into one another, which leads to the absurd prediction that the south side of some gardens bisected by the map lines could grow some plants that could not be grown on the north side. The zone ratings represent someone's opinion of collected observations. (For most species, different listings, provided by different authorities, have been provided, indicative of the range of opinions that have been published.) There may be cultivars of some species that are much hardier than the cultivars on which observations were made. Local factors may alter the significance of minimum winter temperatures; most importantly, snow cover decreases the extent of frost penetration into the ground, and areas of consistent heavy snow may be "warmer" from a plant's viewpoint than indicated by the isotherms. Regions that experience mid-winter thaws, that melt snow cover, will be able to grow a smaller range of plants than places where the snow stays all winter. It is possible to grow a plant one zone north of its stated maximum northward limit simply by varying its microclimate (Currie 1994). The plant hardiness zone listings provided should be thought of as estimates, and should be treated as flexible guidelines. For most of the species examined in this book, there simply isn't a better general predictive system at present.

Selected References

Ouellet and Sherk (1973); Huxley et al. (1992); Currie (1994).

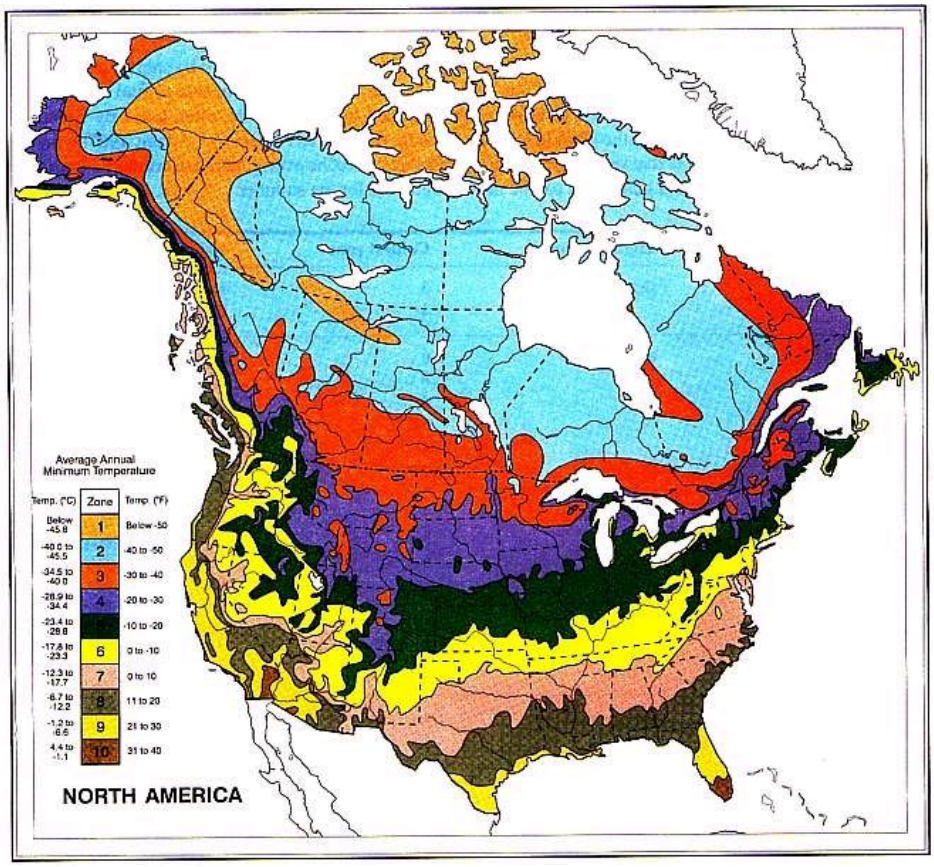


Fig. 17.
United States Department of Agriculture hardiness zone map
[modified from Cathey (1990) for this book, as noted in Acknowledgments].

United States Department of Agriculture climatic zones where perennial herbs can be grown

(A = annual (or can be grown as annual) in most regions; LA = long-season annual, limited by short season in much of northern North America; ! = questionable; "Small" in Reference column means I was unable to find a rating, and the rating given is my suggestion; "Cole" refers to information provided by Trevor Cole, often aided by Brenda Cole, usually based on successfully growing the plant in Ottawa, Canada. Adams 1987 refers to J. Adams 1987 in the bibliography, not R.P. Adams 1987. Note that several perennial species that cannot be overwintered in northern North America are discussed in this book as potted plants that can be moved outdoors for the summer.)

Latin name	English name	Coldest zone	Reference
Acer saccharum	sugar maple	3	Huxley et al. 1992
		4	Cathey 1990
Agastache foeniculum	anise hyssop	6	Henning 1994
		8	Huxley et al. 1992
		4	Adams 1987
		3	Crockett and Tanner 1977
		4	Cole
		A	Small
Agastache rugosa	Korean mint	7	Henning 1995
		8	Huxley et al. 1992
		6	Adams 1987
		A	Small
Agrimonia eupatoria	agrimony	3	Garland 1979
		3	Crockett and Tanner 1977
		A or 3	Small
Allium proliferum	Egyptian onion	5	Huxley et al. 1992
		3	Crockett and Tanner 1977
Allium sativum	garlic	8	Huxley et al. 1992
		3	Crockett and Tanner 1977
Allium schoenoprasum	chives	5	Huxley et al. 1992
		3	Adams 1987
		2-3	Garland 1979
		3	Crockett and Tanner 1977
		3	Perry 1974
Allium tuberosum	garlic chives	4	Barash 1993
		7	Huxley et al. 1992
		3	Adams 1987
Aloysia citriodora	lemon verbena	8	Huxley et al. 1992
		8	Adams 1987
		8	Garland 1979
		7	Crockett and Tanner 1977
		8	Perry 1974

(Table continued on next page)

United States Department of Agriculture climatic zones where perennial herbs can be grown (continued)

Latin name	English name	Coldest zone	Reference
Anethum graveolens	dill	A	
Angelica archangelica	angelica	4	Huxley et al. 1992
		2	Adams 1987
		4	Garland 1979
		3	Crockett and Tanner 1977
Anthriscus cerefolium	chervil	A	
Apium graveolens	leaf celery		
var. *secalinum*	(for herb)	A	
	(for seeds)	8?	Small
Armoracia rusticana	horseradish	5	Huxley et al. 1992
		4	Garland 1979
		3	Crockett and Tanner 1977
Artemisia dracunculus	tarragon	3	Huxley et al. 1992
	(Russian)	4	Adams 1987
	(French)	6	Adams 1987
	(French)	5	Garland 1979
		5	Crockett and Tanner 1977
		4	Cole
Barbarea verna	upland cress	A	
		6	Huxley et al. 1992
		3	Crockett and Tanner 1977
Borago officinalis	borage	A	
Brassica juncea	brown mustard	A	
Calamintha grandiflora	large-flowered calamint	5	Huxley et al. 1992
Calamintha nepeta	calamint	6	Huxley et al. 1992
		4	Adams 1987
Calendula officinalis	pot marigold	6 or A	Huxley et al. 1992
		6, 7	Perry 1974
Capsicum annuum	chile pepper	LA	
Capsicum chinense	Habañero pepper	LA	
Capsicum frutescens	tabasco pepper	LA	
		10	Garland 1979
Carum carvi	caraway	3	Huxley et al. 1992
		3	Adams 1987
		3	Garland 1979
		3	Crockett and Tanner 1977

(Table continued on next page)

United States Department of Agriculture climatic zones where perennial herbs can be grown (continued)

Latin name	English name	Coldest zone	Reference
Chamaemelum nobile	Roman chamomile	4	Creasy 1982
		4	Huxley et al. 1992
		6	Adams 1987
		3	Crockett and Tanner 1977
Chenopodium ambrosioides	Mexican tea	6? & A	Small
Chenopodium botrys	ambrosia	A	
Cichorium intybus	chicory	4	Duke 1992
		3	Huxley et al. 1992
		3	Garland 1979
		3	Crockett and Tanner 1977
Cochlearia officinalis	scurvy grass	1 or A	Small
Coriandrum sativum	coriander	A	
Crocus sativus	saffron	6	Huxley et al. 1992
		7	Adams 1987
		6	Creasy 1982
		6	Garland 1979
		5	Crockett and Tanner 1977
Cryptotaenia japonica	mitsuba	2	Adams 1987
		4 or A	Small
Cuminum cyminum	cumin	A or LA	
Cymbopogon citratus	lemon grass	9	Huxley et al. 1992
Cymbopogon nardus	citronella grass	9	Huxley et al. 1992
Elsholtzia ciliata	Vietnamese balm	A or LA	
Foeniculum vulgare	fennel	A or 5	Huxley et al. 1992
		3	Adams 1987
Galium odoratum	woodruff	5	Huxley et al. 1992
		3	Adams 1987
		4	Reppert 1985
		4	Garland 1979
		4	Crockett and Tanner 1977
Glycyrrhiza glabra	licorice	8	Huxley et al. 1992
		9	Garland 1979
Hibiscus sabdariffa	roselle	10	Barash 1993
		10	Huxley et al. 1992
		LA	Small

(Table continued on next page)

United States Department of Agriculture climatic zones where perennial herbs can be grown (continued)

Latin name	English name	Coldest zone	Reference
Houttuynia cordata	vap ca	5	Huxley et al. 1992
		5	Kuebel and Tucker 1988
Humulus lupulus	hop	5	Adams 1987
		4	Creasy 1982
		3	Garland 1979
Hyssopus officinalis	hyssop	3	Huxley et al. 1992
		2	Adams 1987
		2-3	Garland 1979
		3	Crockett and Tanner 1977
Juniperus communis	common juniper	2	Huxley et al. 1992
		3	Cathey 1990
		2	Garland 1979
Laurus nobilis	bay laurel	8	Huxley et al. 1992
		8	Adams 1987
		8	Creasy 1982
		7	Garland 1979
		8	Crockett and Tanner 1977
		7	Perry 1974
Lavandula angustifolia	English lavender	3-5	Knapke and Still 1996
		5	Huxley et al. 1992
		5	Crockett and Tanner 1977
Lepidium sativum	garden cress	A	
Levisticum officinale	lovage	4	Huxley et al. 1992
		1!	Adams 1987
		6	Garland 1979
		4	Cole
Lirnnophila aromatica	rau om	LA	Small
Lippia graveolens	Mexican oregano	9	Adams 1987
Marrubium vulgare	horehound	3	Huxley et al. 1992
		7!	Adams 1987
		3	Garland 1979
		3	Crockett and Tanner 1977
Matricaria recutita	German chamomile	A	
Melissa officinalis	lemon balm	4	Huxley et al. 1992
		2	Adams 1987
		4	Garland 1979
		4	Crockett and Tanner 1977

(Table continued on next page)

United States Department of Agriculture climatic zones where perennial herbs can be grown (continued)

Latin name	English name	Coldest zone	Reference
Mentha aquatica	watermint	6	Huxley et al. 1992
		2	Adams 1987
Mentha arvensis	field mint	4	Huxley et al. 1992
Mentha gracilis	Scotch mint	6	Huxley et al. 1992
		4	Adams 1987
Mentha longifolia	horsemint	6	Huxley et al. 1992
M. longifolia 'Silver'	silver mint	4	Facciola 1990
Mentha piperita	peppermint	3	Huxley et al. 1992
		2	Adams 1987
Mentha pulegium	pennyroyal	7	Huxley et al. 1992
		6	Adams 1987
Mentha requienii	Corsican mint	6	Adams 1987
		4	Cole
Mentha rotundifolia	round-leaved mint	3	Adams 1987
Mentha spicata	spearmint	3	Huxley et al. 1992
Mentha suaveolens	apple mint,	6	Huxley et al. 1992
	pineapple mint	3	Adams 1987
Mentha villosa	wooly mint	5	Huxley et al. 1992
Micromeria juliana	savory	7	Huxley et al. 1992
Monarda citriodora	lemon bergamot	A	
Monarda didyma	bergamot	4	Huxley et al. 1992
		2	Adams 1987
		4	Garland 1979
		4	Crockett and Tanner 1977
Monarda fistulosa	wild bergamot	4	Huxley et al. 1992
		3	Adams 1987
Myrrhis odorata	sweet cicely	5	Huxley et al. 1992
		2!	Adams 1987
		4	Garland 1979
		4	Crockett and Tanner 1977
		4	Cole

(Table continued on next page)

United States Department of Agriculture climatic zones where perennial herbs can be grown (continued)

Latin name	English name	Coldest zone	Reference
Myrtus communis	myrtle	8	Huxley et al. 1992
		8	Cathey 1990
		8-9	Garland 1979
		9	Crockett and Tanner 1977
		8	Perry 1974
Nasturtium officinale	watercress	6	Huxley et al. 1992
		4	Garland 1979
		3	Crockett and Tanner 1977
Nepeta cataria	catnip	3	Huxley et al. 1992
		2	Adams 1987
	(cv. Citriodora)	6	Adams 1987
		3	Crockett and Tanner 1977
Nigella sativa	black cumin	A(LA?)	
Ocimum basilicum	basil	10	Miske 1994
		A or 9	Adams 1987
Ocimum tenuiflorum	holy basil	A or 10	Huxley et al. 1992
		A or 9	Adams 1987
Origanum dictamnus	dittany of Crete	7	Huxley et al. 1992
		7	Tucker & Rollins 1989
		9	Adams 1987
Origanum majorana	sweet marjoram	A or 7	Huxley et al. 1992
		A or 8	Adams 1987
Origanum majoricum	Italian oregano	7	Huxley et al. 1992
		7	Tucker 1990
		6	Facciola 1990
Origanum microphyllum	small-leaved oregano	7	Tucker & Rollins 1989
		7	Adams 1987
Origanum onites	pot marjoram	8	Huxley et al. 1992
		7	Adams 1987
Origanum syriacum	Syrian oregano	8	Huxley et al. 1992
Origanum vulgare	oregano	5	Huxley et al. 1992
		4, 6	Adams 1987
Panax ginseng	Asian ginseng	6	Huxley et al. 1992
		3	Small
Panax quinquefolius	American ginseng	3	Huxley et al. 1992

(Table continued on next page)

United States Department of Agriculture climatic zones where perennial herbs can be grown (continued)

Latin name	English name	Coldest zone	Reference
Papaver somniferum	opium poppy	A	
Pelargonium species	geranium, fragrant-leaved	10 or A	Huxley et al. 1992
(*P. graveolens*)	(rose geranium)	9	Garland 1979
		9	Crockett and Tanner 1977
Perilla frutescens	perilla	A	
Petroselinum crispum	parsley	A	
var. *crispum*		2	Adams 1987
		3	Garland 1979
Pimpinella anisum	anise	A	
Plectranthus amboinicus	country borage	10	Huxley et al. 1992
		9	Adams 1987
Polygonum odoratum	rau ram	9 or LA	Small
Pycnanthemum pilosum	mountain mint	4	Huxley et al. 1992
Rheum cultorum	rhubarb	3	Huxley et al. 1992
		3	Garland 1979
Rosa canina	dog rose	3	Huxley et al. 1992
		3	Garland 1979
Rosa rugosa	Turkestan rose	2	Huxley et al. 1992
		2	Creasy 1982
Rosmarinus officinalis	rosemary	8	Barash 1993
		6	Huxley et al. 1992
		6	Adams 1987
		8	Yang 1985
		6	Garland 1979
		8	Crockett and Tanner 1977
		6	Perry 1974
Rumex acetosa	garden sorrel	A or 3	Huxley et al. 1992
		3	Adams 1987
		5	Creasy 1982
		3	Garland 1979
Rumex scutatus	French sorrel	A or 6	Huxley et al. 1992
		3	Adams 1987
		5	Creasy 1982
		3	Crockett and Tanner 1977

(Table continued on next page)

United States Department of Agriculture climatic zones where perennial herbs can be grown (continued)

Latin name	English name	Coldest zone	Reference
Ruta graveolens	rue	5	Huxley et al. 1992
		6	Adams 1987
		4	Garland 1979
		4	Crockett and Tanner 1977
		4	Perry 1974
Salvia officinalis	garden sage	5	Huxley et al. 1992
		3	Adams 1987
		3	Garland 1979
		3	Crockett and Tanner 1977
		3	Perry 1974
		4	Cole
Sanguisorba minor	salad burnet	5	Huxley et al. 1992
		2	Adams 1987
		3	Garland 1979
		A	Halpin 1978
		3	Crockett and Tanner 1977
Sanguisorba officinalis	gmat burnet	4	Huxley et al. 1992
		A	Halpin 1978
Satureja biflora	lemon savory	10?	Small
Satureja hortensis	summer savory	A	
Satureja montana	winter savory	6	Huxley et al. 1992
		4	Adams 1987
		5	Garland 1979
		5	Crockett and Tanner 1977
		4	Cole
Satureja viminea	Jamaican savory	11?	Small
Sinapis alba	yellow mustard	A	
Smyrnium olusatrum	Alexanders	A? or 7	Small
Stachys officinalis	betony	5	Huxley et al. 1992
		3	Adams 1987
		4	Garland 1979
		3	Crockett and Tanner 1977
Stevia rebaudiana	stevia	A or 9	Huxley et al. 1992
Symphytum officinale	comfrey	5	Huxley et al. 1992
		2	Adams 1987
		3	Garland 1979
		3	Crockett and Tanner 1977

(Table continued on next page)

United States Department of Agriculture climatic zones where perennial herbs can be grown (continued)

Latin name	English name	Coldest zone	Reference
Symphytum uplandicum	Russian comfrey	5	Huxley et al. 1992
		2	Adams 1987
Tagetes lucida	Mexican mint marigold	A or 9	Huxley et al. 1992
Tagetes patula	French marigold	A	
Tanacetum balsamita	costmary	6	Huxley et al. 1992
		4	Reppert 1987
		3	Adams 1987
		4	Garland 1979
		6	Crockett and Tanner 1977
Taraxacum	dandelion	3	Duke 1992
		3	Garland 1979
		3	Perry 1974
Thymus citriodorus	lemon thyme	5	Miske 1994
		7	Huxley et al. 1992
		6	Adams 1987
		4	Cole
Thymus herba-barona	caraway thyme	3	Adams 1987
		4	Cole
Thymus praecox	creeping thyme	5	Huxley et al. 1992
		1-4	Adams 1987
		4	Cole
Thymus vulgaris	garden thyme	A or 7	Huxley et al. 1992
		2-4	Adams 1987
		4	Cole
Trigonella foenum-graecum	fenugreek	A	
Tropaeolum majus	nasturtium	A	
Tropaeolum minus	dwarf nasturtium	A	
Viola odorata	sweet violet	8	Huxley et al. 1992
		4	Adams 1987
		6	Garland 1979
		6	Crockett and Tanner 1977
		4	Perry 1974
		4	Cole
Zingiber officinale	ginger	10	Huxley et al. 1992
		10	Garland 1979

The Culinary Herb Economy of North America

The Most Important Culinary Herbs

The plants examined in this book differ greatly in their importance for culinary, medicinal, and industrial purposes. They also differ greatly in importance depending on climatic region and season. Also, species will differ in importance in terms of domestic production, domestic use, exports, and imports. Since authors who have examined the relative importance of "culinary herbs" disagree about what plants should be included, the literature provides only a partial guide to relative importance. Nevertheless, it is of interest to examine which species are considered important, especially in North America.

The chile peppers (*Capsicum*) are generally thought to be the world's most popular condiment plant, indeed, the most popular condiment next to salt. However, some consider garden sage to be the world's most popular flavoring and seasoning herb, and the leading culinary herb in the U.S. (Morton 1976).

In the U.S., a majority of fresh-cut herbs come from California, Texas or Florida. California is North America's leading center of herb cultivation. The primary product is dried leaf, used by commercial food processors or distributed as a seasoning or flavoring for use by the consumer. The most important herbs produced are basil, chervil, chives, coriander, dill, garlic, marjoram, oregano, rosemary, sage, summer savory, tarragon and thyme.

Chadwick and Craker (1989) listed the following temperate zone herbs (not just culinary) as the most economically important ones (excluding garlic): ginseng, digitalis, sage, poppy, dill, and parsley (except for digitalis, all are discussed in detail in this book). Macleod (1968, for the U.K.) listed "the seventeen basic herbs that every garden should grow" (all discussed in this book): basil, balm (lemon), bay, chervil, chives, fennel, lovage, marjoram, mint, parsley, rosemary, sage, savory (summer and winter), thyme (garden and lemon), and tarragon. Duke (1985) lists the following (mostly beverage herbs) as "the top herbs in total sales in the U.S." (* = treated in this book): alfalfa, camomile*, carob, cayenne*, chicory*, comfrey*, fennel seed*, fenugreek*, garlic*, ginseng*, hibiscus*, lemongrass*, licorice*, mate (maté), orange peel, parsley*, peppermint*, raspberry leaves, red clover tops, rose hips*, sage*, sarsaparilla, spearmint*, thyme*, wild cherry bark. Dowling (1995) lists the ten top sellers among herb growers in the Ottawa, Canada area: basil, coriander (including cilantro), garlic chives, French tarragon, Greek oregano, mint, lemon verbena, sorrel, bay, and scented geraniums.

Winter supplies of fresh herbs in the U.S. come particularly from California, Hawaii, Florida, and Puerto Rico (Gaskell 1988). The most important winter herb species for the U.S. market according to Gaskell are: chervil, chives, dill, Florence fennel (really a vegetable), marjoram, oregano, rosemary, sage, savory (summer), spearmint, tarragon, and thyme (all discussed in this book).

Imports

Statistics are compiled in the United States for imports of a number of key flavoring plants, as shown in the following table. Similar statistics are unavailable for Canada, but because of the similar diets and economies of the two countries, the relative importance of the herbs listed is probably similar, with the notable exception of mustard seed, for which Canada is the world's major exporter, the U.S. obtaining most of its mustard seed from Canada. As noted below for the period 1991-93, the U.S. annually imported about 248 000 t of the herbs listed, worth about $361,000,000.00(U.S.). For these particular herbs, the U.S. imported about two-thirds of its spice and seasoning requirements, principally from Indonesia, Madagascar, Mexico, and India (Dull 1994*a*). Import prices for processed herbal products are usually so low that they compete well with Canadian and American prices.

Principal United States imports of condiments, seasonings, and flavoring materials. averages for 1991-93 (compiled from Dull 1994*a*). * = plant discussed in detail in this book.

Item	Metric tons	$1,000.00
Allspice (Pimento)	1012.9	1926.1
Anise*	1158.9	2557.1
Basil*	2246.6	3147.1
Caper	1234.6	5971.9
Capsicum or red peppers*:		
Anaheim & ancho	1217.2	4616.3
Other	13509.2	30347.5
Ground	7934.5	7179.7
Paprika	3696.3	7159.4
Caraway*	3617.0	3237.7
Cardamom	190.6	917.0
Cassia & Cinnamon	14145.3	25944.0
(ground)	630.3	1722.4
Celery seed*	2809.1	1691.6
Clove	1180.3	1651.5
Coriander*	2314.2	1503.0
Cumin*	5226.9	9122.8
Curry & curry powder		
(see fenugreek*)	483.6	1570.1
Dill*	698.8	702.4
Fennel*	2783.7	3517.0
Garlic* (dehydrated)	3604.8	3919.1
Ginger* (including fresh)	7929.2	7776.5
(ground)	327.1	942.4
(sweet)	258.5	464.5
(candied)	274.7	918.0
Laurel (Bay)*		
leaves, Thyme*	1700.1	4116.6
(Bay, other than crude)	26.7	59.3
Mace	208.2	409.7
Mint* leaves	223.7	351.0
Mustard* seed	54653.2	15358.7
(ground)	4611.3	4249.8
(prepared)	3781.8	6248.0
Nutmegs	1796.6	2607.8
Onions (dehydrated)	1837.8	2294.8
Origanum*	5698.1	12071.7
(other than crude)	450.7	731.3
Parsley* (manufactured)	393.9	1243.0
Pepper, black	38473.0	44979.3
(white)	5399.4	8750.9
(ground)	605.7	1303.4
Poppy* seed	5010.9	3993.8
Saffron*	4.8	3586.9
Sage*	2174.0	4907.8
Sesame seed	36125.6	39397.4
Thyme* (other than crude)	50.4	118.2
Turmeric	2155.3	2724.8
Vanilla beans	1300.4	66075.8
Mixed spices, other	2790.7	6954.4
TOTALS	**247956.9**	**361039.5**

Essential Oils

In terms of consumption of herbs for use as essential oils in North America, the analysis conducted by Ference (1989) shown in the following table indicates relative importance in North America.

Selected Reference

Tyner (1975).

Crop Diversification and the Business of Growing Herbs

Most supplies of culinary herbs are dominated by "big business." Much of the dried herbs produced in North America are grown in California by a few well-established food companies that dry, process, package, transport, and market the product (Duke 1982). Some popular herbs are handled by large processing companies or food and flavor houses that contract the cultivation and harvest of the herbs to private growers or simply bid on the open market. Some culinary herbs (especially those useful for their essential oils) are grown in such large amounts by individual farmers that the enterprise can be considered to fall within big business. Notwithstanding the economic importance of big business, small entrepreneurs and those interested in crop diversification are of special importance to the future development of the herb industry in North America. There are opportunities for small, private enterprises, and for the cultivation of herbs as part of the spectrum of crops raised by farmers, as noted in the following.

Culinary herbs may offer advantages to the farmer wishing to grow new crops. Herbs are well suited to small scale production because of the relatively limited volumes of produce and the specialized growing conditions often required. They may frequently be grown economically on small acreages, and without sophisticated machinery or at least with machinery that can be modified. Some herbs are rather weedy, and can be grown on marginal land, although generally herbs require good land like other crops.

Estimates of demand for selected essential oils by the North American flavoring and fragrance industry (after Ference (1989), where method of derivation is described). All species listed are discussed in this book except carrot, wintergreen and sweet flag.

Natural essential oil	Projected N.A. demand (volume)		Projected N.A. demand (sales)	
	'000 kg	%	'000 $(U.S.)	%
Peppermint	104.24	18.3	5,275	20.97
Monarda (geraniol)	103.31	18.1	4,649	18.48
Coriander	49.18	8.6	4,328	17.21
Rosemary	123.60	21.7	1,781	7.08
Basil	12.81	2.2	1,296	5.15
Thyme	17.23	3.0	1,251	4.97
Celery	14.96	2.6	1,070	4.25
Spearmint	62.99	11.1	831	3.31
Sage	10.95	1.9	807	3.21
Angelica	1.04	0.2	753	3.00
Garlic	4.44	0.8	520	2.07
Tarragon	1.80	0.3	455	1.81
Myrtle	6.82	1.2	389	1.54
Corn mint	16.58	2.9	292	1.16
Wormwood	4.14	0.7	273	1.09
Carrot	1.34	0.2	242	0.96
Dill	9.92	1.7	169	0.67
Sweet bay	4.55	0.8	150	0.60
Fennel	5.91	1.0	148	0.59
Parsley	0.87	0.2	143	0.57
Wintergreen	2.85	0.5	116	0.46
Caraway	2.89	0.5	95	0.38
Oregano	2.27	0.4	72	0.29
Sweet flag (calamus)	0.41	0.1	28	0.11
Summer savory	0.21	0.0	21	0.09
TOTALS	**565.30**	**100.0**	**25,155**	**100.00**

On the other hand there are risks and problems. Markets may be uncertain, knowledge of how to grow a particular herb may be limited, seed supply sources may provide unsuitable cultivars, and regulations concerning pesticides, herbicides, and fungicides may not have been established. Competition is intense in producing and marketing herbs, and small-scale entrepreneurs must contend with giant, established corporations. Because culinary herbs represent a small proportion of total food consumption, overproduction or shortages can dramatically affect prices, which can drop or escalate overnight.

The following remarks are directed specifically about herbs that are used as food. However, from a business viewpoint it should be understood that plants used as culinary herbs often are more profitable for their non-food uses. Also, it may often be possible to grow and market non-food "herbs" using much the same agronomic and marketing channels as for culinary herbs. The non-food marketing possibilities for herbs (culinary or otherwise) include: pharmaceutical and industrial extracts, particularly essential oils; dried fragrant herbs used to make sachets and potpourri as natural air fresheners; and dried flower arrangements and decorative craft-work made with plants. The marketable products produced specifically by the culinary herb industry include: fresh herbs; dried, frozen or canned herbs; seeds; potted stock; and processed or manufactured edible commodities. Allied interesting areas that are sometimes profitable include writing about herbs (for advice, see Clavio 1990), publishing herb newsletters (for advice, see Meares 1990), and teaching and lecturing about herbs.

Production of herbs for extracts and for dried products is specialized, competitive, and often requires large investments. Dehydrating, processing, and extracting

generally demand considerable knowledge and experience, machinery and equipment. Dehydration or extraction normally is carried out immediately after harvesting, and in close proximity to the area of cultivation. Large firms have established high quality and processing standards, and so dominate the market. Of all factors restricting the herb business, foreign (generally overseas) competition most significantly limits domestic industries, and it is extremely difficult for the enterprising small entrepreneur to break into the dried market. Countries around the Mediterranean Sea, eastern Europe, Latin America and India are the world's major suppliers of dried herbs. For some herbs in these regions, the plants are simply gathered from the wild, not cultivated, and combined with very low labor costs, several dried herbs are placed on the market at low prices. For some herbs, however, pharmaceutical and food companies sometimes look to contract growers to provide a crop, often on an irregular basis dictated by market demand. It is essential for a small private entrepreneur of dried or processed herbs to establish a close working relationship with a buyer or company purchasing the product. Excellent guides to the market potential of herbs (especially those called spices) in North America are provided by periodical publications detailing imports and trends, produced by the United States Foreign Agricultural Service. The most useful periodicals deal with spices and essential oils. For a current list of offerings and prices, write to:

Foreign Agricultural Service
Information Division
Room 4644-S
Washington, DC 20250-1000, USA

The production of seeds is another very competitive area for the major herbs. Imported seed and seed of major herbs produced by bulk North American suppliers once again tend to make this area of the herb business difficult for the small entrepreneur. Germination rates of many common herbs are rather poor and, coupled with poor seed production by many herbs, the profitability of seed production can be marginal. Unfortunately, for many herbs there is an urgent need for production of high-quality, reliably identified seed, that is often not met by suppliers. Imported seeds may be mixtures of cultivars or contaminated by weed seeds. Growers need to be especially sensitive to the issues of quality, purity, and identity, since the success of their crops depends on these factors. It may be necessary for some growers of unusual herbs to produce their own seed to ensure their crop gets off on the right foot.

Fresh herbs are relatively new to produce markets, but there is increasing consumer interest in using them instead of dried herbs. Unlike the market for dried herbs, production and marketing of fresh herbs is usually limited. to small scale operations, with relatively small purchases at a time. Obviously, there are better opportunities for the small entrepreneur in growing fresh herbs than in attempting to break into the dried herb food business. A fresh culinary herb business can easily start off as a hobby or part-time business. [Sturtivant (1988) is a small but well-written book with lots of common sense recommendations on how to establish a backyard herb business.]

The highly perishable nature of fresh herbs limits imports, and by setting up shop near major metropolitan areas fresh herb producers can take advantage of local demand, supply a very fresh product, and minimize packaging and transportation costs. "Organic" or pesticide-free fresh herbs are of special attractiveness to local restaurants and natural food outlets. Very curiously, some herb connoisseurs use the presence of blemishes and damage apparently caused by insects as a criterion that the material has been organically grown, apparently in the belief that if it looks too good, it was probably sprayed with chemicals to keep insects away.

A critical problem for the small grower trying to create a large, profitable fresh herb production firm is the reluctance of large marketing chains to become associated with small growers. Even with the problems posed by long-distance transportation costs and the significant loss of quality, large chains are attracted by the large volumes and packaging that are usually supplied by large growers, especially those in foreign countries. Small growers need to explore business arrangements with smaller marketing chains, and to emphasize the advantages of organically-grown, locally-produced, fresh herbs. Reliable supply and delivery is critical to obtaining both restaurants and retailers as clients.

Many culinary herbs flourish outdoors, but because they are so easily produced and relatively little is required for the fresh market, out-of-season production should be evaluated. This means that prospective producers should seriously consider a greenhouse. Greenhouses allow excellent regulation of temperature, moisture, humidity, diseases and insects, and indeed serve to avoid most insects and weeds, as well as birds, dust, and atmospheric pollution. The growing ethnic population from warmer climates than found in northern North America is particularly receptive to herbs familiar in the homeland, which often can only be grown under glass. Ethnic dishes are

also becoming more popular with everyone, and are appearing on menus of upscale restaurants, providing opportunities to market unusual culinary herbs.

Greenhouses are also a necessity for another profitable area of the herb business for the small entrepreneur: the supplying of live, potted plants for the local nursery business. People increasingly want to escape at least briefly from their urban existence by cultivating plants themselves, and coupled with the movement to consumption of more fresh herbs, there is a growing market for potted herbs. Potted stock is often sold wholesale to nurseries, garden centers, discount stores, supermarkets, chainstores, and other retail outlets. Distribution tends to be local, usually within 200 km of the grower, and so competition is reduced. However, the problem of cheap, high-volume importation from hot southern areas remains significant.

A knowledge of storage conditions for individual crops is essential to market fresh herbs. Shelf life of most herbs is greatly extended by holding them at temperatures of 0-5°C. High humidity (>95%) in the packing area, cold rooms, and transport vehicles is desirable to reduce wilting. Sealed bags may result in excessive humidity. Constant temperature reduces condensation inside sealed bags, reducing the risk of fungal and bacterial growth. Perforated bags and bags constructed of polymers partially permeable to water vapor can also be used. Translucent bags may be undesirable for some herbs that do not store optimally under light. Careless handling and consequent physical injury to most fresh herbs can result in extensive discoloration and infection. Packaging - for example the use of "pillow packs" (partially inflated plastic bags) -can frequently lessen this problem.

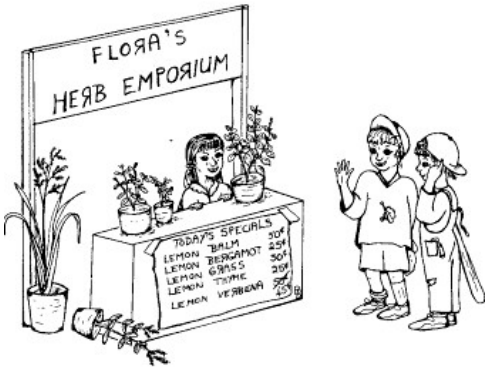


Fig. 18.
"Lemon herb stand." Prepared by B. Brookes.

Because of the limited demand for most individual herbs, a successful herb business may necessitate offering a variety of herbs. Another solution to the problem of limited market for the culinary aspects of herbs is to have the herbs as just part of a larger business, additionally offering other goods and/or services. "Small herb businesses, if they are to survive and be successful, usually have to be diversified" (Long 1992). Even large herb operations may find it necessary to intensively manage several different crops. Market conditions may make it appropriate to organize groups of small growers.

Trial plots can be attempted to help growers assess the potential of culinary herbs in their area. Private marketing should also be considered. This could include supplying local gourmet and ethnic-background restaurants, supermarkets, and health food stores. Also, processing and developing product lines, such as dried culinary herb mixtures, vinegars, herbal honeys, and jellies, should be considered. Edible bouquets are a "hot commodity" at present, increasing in popularity with upscale restaurants. Note that considerable information and references to literature on edible flowers is presented in this book.

"Growing a small wholesale herb business is not much different from starting any business. You start small, you make mistakes, you learn from them, you adjust - and hopefully you grow" (Pomeroy 1990). Locating a herb business is one of the first critical considerations. Mail-order suppliers can be stationed outside of population centers, but those who choose to supply fresh herbs need to be within reasonable proximity to clients, to ensure quick delivery and to limit transportation costs. Local city and agricultural regulations for opening and operating a herb business need to be clearly understood. Searching for clients should be done systematically and aggressively. For a fresh culinary herb business, explore the possibilities of supplying supermarket operators, specialty restaurants, and caterers. Initially, concentrate on a few popular herbs, such as sweet basil for supermarkets, lemon grass for Oriental restaurants, and cilantro for Mexican and east Asian restaurants. Caterers will probably be interested in attractive garnishes, especially edible flowers. Supplying free samples and advice to potential clients can pay off in the long run. Knowledge of the culinary use of herbs is important in merchandising them. Providing demonstrations and recipe hand-outs in supermarkets can be effective in developing a demand.

While big business domination of most commercial areas of herb production and marketing is likely to continue, the "cottage industry" approach outlined above offers interesting possibilities for many small entrepreneurs. A

final warning is in order with respect to competition. The mystique of herbs is an extraordinarily strong motivator, and many individuals today are attracted to the idea of starting a herb business. Given geographical areas are easily saturated by even one herb supplier, and it is important to size up the competition, both large and small.

Probably the best advice that can be give to those contemplating getting into the business of herbs is to spend about a year doing research. Libraries can be good sources of information. Although travel is expensive, attendance at market-oriented conferences can provide key ideas and contacts. Marketing publications (see the section below on key sources of information), agricultural departments of government and universities, and established growers can provide invaluable information and can save you from mistakes. A personal business plan should be created (for advice on business plans, note Dove 1990, Dove 1994, Hankins 1994), and as much expert help as possible sought in preparing this. Keep in mind the grower's motto "find your market before you sow your seed."

Selected References

Simon and Craker (1983); Miller (1985); Simon and Grant (1987*a, b*); Gaudiel (1987); Kebede (1988*b*); Sturtivant (1988); Simon and Clavio (1988); Handwerker (1990); Peddie (1990*b*) [has considerable down-to-earth, common-sense advice for the novice; part of a symposium called "The business of herbs"]; Pomeroy (1990); Simon (1990); Holcomb (1991); Long (1992); Kestner et al. (1994) [Part 4, The business and marketing of herbs, contains nine extremely useful articles on various business aspects]; Sturtivant (1994) [a gold-mine of information and ideas for the novice herbal entrepreneur, contains many analyses of herbal business ventures that can provide insight into whether or not a herbal business is what you really want]; Lutz and Craker (1994) [advice on financial management].

Research and Information Needs

Herbs that are grown for culinary purposes are also often useful for pharmaceutical and industrial products. Indeed, extracted flavorings, oils, dyes, medicinals, and industrial chemicals are the primary economic reason for growing many edible herbs. International trade in herbs amounts to billions of dollars annually. Moreover, interest in herbs is increasing. There are several reasons for increasing use of culinary herbs: growing popularity of ethnic foods; dietary restrictions on substances like salt that require flavor substitutes; changing lifestyes stimulating a demand for variety of food preparations. From the viewpoint of medicine, the search for bioactive compounds that can treat diseases in animals and man is becoming more rapid and sophisticated. Diseases of plants, too, may be controlled by the discovery of new compounds. Essential oils and other industrial components of herbs may also be expected to increase in importance as industry continues to find new ways of utilization.

The U.S. is the world's largest importer of herbs and herbal products, mostly from overseas sources. Foreign competitors have inherent advantages: many spices can only be cultivated in tropical areas, labor costs are sometimes shamelessly low, and traditional expertise has been developed. Nevertheless, with such a large indigenous market in North America, it would seem that there is considerable scope for increasing Canadian and American market share. Craker (1989) noted the need for increasing research in several areas: screening and breeding of more productive varieties adapted to local conditions; scientific investigations of cultural and post-harvest requirements, including weed and pest control, soil nutrition, planting densities, packaging, and critical storage temperatures; safeguarding of natural habitat for germplasm; exploration and storage of germplasm; evaluation of phytochemistry and pharmacology. To this list I would add a need for comprehensive information and education, so that researchers, growers, marketers, and consumers could readily make informed judgments. Our increasingly complex society and demands on our time and resources means that priorization has become essential. I believe that the single-most important priority for improving the herb economy of North America is the preparation of a systematic, conputerized information system that would serve diverse needs. Assembling the information in this book from scattered and often obscure sources has impressed me with two facts: the amazing volume of information that is available, and the lack of mastery of more than a tiny fraction of that information by any person or book. Fourteen books cited in the bibliography bear a title like "The complete book of herbs." If only that were true.

Selected References

Craker (1989).

Plant Classification and Plant Names

All of the plants described in this book belong to a large natural group of at least 250 000 species, called *vascular plants* or Tracheophyta (because they possess specialized vessels in the stems for transporting water, minerals, and the products of photosynthesis). The vascular plants include ferns and fern allies which reproduce by spores rather than seeds (none is included in this book); and the *seed plants*, which reproducing sexually by true seeds. In turn, the seed plants are made up of species with obvious flowers (the *Angiosperms*), which include all but' one species treated extensively in this book; and the *Gymnosperms*. Gymnosperms are said to lack both true flowers and true fruits, although this has been debated, since both flowers and fruits are difficult to define. The only gymnosperm treated at length in this book is common juniper. Distantly related plants, such as the mosses, do not possess flowers, well-developed vascular tissues, or true seeds, do not belong to any of the above groups, and do not furnish any culinary herb of note. Whether bacteria, fungi, and most algae are true plants is open to debate, but they are rather distantly related to flowering plants. They do sometimes furnish edible herb-like material, but are outside the scope of this book [for references to edible seaweeds and fungi, see Munro and Small (1997)].

Natural and Artificial Classifications

The words systematics and taxonomy denote fundamental biological sciences that have been defined in various ways (Small 1989); in simple terms, both designate studies concerned with classification of living things. Taxonomists are specialists in the classification and naming of organisms. Classifications are important because they facilitate identification and information retrieval, and make it easy to understand the relationships of the things being classified.

"Natural classifications" are based on genetic and evolutionary relationships. It can be very important to have a natural classification, because this reflects closeness of genetic relationships, and sometimes it is useful to know which culinary herbs are related. For example, crops susceptible to a given soil-borne disease usually should not be included in a rotation with related crops, because they too may be susceptible, with the result that the disease organism may accumulate in harmful concentration. Sometimes allergies to one kind of plant may also be elicited by related plants, and so it may be wise to be suspicious of species in the same genus or even in the same family.

"Artificial classifications" are special-purpose classifications based on one or several characteristics of interest; such systems usually do not reflect natural relationships, but are often useful. For example, classifications of cultivars on the basis of earliness of flowering, or fruit color, may not reflect genetic relationships, but if one is interested in finding early-maturing varieties with a certain fruit color, such a classifications is very useful. An example of artificial classification is the groupings of culinary herbs on the basis of the part used, whether root, leaves, flower, or fruit, as presented in the Introduction.

The vascular plants that are described in this book are divided into progressively smaller groups; those of most concern for this book are: family, genus, species, subspecies, and variety. About 300 families of vascular plants are recognized, but as noted above most plants used as herbs come from only a few families. The names of families end in *aceae*, although for 13 of the first families recognized by botanists there are alternative names that do not end in this suffix. The families with alternative names that are mentioned in this text include: Leguminosae (Fabaceae), Gramineae (Poaceae), Cruciferae (Brassicaceae), Labiatae (Lamiaceae), Umbelliferae (Apiaceae), and Compositae (Asteraceae). Families may have as few as one or up to about 25 000 genera. A genus (plural: genera) may have as few as one, or more than a thousand species.

One aim of plant taxonomy is to organize all plants clearly into families, genera, species, and so forth. Unfortunately there is not yet universal agreement on the classification of flowering plants. Sometimes a family recognized by one taxonomist is not accepted by another. Sometimes one taxonomist puts a given genus into one family, while another places it in a different family. For example, *Allium* was long placed in the Liliaceae, more recently considered a member of the Amaryllidaceae by some, and still more recently placed by others in an intermediate family, the Alliaceae. There can also be disagreements about whether or not a genus or a species should be recognized, or just which plants should be included. With more and more study, some disagreements can be resolved. However, sometimes just how plants should be grouped is inherently difficult simply because the pattern of relationships is complex, and in such cases competing classification systems may exist. In this book, information is provided about the state of knowledge of the taxonomy of the herbs included.

Plant Nomenclature

The first aim of botanical taxonomy, described above, is to classify plants into recognizable groups. A second aim of taxonomy is to provide unambiguous names for all such groups (families, genera, species, etc.). This aspect is known as *nomenclature*. The Swedish naturalist Carl Linnaeus (1707-1778) standardized a system of naming called binomial nomenclature, whereby every species was designated by two words (hence "binomial"), normally of Latin form but often derived from Greek. These Latin (or latinized) names are properly called "scientific names," or for plants, "botanical names." The first of the two words is always the name of the genus to which the species belongs; the second belongs to only one species of that genus. Subspecies or varieties of species are designated by trinomials (three words), for example: the trinomial *Allium sativum* var. *ophioscorodon* (referring to the top-setting variety of garlic). Rarely, quadrinomials (four words) are encountered, in the form *Cannabis sativa* subsp. *indica* var. *spontanea*. No quadrinomials are used in this book.

Plants of general interest also have "common," "vernacular" or "trivial" names, some of great antiquity. This book often lists ten or more common English names for the species discussed in detail, and as many common French names. A difficulty with many common names is that the same name is often used by different people, or in different regions, to designate different species. Of course, this can make it impossible to know what is meant. Foster (1992) is an attempt to standardize common names of herbs used in commerce (i.e., have just one name for each herb) but, generally, alternative common names of many plants are so well established that any attempt to legislate them out of existence would be futile.

Scientific (latinized) names are used by biologists in order to control and reduce different names for the same groups of living things. To avoid ambiguity, taxonomists have devised rules for coining new scientific names, and for deciding on which name must be adopted when a group has received more than one name. *The International Code of Botanical Nomenclature* (Greuter et al. 1994) provides many rules for deciding which names are correct. Only one name is the "correct" name, and other names are called "synonyms." Sometimes it is important to know which name is a synonym of what other name, because information in the literature may be recorded under a synonym. In this book, synonyms are given only when there is some probability that articles will be found which use the synonym rather than the correct name. For many of the species discussed in this book, there are dozens, even hundreds of synonyms.

For bibliographical convenience, botanical taxonomists have adopted a system of citation of the authors of names, usually abbreviated. Thus in the names *Ruta graveolens* L. and *Thymus vulgaris* L., the "L." refers to Linnaeus, the author of these names. In "double citation" an original author and an author transferring the specific or varietal epithet to another genus or species are both cited. For example, in the name *Mentha longifolia* (L.) Hudson, based on *Mentha viridis* L. var. *longifolia* L., William Hudson gave Linnaeus's variety specific rank, but the "(L.)" reflects the fact that Linnaeus originally published the epithet *longifolia*. When an author has proposed a name, for example by writing it on a collection housed in a museum, but has not himself published it, this name may be accredited to him by a later author who properly published his name, by the use of the word 'ex'; for example, the citation *Gossypium tomentosum* Nutt. ex Seem. means that Nuttall proposed the name *Gossypium tomentosum* but Seemann validly published it. ("Ex" means "out of," but the sequence A ex B is read backwards, i.e., "B out of A"; strictly, the "Nutt. ex" isn't needed, and some taxonomists simply cite the name as *Gossypium tomentosum* Seem.). Citation of authors of names may be important because different authors have often (unknown to each other) created exactly the same binomial, for example: *Acer barbatum* Sarg. and *A. barbatum* Michx. refer to two different species of North American maples. Such names, duplicating each other but designating different species or genera, are termed homonyms.

Another nomenclatural convention needing explanation is the "autonym," or "automatically established name." There may be no recognized subdivisions of a species, neither subspecies nor varieties, in which case there are no autonyms. However, when a taxonomist first recognizes a new subspecies (or variety), automatically a second subspecies or variety is recognized. For example, when De Candolle published the name *Viola pedata* L. var. *linearilobа* DC., he automatically created the name *Viola pedata* var. *pedata*. Two things should be noted about such an automatically established name (autonym): first, the third word repeats exactly the second; and second, there is no author cited for coining the autonym.

Many horticultural plants are of hybrid origin. Sometimes a "formula" made up of the two parental names separated by the mathematical multiplication symbol is used to label such plants. For example, peppermint may be designated as *M. aquatica* L. *M. spicata* L. (Note that the in such cases always has a space on either side.) When hybrids are well established in horticulture, they are often given their own name, and this is the case for peppermint

Mentha x*piperita* L. (Frequently a space is left between the and the final latin word, in such cases, e.g., *Mentha piperita*, but this is not essential.)

Misapplication of Names

Sometimes botanists have inadvertently misapplied a specific name published by another botanist, and such a misapplication has been widely copied. For example, the correct name of German chamomile is *Matricaria recutita* L., but for many years this was called *Matricaria chamomilla* L., a different species. In this case, *M. chamomilla* L. is not a synonym of *M. recutita* L. Misapplied names create a great deal of confusion, and unfortunately some misapplied names have become well established in the horticultural trade. Sometimes two authors have coined exactly the same name for different plants, and to prevent misapplication, the wrong name is cited following "not" or "non" For example: *Brassica alba* (L.) Rabenh. (not *B. alba* Gilib.).

Sometimes names misapplied in horticultural circles are indicated by "hort." (never Hort., which could be an abbreviation of the author Horton) following the name, for example *Ambrosia mexicana* hort., a name sometimes applied to ambrosia, *Chenopodium botrys* L. Sometimes the addition of hort. to a name is used just to indicate a name of no botanical standing used in horticultural circles. It should be understood that the usage of hort. following a name means that it is either not a correct name accepted by botanists, or simply a misidentification.

What is a Variety?

The word "variety" is ambiguous, because it has both a scientific and a common meaning. Scientifically, variety denotes a formal classification category, below a subspecies. However, in common speech the word variety refers to a kind, and while varieties in the scientific and popular sense may correspond, often they do not. Horticulturists use the term "cultivar" to designate cultivated varieties (in the common, not the scientific sense) by descriptive names or phrases (such as Giant or Black Beauty) rather than by Latin words. Cultivar names (also known as fancy names) are usually not Latinized names, and therefore many languages are used to coin them. Cultivar names are indicated in Roman characters, never in italic type like scientific names. By convention, cultivar names are either shown in single quotation marks or after the abbreviation cv. (for cultivar), following the scientific name, and many journals and book editors adhere to this convention. For example, *Mentha spicata* 'Kentucky Colonel' (or *Mentha spicata* cv. Kentucky Colonel) is a cultivar of spearmint. However, it is permissible to simply refer to Kentucky Colonel, without quotation marks, when it is clear what species is under discussion, and this practice is followed in this book. *The international code of nomenclature for cultivated plants* (Trehane et al. 1995) provides considerable information on this and related topics.

The word "cultigen" is confusingly similar to "cultivar." A cultigen is a part of a species that has been genetically changed by domestication and is cultivated. A cultigen may or may not have a number of cultivars, simply depending on whether or not particular races of the cultigen have been recognized and named. Some specialists recognize more than one cultigen in a given species (for example, in the species *Cannabis sativa* L. one could recognize a cultigen used for oilseed, another used for fibre hemp, and another used for narcotics). Some species are thought to be entirely a cultigen, lacking wild relatives within the species (e.g., saffron, *Crocus sativus* L.).

Latin Names

The scientific names of plants often originate from Latin or Greek and in any event are in Latinized form. Stearn (1992*a, b*) provides guides to modern pronunciation. Academic, classical Latin pronunciation is the ideal for international use, but simply pronouncing scientific names as if they were English words usually suffices. In any event, one finds differences in pronunciation of Latin names even among professional botanists. Pronunciation of scientific names should not be a source of frustration. "How they are pronounced really matters little provided they sound pleasant and are understood by all concerned" (Stearn 1992). Latin pronunciation is not of much help for most generic names, which usually originate from foreign languages other than Latin, and may be difficult for English speakers to pronounce. A good way of pronouncing scientific names is to copy the pronunciations of experts who have used the names for a long time and have become familiar with how most botanists say them.

Many scientific names were crafted to have some meaning, although many others originate simply from old languages. Often a knowledge of what the names mean is helpful in remembering the names; and often there are interesting stories and facts behind the names. For those interested in the meaning or origin of Latin names for plants, the best modern guide is Stearn (1992*a*). Jaeger (1972) is another excellent guide to the etymology of scientific names. The origins of many English and Scientific names are examined in the Curiosities section of many of the herbs discussed in this book. As will be noted, authorities do not always agree.

Fig. 19.
Poison hemlock *(Conium maculatum)*, from Köhler (1883-1898). Poison hemlock contains the toxic alkaloid coniine and other closely related compounds. Contact can cause dermatitis, and ingestion can result in weakness, drowsiness, nausea, labored respiration, paralysis, asphyxia and death. Introduced many years ago from Europe, poison hemlock is now distributed throughout the U.S. and southern Canada, especially in the northeastern, north-central, and Pacific northwestern states and adjacent Canada, in roadsides and waste areas. Unfortunately this and some other deadly wild species of the carrot family ressemble many of the edible herbs of the family. Sometimes encountered in gardens, poison hemlock is easily mistaken for edible plants such as parsley, or the seeds for anise. The roots have been mistaken for parsley.

French Names

French names have been given prominence in this book because, first, French is an important language in North America and other parts of the world, and second, there is a long and rich French tradition of culinary use of herbs, and consequently the use of French for culinary herbs. In most cases the French name featured is the one most used in Quebec; in most cases this will correspond to the most popular usage in international French. Some species, especially those from Asia that have recently been introduced to North America, either do not have French names or have names used only in one or a few French-speaking

Fig. 20.
Foxglove (*Digitalis purpurea*), from Engler and Prantl (1897). Foxglove is the source of digitalis, the first effective drug for heart disease. Although safe in controlled medicinal dosages, the plant is poisonous. Chewing even one leaf can result in paralysis or sudden heart failure. The plant has repeatedly been mistaken for comfrey in gardens, with fatal results. Bees collecting nectar from foxglove have been reported to produce poison honey (Krochmal 1994).

countries outside of France. In these cases, the advice of experts (see Acknowledgements) was sought. Key sources of information on French names that were consulted include: Wijk (1911); Fleury de la Roche (1924); Bois (1927, 1934); Fournier (1947-48); Secrétariat d'État (1974); Ferron and Cayouette (1975); Ledésert and Ledésert (1976); Maghami (1979); Stuart (1981); and Kays and Silva Dias (1995).

The Importance of Correct Identification

Shen Nung was a legendary emperor/sage with remarkable talents, as one might have predicted, since he learned to talk by the age of 3 days and walk after I week; and after inventing the plow, he invented agriculture by cultivating a field at the age of three (Moerman 1982). About 3 000 B.C. he is believed to have authored China's first great herbal, the *Pen Tsao Ching* ("Classic of Herbs"). He is reputed to have personally tested hundreds of herbs, until one that was quite poisonous killed this genius (Castleman 1991). About 1% of plants are seriously poisonous (Larkin 1983), so that eating strange plants is like playing Russian roulette (perhaps Chinese roulette in Shen Nung's case) with a gun loaded with one bullet and 99 blanks.

While most people are wary of eating wild plants, the need for caution in a garden is less apparent. However, foraging for herbs in a garden can be as dangerous as collecting in the wild. With the growing popularity of herbs, seed suppliers have placed on the market an astonishing number of medicinal, often poisonous herbs. Moreover, some ornamental herbs can be quite toxic. The Greek philosopher Socrates (470? - 399 B.C.) died from consuming a herbal tea made of hemlock (not the evergreen tree *Tsuga canadensis* (L.) Carr., but the Old World herbaceous *Conium maculatum* L., which has become a weed in parts of North America). Some people like to have piranhas in their aquarium, so it should not be surprising that poison hemlock is available through herbal suppliers and is sometimes grown in gardens. Poison hemlock is a member of the carrot family (the Umbelliferae), like many of the herbs presented in this book, and is difficult for most people to distinguish from other members of the family. Even those familiar with the plants may mistake poison hemlock for such plants as caraway (*Carum carvi*, treated in this book) and sweet cicely (*Myrrhis odorata*, also discussed in this book). In one memorable incident, the kitchen help at a restaurant serving dishes made with fresh herbs went to a nearby garden to harvest some umbelliferous herbs, but instead chose poison hemlock; the owner came into the kitchen just in time to stop his chef from giving the guests a last meal (Creasy 1990). Less fortunate were an elderly

Fig. 21.
Picking herbs for culinary purposes without being certain of their identity is dangerous. Prepared by B. Brookes.

couple in Washington state in 1977, who died within 24 hours of drinking tea brewed from foxglove (*Digitalis*), that they had mistaken for comfrey (*Symphytum officinale*, discussed in this book) (Larkin 1983). Exactly the same fatal mistake was made by a 70-year-old Englishman (Awang 1987). Foxglove tea poisoning of the elderly seems to occur with some frequency (Dickstein and Kunkel 1980). Wild mushroom hunters have a cautionary proverb (Snider 1991):

> There are old mushroom hunters.
> And there are bold mushroom hunters.
> But there are no old, bold mushroom hunters.

YOU MUST BE ABSOLUTELY 100% CERTAIN OF THE CORRECT IDENTITY OF HERBS YOU CONSUME. Fortunately, reported unintentional fatal mistakes such as those described above are uncommon -less than ten/year in the U.S. (Foster and Duke 1990).

The importance of correctly identifying plants is obvious in the case of poisonous plants, but there are other costs associated with incorrect identifications. Considerable time, resources and money have been wasted in industry and research because of incorrect identification (Small 1993). Speaking as a representative of the profession, taxonomy renders invaluable services in this regard.

Key Sources of Information on Culinary Herbs of Northern North America

We are in an age of explosive expansion of information, and this is true for most of the important herbs presented in this book. No doubt, increasing emphasis on electronically stored and retrievable information will facilitate keeping up to date in the future. Much information on plants, including herbs, does not go out of date, or at least does so very slowly, so that major print publications retain much of their usefulness for a very long period. On the other hand, new information may be critical - such as when it is discovered that a given plant has previously unappreciated toxic or economic properties. Key completed and continuing publications are listed below, which provide guides to much of both the old and the new.

Retrieving a substantial core of information on herbs is a relatively easy exercise, but there is also much information that is difficult to obtain because it has been published in obscure journals or mentioned so incidentally that it is difficult to locate. For the new abstracting journal *Review of Aromatic and Medicinal Plants*, which deals with herb, spice, and condiment plants, Bhat (personal communication) found that whereas about half the total volume of literature on the species was published in about 50 periodicals, the remaining half is very thinly scattered across some 2500 other serials in a very wide range of disciplines.

From the categories of information presented for the herbs discussed in this book, it will be evident that most of the species included have been studied extensively in contexts other than as culinary herbs. Many of the herbs are primarily important not as culinary herbs but as essential oil plants, medicinal plants, insecticidal plants, or ornamentals, and so available information has been published in journals, books, conference proceedings, reports, etc. aimed at readers in a wide range of disciplines, such as botany and horticulture, organic and synthetic chemistry, perfumery and cosmetics, food technology, and human and veterinary pharmacology.

The following notes selected publications important for the purpose of finding information on the plants discussed in this book. For most herbs the bulk of published information originates from outside North America. The choice of literature surveyed for this book is overwhelmingly English. (This focus on information available in English was somewhat alleviated by many of the reviewers of this book, expert in languages other than English, who provided information not available in English.) English is the dominant language of science - for example, Chadwick and Craker (1989) noted an example of a recent database of world scope on herbs in which 73% of language use was English. Nevertheless, much important early as well as recent literature is in foreign languages and, especially for many minor and foreign herbs, a considerable body of information is only available in foreign languages. Chadwick and Craker (1988) provide a number of suggestions on sources of information on herbs in foreign languages, and Chadwick and Craker (1989) list important foreign journals that deal with herbs in various languages.

All literature mentioned in this book, including the following (unless full details are given), is cited in the bibliography at the end of the book.

Articles:

Andrews 1987 (A guide to the literature on herbs.)

Chadwick and Craker 1987, 1988, 1989 (Advice on finding literature on herbs and a listing of reference tools.)

Craker et al. 1986 (An introduction to the scientific literature on herbs, spices, and medicinal plants.)

De Muth 1992 (Provides many suggestions where information on herbs of all kinds can be obtained.)

Books:

Andrews et al. 1982 (A bibliography, mostly of books, with abstracts of contents, dealing with a wide variety of subjects related to herbs.)

Craker, L.E. 1993 (A directory of addresses of individuals throughout the world, specializing in herbs, spices, and medicinal plants.)

Duke, J.A. and co-authors (Several books listed in bibliography. Duke, recently retired from the U.S. Department of Agriculture, has authored many authoritative reference works on herbs, especially on medicinal aspects.)

Facciola 1990 (A comprehensive guide to all classes of edible plants of the world, both wild and cultivated, to cultivars of many of the species, and to sources of seeds.)

Fernald et al. 1958 (A guide to edible wild plants of eastern North America; somewhat dated, but nevertheless the best guide written on the subject of native edible plants of North America.)

Grieve 1931 (An encyclopedic, exceptionally scholarly analysis of traditional medicinal uses of over 1000 plants; rather dated, but contains a wealth of historical information on many plants used for culinary purposes.)

Morton 1976 (A gem of a small book on herbs and spices, wonderfully illustrated, and marvellously packed with information by one of the world's best documenters of useful plants.)

Munro and Small 1997 (Deals with vegetables of Canada in much the same format of this book; includes several species that are often considered to be culinary herbs.)

Phillips and Foy 1990 (A superb collection of color photographs of herbs, many of which are culinary.)

Simon et al. 1984 (An indexed bibliography covering the 1971-80 literature on selected herbs, with almost 8000 references.)

Stobart 1977 (A witty guide to culinary aspects of herbs.)

Sturtivant 1994 (Provides extensive information on herb publications, associations, and suppliers.)

Szczawinski and Turner 1978 (A guide to edible weeds of Canada, most of which are wild culinary herbs.)

Turner and Szczawinski 1978 (A guide to wild plants of Canada that can be used to make coffee and teas.)

Symposium Proceedings:

Proceedings of the National herb growing and marketing conferences (Annual, started 1986, numerous contributions on diverse practical subjects related to the business of growing and marketing herbs.)

Encyclopedias:

Catalogue of agricultural and horticultural plants (excluding ornamentals) (Mansfeld 1986, 4 vol., in German; a valuable, highly competent source of information on crop plants, including the majority of culinary herbs treated in this book.)

Edible horticultural crops. A compendium of information on fruit, vegetable, spice and nut species (Hackett and Carolane 1982; provides agronomic, climatic, ecological, nutritional, etc. information on 150 crops of the world, including a dozen species dealt with in this book.)

Flora Europaea (Tutin et al. 1964-1980, 5 vol.; Vol. 1 (second edition) 1993; provides authoritative taxonomic information for many of the herbs of European origin treated in this book.)

Hortus third (Bailey and Bailey 1976; a comprehensive listing of most horticultural plants of the U.S. and Canada, with brief taxonomic, descriptive, and cultural information.)

The European garden flora: a manual for the identification of plants cultivated in Europe, both out-of-doors and under glass. [Vol. 1, 1984; first three volumes edited by S.M. Walters et al., fourth (1995) edited by J. Cullen et al. Projected two volumes remaining. Cambridge University Press. Provides rather technical descriptive, identification, and nomenclatural information.]

The new Royal Horticultural Society dictionary of gardening (Huxley et al. 1992; 4 vol., covers over 50 000 kinds of plants of the world, including most plants cultivated in North America.)

Journals

(for a considerably longer list of journals concerned with herbs in the broad sense, see Chadwick and Craker 1989):

Economic Botany (Vol. 1, 1947, currently issued quarterly.)

The Herb, Spice, and Medicinal Plant Digest (Vol. 1, 1983, currently issued quarterly; volume 5 issue 4 (1987) provides an extensive list of newsletters and magazines on herbs and spices (many of which have been discontinued); this was updated in volume 9 issue 3 (1991), with a supplement in volume 10 issue 1 (1992), both of which have become somewhat dated.)

The Herbarist (Vol. 1, 1935, issued annually; publication of the Herb Society of America, the largest society in North America dedicated to herbs.)

Journal of Herbs, Spices & Medicinal Plants (Vol. 1, 1992; initial issues published at irregular intervals.)

Review of Aromatic and Medicinal Plants (Vol. 1, 1995, bimonthly).

Trade-Oriented Journal/Newsletters:

The three noted below are particularly well known, and may be used as sources for additional journals, newsletters, and other kinds of media publications (also see note for Herb, Spice, and Medicinal Plant Digest, above).

The Business of Herbs (Vol. 1, 1982, issued bi-monthly; published by Northwind Farm, Rt. 2, Box 246, Shevlin, MN 56676.)

Herbalgram (Vol. 1, 1983, issued quarterly; published by the American Botanical Council, P.O. Box 201660, Austin, TX 78720.)

The Herbal Connection (Vol. 1, 190, issued bimonthly; published by the Herb Growing & Marketing Network, P.O. Box 245, Silver Spring, PA 17575. "The Herbal Green Pages" produced by the same organization provides a guide to herb businesses in the U.S. and elsewhere, and an annually updated listing of periodicals.)

Databases:

See Chadwick and Craker (1989) and Kasparek et al. (1996) for more extensive lists; databases are increasing rapidly and researchers need to be aware of the most recent. Only some chief, well-established databases are noted below (mostly available on CD-ROM, usually in major libaries, as well as on-line through vendors).

AGRICOLA (U.S. National Agricultural Library, Beltsville, MD, 20705). This is an internationally-based database concerned with agriculturally-related topics. Citations emphasize North and South America, Canada and Western Europe.

AGRIS International (United Nations Food and Agriculture Organization, Rome; Coordinating center: Via della Terme di Caracalla, 1-00100, Rome, Italy). This provides references to international information related to food, agriculture, nutrition, and rural development, with emphasis on developing countries.

BIOSIS (Biosciences Information Service, Philadelphia, PA). Corresponding to the printed *Biological Abstracts*, this provides comprehensive coverage of the world's biological research literature.

CAB International (North American representative: 845 North Park Ave., Tucson, AZ 85719). This covers all branches of agriculture.

GARDEN LITERATURE INDEX (398 Columbus Ave., Suite 181, Boston, MA 02116). Subtitled "An Index to Periodical Articles and Book Reviews," this provides an index to literature on all aspects of gardens and landscapes.

MEDLINE (MEDLARS Management Section, U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894). Corresponding to the printed *Index Medicus*, this provides international coverage of medical journals, and includes information on medicinal plants.

MEDICINAL & AROMATIC PLANTS ABSTRACTS (Publications & Information Directorate, The Council of Scientific & Industrial Research, New Delhi, 110 012, India).

Internet:

Numerous World Wide Web sites deal with herbs and related gardening, medicinal and other topics. An especially comprehensive (some would say overwhelming) source of information on agricultural topics, including herbs, is the United States Department of Agriculture web site (www.usda.gov; to locate a variety of links to herbal information, go to: http://www.msue.msu.edu/cgi-bin/impsrch/mod03?herb). The most important Canadian agricultural site which has relevance to herbs is: Agriculture and Agri-Food Canada Electronic Information Service (http://aceis.agr.ca).

Some other notable sites available on the web at the time this book was prepared are as follows (most of these provide links to additional sites of interest):

- Herbs 'n' Such World-Wide: A Collection of Knowledge Regarding Herbs and Related Topics (http://www. accessnow.com/herbs/welcome.html)
- An electronic version of Grieve (1931) (http://www.botanical.com/index.html)
- World of herbs (http://pages.prodigy.com/FL/Tampa/lemon/hercoi.htm)
- HerbNET service of The Herb Growing and Marketing Network (http://www.HerbNET.com)
- Algy's herb page (http://www.algy.com/herb/culinary.html)
- Internet directory for botany (http://www.helsinki.fi/kmus/botmenu.html)
- Internet directory for botany/Economic Botany - Ethnobotany/Herbal medicine (http://www.helsinki.fi/kmus/botecon.html#herbs)
- Internet directory for botany/Gardening (http://www. helsinki.fi/kmus/bothort.html)
- Reference guide for herbs (http://thelinx.com/healthy/herbs.htm)
- The Plant Tracker (http://www.axis-net.com/pfaf)
- Richters herb specialist home page (http://www.richters.com/index.html)
- Herb archives (http://sunsite.unc.edu/london/herbs.html)
- Henriette's Herbal Homepage (http://sunsite.unc.edu/herbmed)
- The Herb Society (UK) Homepage (http://sunsite.unc.edu/herbmed/HerbSociety)
- The Whole Herb homepage (http://www.wholeherb.com/index-y.html)
- Gateway to the New Crop Resource Online Program (http://www.hort.purdue.edu/newcrop/home)
- The Alternative Medicine homepage (http://www.pitt.edu/~cbw/altm.html)
- World Wide Web Herbal Links (http://www.herb.com/link.htm)
- Herb Research News (http://sunsite.unc.edu/herbs)
- Agricultural Research Service Phytochemical and Ethnobotanical Databases (http://www.ars-grin.gov/~ngrlsb)
- Homeopathy Homepage (http://www.dungeon.com/~cam/homeo.html)

• Herbs and Spices, by J. Dawkins and R. Lunde (http://www.teleport.com/~ronl/herbs/herbs.html)

• Herbweb (http://www.herbweb.com)

• The Herb Society of America (http://www.herbsociety.com)

• Clinical Herb Manuals by Michael Moore (http://chili.rt66.com/hrbmoore/ManualsMM/MansMM.html)

• Herbal Hall (http://www.herb.com)

• Howie Brouwnstein's home (http://www.teleport.com/~howieb/howie.html)

• U.S. Dept. Agriculture climate zones for U.S. [provides link to zones in southern Canada, but this wasn't functional at time of writing of this book] (http://www.klippo.se/nilsson/usdazones.html)

• U.S. Dept. Agriculture climate zones for northeastern U.S. (http://www.ncia.net/mrff/zones.htm)

• Climate zone map for Europe, based on U.S. Dept. Agriculture climate zones (http://www.klippo.se/nilsson/eurozoner.html)

Internet herbal resources are discussed by Chadwick (1995). Internet links change, move and often rapidly become defunct. As the internet is a transient, volatile medium, addresses may not continue to be accurate, and use of the increasingly sophisticated search engines and web crawlers that are becoming available is recommended. Even if many of the above URL's become dated, their titles furnish key words for a search.

On the whole, I have found the internet to be a valuable adjunct to information concerning herbs obtained from printed sources, especially of very recently generated information. There are numerous illustrations that are available, usually in color, and this pictorial capacity of the internet is already very impressive insofar as herbs are concerned. I certainly urge those who have not yet become acquainted with the internet to do so, as this is an extremely efficient, cheap, and entertaining mode of communication that appears destined to become the world's central storehouse of information. However, it is clear that, as of this writing, most of the knowledge that has been accumulated concerning herbs is not yet available on the internet. Moreover, the quality and reliability of internet information concerning herbs is extremely variable and, as a result of searching for supplementary information for this book, I would suggest that more than 99% of documents that are currently on the World Wide Web are not authoritative and cannot be trusted. Scholarly, academic work is usually recognizable by its nature, and is relatively trustworthy. Sites that are maintained by governments, universities and other major research organizations tend to produce quite reliable information.

Acer

Family: Aceraceae (maple family)

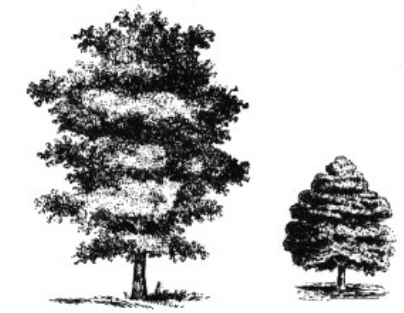


Fig. 22.
Sugar maple trees *(Acer saccharum)*, from Harter (1988).

Genus Notes

Acer has perhaps 150 species, mostly trees, and some shrubs. The majority are native to the north temperate zone, particularly to eastern Asia, with about a dozen species indigenous to North America and some in Central America and North Africa. Most species of maple are deciduous, and flower in late winter or early spring. The leaves, arranged oppositely on the stems, are usually simple and palmately lobed, although sometimes they are compound (i.e., with several leaflets). Individual trees may bear unisexual flowers, or hermaphrodite flowers, or a mixture of both. Some species produce nectar and are insect pollinated, others are wind pollinated, and still others are both insect and wind pollinated. The distinctive fruit consists of two attached seeds, each encased by a protective fruit wall that expands into a wing on both sides of the pair of seeds. The wings rotate like the blades of a helicopter, parachuting the seeds some distance away from the parent tree.

The sugar maple is not the only tree that produces usable quantities of sweet sap. In India, palms are used for this purpose. Birch trees (*Betula*) and other species of maple also often furnish substantial quantities of sugary sap. However, the sugar maple produces considerably more concentrated sap than other trees available in the New World. Facciola (1990) provides information on the sugar content of many maple species.

The inclusion of sugar maple in a book on culinary herbs may seem odd. Only a few trees and shrubs are discussed in this book; most culinary herbs really are herbaceous. Moreover, unlike maple trees, most culinary herbs are distinctly aromatic, and are consumed with main dishes at lunch or dinner, rather than as part of dessert or breakfast. It should be remembered that culinary herbs are defined in this book as plants consumed in small amounts that produce large differences in taste, and teas and coffees are accepted as meeting this definition. Plants whose only culinary use is as extractives are generally excluded from this book, but maple syrup is a very special case. It is the only natural sweetener from plants indigenous to northern North America obtained in commercial amounts, it is uniquely associated with northern North America, and has an extraordinarily attractive and celebrated flavor. Of course, the volume of maple syrup produced is dwarfed by comparison with the world's predominant sweetener, the disaccharide sucrose obtained from sugar beet (*Beta vulgaris* L. subsp. *vulgaris*) and sugarcane (*Saccharum officinarum* L.). The former is discussed in a companion volume to this book, treating vegetables (Munro and Small 1997). The latter is adapted to warmer climates than found in northern North America.

The historical use of species of *Acer* as food by Indigenous Peoples of Canada is discussed in some detail by Kuhnlein and Turner (1991). Aside from the use of various species as sources of maple sugar, the following culinary uses may be noted. *Acer macrophyllum* was used by various tribes: the Lower Nlaka' pamux (Thompson) of British Columbia ate raw young shoots and boiled, sprouted seeds; the Sechelt also consumed the seeds of this species and the Saanich ate the inner bark. The Micmac of the Maritimes made tea from the bark of *A. pensylvanicum* L. The Blackfoot used the dry crushed leaves of several species of maples to spice stored meat. The Iroquois of the Lake Ontario region pounded the dried bark of *A. rubrum* L. into flour for bread, as did the Iroquois who used the bark of *A. saccharinum* L. for this purpose. In the U.S., American Indians also once prepared bread from the inner bark of maples (Fernald et al. 1958). Outside of North America, maple seeds have also been used as food. Dewinged maple seeds were cooked in butter and milk by the Calmucks of Mongolia (Fernald et al. 1958). However, Duke (1992*a*) noted that some maple seeds are toxic.

Mountain maple (*Acer spicatum* Lam.) is a tall shrub or small tree of the northern U.S. and Canada. It is employed in tobacco flavoring, and extracts have been used in non-alcoholic beverages, ice cream, candy, and baked goods (Furia and Bellanca 1975).

Acer is the most important deciduous genus of plants employed in bonsai, several Oriental species used especially for this purpose (Huxley et al. 1992).As well, many species of maples are grown as ornamentals. Almost all maples produce good fall coloration.

The names flowering maple and parlor maple refer to species of the genus *Abutilon*, quite unrelated to *Acer*.

Acer Saccharum Marsh.

Fig. 23.
Sugar maple *(Acer saccharum subsp. saccharum)*,
from Sargent (1891).

Scientific (Latin) Synonyms

A. saccharophorum C. Koch.

[In much of the literature produced in the late 19th and early 20th centuries, the name used for the sugar maple was *A. saccharinum* Wang.; this should not be confused with another maple of North America, *A. saccharinum* L., the silver maple (see Shaw (1977) for a discussion of past applications of the epithets *saccharum, saccharophorum*, and *saccharinum*). Similarly, another early name was *A. barbatum* Sarg., which should not be confused with another North American maple, the southern sugar maple, *A. barbatum* Michx., recognized as a subspecies of sugar maple in the following discussion.]

English Names

Sugar maple
Also: bird's-eye maple, Caddo maple (for the cultivar Caddo), hard maple (an allusion to the hard wood), curly maple, rock maple, sugar-maple

French Names

Family: Acéracées
Érable àh sucre (m)
Also: árable franc, érable franche
[Black maple = érable noir.]

Description, Taxonomy, and History

The sugar maple is one of the most common trees of eastern North America, dominating the maple-beech climax association covering much of this area. It ranges from the Gaspé Peninsula in Quebec to the southeastern corner of Manitoba, southwards to Florida and Texas, and even Guatemala. It is also found in the Rocky Mountains and their Mexican extensions. When growing in a forest, a straight, branch-free trunk as high as 40 m develops. Open-grown trees develop a rounded crown. The trunk may exceed 1.5 m in diameter at maturity (see Curiosities for record size). The wide-spreading root system is shallow, like that of other maples, but is deeper than found in most species of *Acer*. Tassel-like clusters of flowers appear with the unfolding leaves in the spring, and the fruits mature in the fall.

The following are the more prominent of the several infraspecific groups that have been recognized. The first two are mainly responsible for the commercial sugar maple harvest.

a) Subspecies *saccharum* (*A. barbatum* Sarg.) is found from Nova Scotia to southern Minnesota, south to West Virginia and Arkansas.

b) Subspecies *nigrum* (Michx. f.) Desmarais ranges from southern Quebec to southern Minnesota, south to West Virginia and Arkansas, but is abundant only in the eastern portion of its range. It often occurs in moister (bottomland) sites than does subsp. *saccharum*. The two intergrade (Dansereau and Desmarais 1947), so that it is sometimes difficult to identify a given tree as one or the other. This distinctive form of sugar maple is known as black maple and black sugar maple, and is often

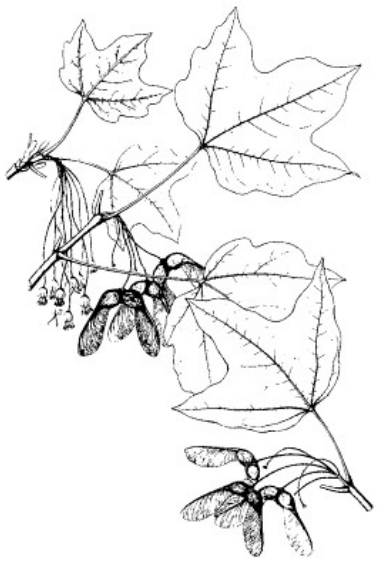


Fig. 24.
(Black) sugar maple *(Acer saccharum subsp. nigrum)*,
from Sargent (1891).

recognized as a separate species. The bark is relatively black; the leaves have fewer lobes than subsp. *saccharum*, often three, and the sides of the leaves often have a rather wilted or drooping appearance.

Fig. 25.
Rocky mountain sugar maple *(Acer saccharum subsp. grandidentatum)*, from Sargent (1905).

c) Subspecies *grandidentatum* (Torr. &A. Gray) Desmarais, known as Rocky Mountain sugar maple and big-tooth sugar maple, grows in deep, protected canyons from Wyoming to Utah and the northern part of Mexico.

Fig. 26.
Chalk (sugar) maple *(Acer saccharum subsp. leucoderme)*, from Sargent (1905).

d) Subspecies *leucoderme* (Small) Desmarais (*A. leucoderme* Small), chalk maple (sometimes white-bark maple), ranges from southern Virginia to northern Alabama.

Fig. 27.
Southern sugar maple *(Acer saccharum subsp. floridanum)*, from Sargent (1905).

e) Subspecies *floridanum* (Chapm.) Desmarais (*A. barbatum* Michx.), southern sugar maple, is found on the Coastal Plain from Texas to East Virginia, and in the Ozark Plateaus of Missouri and Arkansas.

In addition to the above well-known subspecies, the following two have been recognized (see Dent 1992). Subspecies *schneckii* (Rehder) Desmarais occurs in the zone of overlap of either of the northern subspecies *nigrum* or *saccharum* with either of the southern subspecies *floridanum* or *leucoderme*. Subspecies *skutchii* (Rehder) E. Murray occurs from the mountains of Tamaulipas, Mexico to some isolated stations in Chiapas, Mexico, and Departments Quiche and Zacapa in Guatemala.

The sugar maple has been domesticated in that there are ornamental cultivars available. As well, some selection by forestry breeders has occurred for lumber characteristics. Sugarbush farmers often preserve high-yielding trees while eliminating trees with low yields of sap and low concentrations of sugar. However, at this time trees from which the sap is harvested are basically unmodified wild plants.

Virtually all Indigenous Peoples within the range of the sugar maple prepared syrup and sugar from it; indeed, maple sugaring was a prehistoric activity, and an important part of the subsistence cycle of peoples of the Eastern Woodlands (Kuhnlein and Turner 1991). In 1870, approximately 7 000 kg of maple sugar were annually sold to the Northwest Fur Company by the Winnebagoes and Chippewas of the Great Lakes.

The native Indians of North America collected sap in crude wooden (particularly birchbark) or pottery vessels in the early spring after simply hacking wounds on the trunks of the trees. Such a procedure eventually killed the trees. Since metal containers were not available prior to Columbus' discovery of the New World, present-day technology of lighting fires under containers of sap could not be used. The sap was concentrated by boiling, achieved by dropping hot rocks into the filled vessels that were available (Klein 1979).Alternatively, the containers of sap were left until a layer of ice formed at the top; this (mostly sugar-free) ice was removed, and the process repeated until the sap was sufficiently concentrated. Maple syrup was the principal confection of the Eastern Woodlands Indians, who used the syrup and its sugar to flavor and season vegetables, fruits, stews, cereals and fish (Kavasch 1979; Kuhnlein and Turner 1991). Munson (1989) concluded that while maple syrup production is quite ancient in North America, maple sugar was not produced by North American Indians prior to about 1675. A variety of beverages, including fermented drinks, were also prepared from sugar maple (Kuhnlein and Turner 1991). [Note that these historical flavoring uses are completely consistent with defining sugar maple as a "culinary herb!"] By the 17th century, European colonists improved on the Indian techniques of collection. Until cane sugar became available, about 1860 in New England, maple syrup was an important component of the colonists' limited culinary fare. Even the southernmost sugar maples (subsp. *floridanum*) were a regular source of sugar until sugar cane and sorghum were extensively grown (Fernald et al. 1958). Sugar beet and cane sugar increasingly supplanted maple sugar as the common sweetener of North America; current production is about one fifth of 1900 levels (McGee 1984). In the U.S., 1852 was probably the top year for maple syrup and sugar production (Thompson 1978).

Fig. 28.
Sugar cane *(Saccharum officinarum)*, from Engler and Prantl (1887). Sugar cane is the source of cane sugar, the world's most widely used sweetener, and probably the cheapest form of food produced (Crammer and Ikan 1986). It represents between 15 and 30% of the total calorific intake of the world (24% of the calories consumed by the average American), but has been associated with certain health problems such as tooth decay, obesity, diabetes, and cardiovascular disease (Tripp 1985; Brody 1987). Alternative, natural sweeteners discussed in this book include licorice, maple sugar, stevia, and sweet cicely.

Uses

Most popularly, sugar maple syrup is served "as is" on pancakes, waffles, ice cream, and other desserts. It can be processed into taffy, soft and hard sugar, and maple butter, and is sometimes used as an ingredient in a number of confectionery items. The ritual of the sugar-on-snow party is a familiar one to many northern North Americans. Hot, thick syrup is first produced by boiling the sap beyond the

syrup point until it reaches the consistency of molasses, and this is ladled onto fresh snow, where it quickly hardens into a taffy-like mass. Maple butter, maple honey, and maple cream are other forms of maple sugar. The tobacco industry purchases considerable maple syrup for flavoring its products. Maple is one of the commonest woods used as a flavoring smoke for meat and other foods (*see* Medicine).

As well as being a source of syrup, the sugar maple is one of the most valuable commercial hardwoods in Canada and the northern U.S. It is the chief source of maple wood in North America, and is considered the most valuable of all maples for commercial timber production (Huxley et al. 1992). Sugar maple is used for the production of furniture, flooring, farm tools, turnery, veneer, plywood, dies and cutting blocks. It is the preferred wood for bowling pins, piano frames, shoe lasts, billiard cues, and many other products. Its strength makes it an outstanding choice for factory, dance-hall, and bowling-alley floors.

Sugar maple is also widely grown as an ornamental tree in lawns and parks, and along streets. "The sugar maple is considered by some to be the most beautiful tree in the world" (Weiner 1991).

Recipe Sources

Nearing and Nearing (1950) give 14 recipes, including Maple apple sauce, Maple gingerbread, and Maple sugar cinnamon toast. Fernald et al. (1958, p. 269) provide a recipe for maple been Gibbons (1962) gives instructions for preparing maple syrup, maple sugar, and recipes for the following: Maple nut divinity (with black walnuts or hickory nuts); Creamy pralines (with pecans or hickory nuts); Praline sauce. Day and Stuckey (1964) give recipes for: Maple-flavored browned butter frosting, Maple frosting, Maple custard pie, and Maple-flavored carrots. Thompson (1978) provides almost 100 recipes; those not for sweet desserts are: Maple fruit salad dressing, Maple salad dressing, Glaze for ham, Maple sauce for ham, Maple sweet potatoes or carrots, Maple candied sweet potatoes, Maple gingered carrots, Maple baked beans, Maple sausage and apples, and Maple syrup ham. Rose (1979) gives recipes for the following: My momma's bread pudding; Buckwheat cakes or waffles; Dried corn Indian soup; Indian corn; Jean's beans; Penny's all star granola; Bryan's pound cake; The best dark fruitcake. Phillips (1986) provides recipes for: Maple-glazed pear pyramid, Creamy maple pralines, and Maple cocktail.

References to other recipes are: Whipped maple-cinnamon butter (McCormick 1979); Drie-**i**n-de-pan (Three-**i**n-the-pan Dutch pancakes) (Chantiles 1984); Flambéed apples in maple syrup (Hacker 1993).

Importance

Sugar maple syrup is generally considered a luxury item, since cane and beet sugar, and corn syrup are produced very much more cheaply. The quantity of sugar maple syrup is only commercially important in primarily northern or alpine areas, where alternate spring freezing and thawing produces an exceptionally high sap yield. Sugar maple production is a uniquely North American industry, with over 10 million L often produced annually. Canada accounts for three quarters of world production, with Quebec yielding three quarters of Canada's output. In Quebec, production is greatest in the Beauce (southeast of Quebec City), with lesser quantities from the area around Quebec City and in the Eastern Townships. The value of maple sugar to producers of Quebec in 1990 was $61.7 million, more than the fruit or potato crop industries (Robitaille et al. 1995). In the remainder of Canada the industry is located in eastern Ontario, Nova Scotia, and New Brunswick. In the U.S., maple sugar syrup is produced commercially in 13 northern states from Maine to Minnesota. The leading states are Vermont, New York, Pennsylvania, Michigan and Ohio.

Sugar maple syrup production is a seasonal industry, conveniently occurring during a farm's slack season. Although a multi-million dollar industry, few producers rely on it as the chief source of income. Harvesting syrup is labour-intensive, and in North America approximately 60 000 part-time workers are employed each year.

Because of its attractive flavor and relative expense, maple syrup is often imitated. Synthetic chemicals like cyclotene, maraniol, and butylidene phthalides are often used to obtain maple taste (Arctander 1960). So are natural materials such as fenugreek, celery seed, and lovage (all discussed in this book). Artificial syrup is based on sugar syrup with the addition of natural and synthetic flavorings. Possibly ten times as much artificial maple syrup as the real thing is sold (Arctander 1960).

Cultivation Notes

Soil

Houston et al. (1990) provide extensive information on soil requirements for sugar maple. The trees grow best on moderately coarse-textured, moist, well-drained deep soils. The pH tolerance range of the soil is 4.5 to 7.3. Stoniness of the substrate has little effect on development provided that the soil is adequate for growth. Fertilization on the whole has produced mixed results, and should not be attempted without adequate chemical analyses of soil and foliage. Liming of the soil to correct presumed increase of acidity, commonly suggested as the cause of maple decline, is

an uncertain undertaking. Too much lime can decrease the availability of certain nutrients and inhibit mycorrhizae (plant-root - fungus associations) that enhance the trees' ability to take up nutrients. Roadside trees often show the damaging effects of winter road salt, so that trees to be tapped are preferably located away from salted areas.

Climate

Acer saccharum is hardy northwards to areas with mean minimum temperatures of-40°C (Deschênes 1970). Like most maples, it is quite shade-tolerant, although it is best grown in full sun to light shade. There is considerable genetic variation for tolerance to sunscorch, drought, winter hardiness, and other characteristics (Kriebel 1957).

Several climatic conditions are thought to promote good sap production: a sunny summer and fall, a late frost, a severe winter that freezes the roots, snow cover that keeps the roots cold in the spring, and extreme variation in temperature from day to night (typical of mountain climates) (McGee 1984). Southeastern Canada and the northeastern states provide these conditions most consistently, and therefore are where maple sugar. production occurs commercially.

Propagation and Cultivation

Sugar maple can be propagated from seeds. The seeds must be stratified (stored under cold, moist conditions) before they will germinate. Seeds soaked in water overnight and stored moist just above freezing will germinate in 2 to 3 months (Janerette 1979).

Ornamental cultivars should be reproduced by cuttings stimulated to root with hormones, or by grafting to compatible rootstocks. Getting cuttings to root is perhaps a job for professionals. Cuttings from some trees can be stimulated to root readily, others not at all, and in some cases roofing hormones are not helpful (Yawney 1984). Sometimes cuttings can be rooted, but will not sprout buds after overwintering. June is the best time for taking cuttings. For most people, it is easiest to simply purchase potted plants from nursery supply houses.

It is clear that some trees are better producers of sap than others, and an experienced sugarbush farmer will identify superior trees, and remove poor ones. Research has been conducted on the physical characteristics of sugar maple trees and yields of sap and sugar. Early investigators concluded that an ideal sugar tree was one with a wide, deep crown characteristic of open-grown trees (Blum 1973). Open-grown trees have been shown to average 1 to 1.5% higher sugar content than trees growing in a forest stand, so that 35 to 50% less sap is required to produce a given volume of finished maple syrup (Kriebel 1989). This means that well-spaced trees in orchards or even trees planted along roadsides where they would receive considerable light could be much more productive than dense, natural stands.

Harvest and Storage

Sugar concentration averages less than 3% sucrose in the sap (some trees have as much as 8% sugar content), so that 30-40 L of sap often must be boiled down to produce a litre of syrup. At 2% sugar content, 43 L of sap are required to produce 1 L of syrup; at 4% sugar content, 22.5 L of sap are needed. A large tree can produce 4 L of syrup in one season. Production varies considerably from year to year, and the factors responsible for this are largely unknown. The running of sap in the spring is poorly understood. In the previous growing season, sugars formed in the leaves by photosynthesis and moved down to the trunk and roots, where they were converted into starch and stored in living ray cells of the wood. When the trunk warms up sufficiently in the spring, the starch is first converted into glucose sugar, then into invert sugar (a mixture of glucose and fructose), and finally into sucrose. Ideal temperatures for the sap to run are 7°C in the daytime and -4°C at night. Warm days and freezing nights create a pumping action. Cold nights induce a negative pressure within the tree, with moisture being absorbed through the roots. Warm days provide positive pressure, forcing the sap out of the tree. However, the actual physiological mechanisms causing the development of positive and negative pressure in maple trees are poorly appreciated. Only a small percentage of the sap of the tree is removed each year, and trees can be used repeatedly for a century or more. An excessive number of holes in the trees or extra-large holes may damage trees by encouraging decay.

The technology of production of maple syrup is now fairly advanced (Northeastern Forest Experiment Station 1982). Holes of a standard diameter (typically 7/16 inch) are drilled to a depth of about 7 cm past the bark, slanting slightly upward to facilitate the downward flow of sap. Several such holes may be drilled in a large tree. A plastic or metal spout (*spile*) is inserted into the hole, with the sap flowing though this into plastic buckets. Galvanized buckets have often been used, with minute amounts of zinc dissolving into the sap. Lead-coated buckets or buckets painted with lead paint should not be used because unsafe levels of lead may dissolve into the sap. Aluminum buckets are popular and considered satisfactory. Plastic bags are sometimes used. Traditionally the buckets are emptied by

hand into vats that are hauled to the evaporators by horse-drawn sledges. Many producers, however, attach quarter-inch plastic tubing to the spouts, about 120 cm above the ground, feeding these lines into a 1 inch master line that carries the sap to a tank supplying the evaporators.

In Canada, trees are usually tapped between the middle of March when temperatures have reached about 5°C and the end of April. In the U.S., the season is progressively earlier southward. Sap must be collected within 2 days after it runs, and boiled as soon as possible, as allowing it to warm has been observed to produce dark syrup of poor quality. The early runs of sap produce light-colored, aromatic "fancy" grades of syrup, slightly less concentrated. However, sugar concentration remains more or less constant during the season. As the season progresses, the syrup darkens, and eventually the maple taste becomes strong and almost unpleasant, so that the product is used mainly to flavor breakfast cereals and junk food.

Maple syrup is boiled down in an evaporator that reaches a temperature of 4°C above the boiling point of water at a particular location. In a modern commercial operation the syrup is filtered and stored under refrigeration in sterilized containers. Although high in sugar content, maple syrup spoils at room temperature; once opened, containers should be stored in the refrigerator. Commercially, potassium sorbate and sodium citrate are widely used as preservatives (Munson 1989).

Maple sugar is prepared by concentrating the sucrose to the point that it will crystallize out of solution when the syrup cools. Maple cream is a malleable mixture of very fine crystals in a small amount of dispersed syrup, prepared by cooling the syrup very rapidly to about 21°C by immersing a pan of syrup in a bath of iced water, and then beating it continuously until it become very stiff. The mass of material is then rewarmed in a double boiler, becoming smooth and semisoft (McGee 1984).

Example Cultivars

Caddo, Newton Sentry, Slavin's Upright, Temple's Upright (= Monumentale) (described in Huxley et al. 1992). Green Mountain is mentioned by Cole (1979). The cultivar High Sugar is alleged to have sap with double the usual sugar content, or around 4% (Facciola 1990).

Additional Notes

Decline of certain forest tree species in parts of their distribution range has been documented in various regions of the world for hundreds of years, but especially during the present century (Carrier 1986). Maple dieback or decline in recent years has caused great concern in the sugar maple industry. It seems clear that a primary cause is insect defoliation followed by fungus attack (Houston et al. 1990). Robitalle et al. (1995) found evidence that deep soil freezing at times of low snow cover can result in dieback. Atmospheric deposition, notably acid rain, has been hypothesized as an important additional factor stressing trees and resulting in dieback. Acidic substances, perhaps ozone and heavy metals, might be causal agents. However, there is disagreement regarding the role, if any, of atmospheric deposition in maple decline (Houston et al. 1990).

Chemistry

Maple syrup is graded on the basis of color, taste, concentration of salts, solid matter held in suspension, and presence of sugars other than sucrose, such as fructose and glucose. The flavor of the syrup is determined by many poorly understood factors. The characteristic flavor is the result of browning reactions between sugar and amino acids in the sap. The color becomes darker and the taste heavier, the longer and hotter the syrup is boiled (Mcee 1984). The composition of maple sugar is about 62% sucrose, 35% water, 1% glucose and fructose, and 1% malic acid (McGee 1984). Small amounts of calcium, potassium, phosphate and sodium ions, and organic compounds including invert sugars, amino acids, and small amounts of citric and other acids are present. Also important are minute amounts of phenolic compounds, particularly those involved in the formation of wood lignins.

Medicine

Duke (1986) reviewed North American Indian medicinal usage of sugar maple. The Iroquois used the sap for shortness of breath. The inner bark was used by the Mohegan for cough, by the Ojibwa for diarrhea and to promote urination, and by the Potawatomi to clear mucus from the respiratory tract. The Walpole Island Ojibwa employed an infusion of the bark for cataracts and as an eyewash. During the maple syrup season, New Englanders used to drink collected sap as a spring tonic (Foster and Duke 1990).

Maple is one of the most popular woods used to make liquid wood smoke for flavoring foods (Rinzler 1990). Several major toxicity studies have shown that liquid smoke appears safe, but a 1988 Massachusetts Institute of Technology study indicated that liquid smoke was mutagenic when applied to human white blood cells (Rinzler 1990).

Nutrition

As noted above, small amounts of minerals are present. However, maple sugar does not contribute appreciably to nutrition.

Curiosities

• According to an old story, long ago the Indians were able to draw thick maple syrup directly from the sugar maple. A legendary Indian hero, Ne-naw-Bo-zhoo, thought that this would make the Indians lazy, so he diluted the sap by climbing all the maple trees and pouting water into them (Nearing and Nearing 1950; Gibbons 1962).

• An Iroquois legend attributes the discovery of maple syrup to the wife of chief Woksis. She noticed that a maple tree was dripping liquid where her husband had imbedded his tomahawk the previous night. Rather than making a trip to get cooking water, she used the maple sap. By the time the chief had returned from hunting, the maple sap his wife had used had boiled down to syrup, making the sweetest meal they had ever eaten (Nearing and Nearing 1950).

• The Iroquois worshipped the sugar maple each spring as a sign of the Creator's renewed covenant (Cheatham and Johnston 1995).

• On journeys, the Iroquois carried maple syrup in empy quail and duck eggs, colorfully described by Weiner (1991) as the first 'no-deposit-no-return' biodegradable containers.

• Maple sugar was much cheaper and more available than the heavily taxed refined sugar imported from the West Indies. After the American Revolution, a moral justification for preferring maple sugar to cane sugar was advanced on the basis that the latter was produced largely with slave labor. Benjamin Rush (17457-1813; physician, social reformer, American patriot, and signer of the Declaration of Independence) wrote to Thomas Jefferson in 1791 (cited in McGee 1984):

> *In contemplating the present opening prospects in human affairs, I am led to expect that a material part of the general happiness which Heaven seems to have prepared for mankind will be derived from the manufactory and general use of maple sugar... I cannot help contemplating a sugar maple tree with a species of affection and even veneration, for I have persuaded myself to behold in it the happy means of rendering the commerce and slavery of our African brethren in the sugar islands as unnecessary as it has always been inhuman and unjust.*

• North American colonists often apologized for serving maple sugar instead of the rather inferior, costly, scarce manufactured brown sugar of the time (Angler 1978). Today, the mantle of inferiority has passed to sugared, maple-flavored imitations of real maple syrup.

• Fernald et al. (1958) relate the story of American tourists in rural Gaspé Peninsula, Quebec in the early part of the 20th century, before the area became a sightseeing attraction. The tourists were given a bill of $2.56 for "supper, lodging, and breakfast for three and bedding and feed for the horse." After paying $2.75, the innkeeper refused the tip (generous by the standards of the day), but was embarrassed to find he didn't have change. Taking down an enormous loaf of maple sugar from a shelf, he chopped off 5 pounds and gave it to his guests as change.

• As noted earlier, sugar concentration averages less than 3% sucrose in the sap, although Thompson (1978) reported that some trees may have as much as 11%. By comparison, the sucrose in sugar cane is between 16 and 17%, and in sugar beets about 18% (Thompson 1978). The date palm yields the strongest sugar solution of any known tree used for sugar extraction - 15 to 20% (Nearing and Nearing 1950).

• In pioneering days of the U.S., apples and such root crops as carrots and potatoes were stored separately between layers of maple leaves to help in their preservation (Reppert 1976).

• The maple is Canada's national tree. However, just which species of maple should qualify for this honor has never been stated in official statutes. The stylized. maple leaf on the Canadian flag looks much like the Norway maple (*Acer platenoides* L.), a foreign, introduced maple, which should hardly represent Canada. In an intriguing article, W.G. Dore (1967) pointed out that two North American maples, silver maple (*A. saccharinum* L) and red maple (*A. rubrum* L.) widely hybridize and intermingle in Canada to produce "a tree of mixed parentage, a vigorous and vital breed, newly sprung from the particular milieu which pertains to Canada!" Dr. Dore proposed the name "united maple" for the hybrid tree, and recommended that it be identified as Canada's emblematic maple.

• The sugar maple is the state tree of New York, Vermont, West Virginia, and Wisconsin (Cheatham and Johnston 1995).

• All maples are "hardwoods," a term used to designate most deciduous trees, as opposed to the "softwoods," the contrasting term referring in general to coniferous, evergreen trees, which generally have softer wood than the hardwoods. Most of the dozen or so North American species of Acer, including sugar maple, are "hard maples," so-called because of the very hard texture of the wood. The silver and red maples referred to above are "soft maples," with softer, although still quite hard, wood.

Maple wood can be identified as hard or soft by applying a solution of ferric salt to the sapwood; blue stain indicates a soft maple and green stain identifies the tree as a hard maple.

• "Birdseye" is a distortion of the grain in sugar maple wood, associated with a pattern of conical indentations in the growth rings. Its causes are poorly understood, but the attractive pattern of "eyes" in the wood grain make the lumber from affected trees as much as 40 times as valuable as normal sugar maple lumber (Bragg and Stokke 1994).

• Maple syrup has been made in home kitchens, boiling sap down on the kitchen stove. A frequent result is that the huge volume of water vapor produced has condensed on walls, sometimes peeling wallpaper away (e.g., Gibbons 1968).

• Maple sap that flows in the spring appears to come from all directions (not just from the roots): from above, below, and sideways within the tree, apparently to prepare critical areas of the plant for growth. The lateral flow provides sugar to the growing part of the tree trunk (cambium), near the bark, for active growth in the spring (McGee 1984).

• The biggest known sugar maple, located in Norwich Connecticut, in 1984 possessed the following dimensions (Bronaugh 1992): circumference at "breast height" of 1.37 m (4.5 feet): 683 cm (22 feet, 5 inches); height: 28.3 m (93 feet); crown spread: 24.4 m (80 feet).

Problems and Potential

The market for maple syrup is stable and is likely to remain so. It is possible to breed sugar maples for higher sap yield (Krieble 1989, 1990), although at present wild trees completely meet market demand. The chief threat to the future of the maple industry lies in decline of the vigor of trees. A cooperative program between the U.S. and Canada was established to examine maple decline in North America (Millers et al. 1991). Insects can occasionally pose serious problems. For example, in 1988 an outbreak of pear thrips defoliated 200 000 ha of maple forest in Vermont (Bronaugh 1992).

Selected References

Nearing and Nearing (1950); Gibbons (1962); Thompson (1978); Northeastern Forest Experiment Station (1982); McGee (1984); Houston et al. (1990); Gelderen et al. (1994); Cheatham and Johnston (1995).

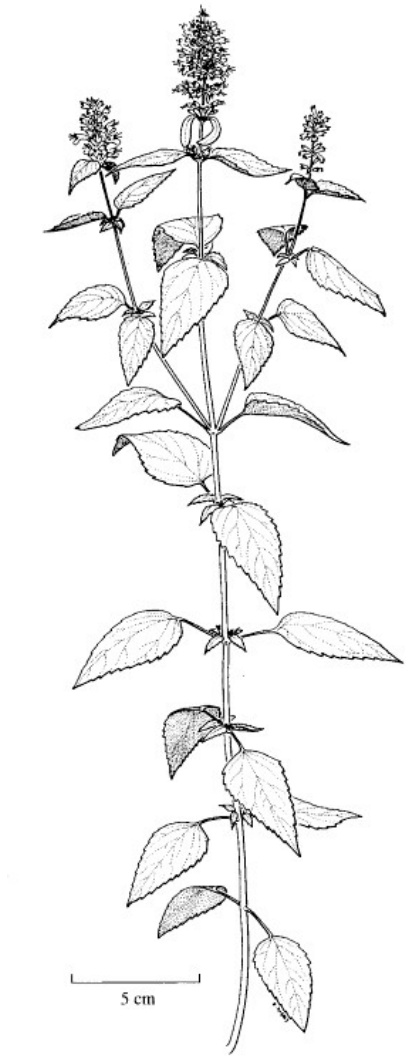


Fig. 29.
Anise hyssop *(Agastache foeniculum)*, prepared
by S. Rigby. (Based on H. Marshall M-1621
at Agriculture and Agri-Food Canada herbarium, Ottawa.)

Agastache

Family: Labiatae (Lamiaceae) (mint family)

Genus Notes

Agastache has about 22 aromatic upright or trailing perennial species, all native to North America, except *A. rugosa*, which is found in China, and Japan. Two species cultivated for culinary purposes are discussed in detail below; both belong to section *Agastache* of the genus (Vogelmann 1985; Vogelmann and Gastony 1987). Several western American species are gathered locally from the wild for use as flavoring herbs (Facciola 1990). Mexican giant hyssop (*A. mexicana* (Kunth) Link & Epling), a native of northern Mexico, is a reddish-flowered ornamental grown in temperate zone gardens. It has leaves that are useful for flavoring and tea (Morton 1976; Mansfeld 1986). A white-flowered subspecies is a popular medicinal plant in Mexico (Bye et al. 1987).

Apparent hybrids between *A. foeniculum* and *A. rugosa*, the species discussed below, were studied by Charles et al. (1991) and Wilson et al. (1992). Since the two species do not grow together naturally, these hybrids presumably were generated in cultivation.

Agastache foeniculum (Pursh) O. Kuntze

Scientific (Latin) Synonyms

A. anethiodora Nutt. ex Britt., *Lophanthus anisatus* (Nutt.) Benth.

English Names

Anise hyssop
Also: blue giant hyssop, elk mint, fennel giant hyssop, fragrant giant hyssop, giant fennel hyssop, giant hyssop, lavender giant hyssop, licorice mint

[Giant-hyssop is a variant of giant hyssop, and similarly one sometimes finds anise-hyssop. "Fennel," a name used in some of the above names is best reserved for *Foeniculum vulgare*, also discussed in this book; anise hyssop resembles it in its scent. The blossoms of anise hyssop and true hyssop (*Hyssopus officinalis*, also discussed in this book) are similar in having two pairs of protruding stamens, terminal spikes of lilac-blue flowers, as well as other resemblances reflecting their belonging to the same family.]

French Names

Family: Labiées, famille de la menthe

Hysope anisée (f)

[Name suggested by H.S. MacKee (personal communication).]

Description, Taxonomy, and History

Anise hyssop is a stiffly erect perennial, aromatic herb, 0.8 to 1.5 m tall. Its leaves are softly white underneath, due to a covering of white, felty hairs. The plant usually smells strongly of anise. Cool weather in the spring may result in a purple cast on new foliage. The blue flowers, 8-10 mm long, are produced in the summer, with blooming lasting for many weeks. In Canada it is indigenous from British Columbia and the District of MacKenzie east to

Fig. 30.
Anise hyssop *(Agastache foeniculum)*,
prepared by M. Jomphe. (Based on "J. Morton
on 12/1984" at Agriculture and
Agri-Food Canada herbarium, Ottawa.)

southern Ontario. In the U.S. it is found from Washington to Illinois, although very rarely in or west of the Rocky Mountains. The species has escaped from cultivation in eastern Ontario, Quebec, and New Brunswick, and in parts of the eastern U.S.

This North American herb was used by Native Americans to make beverages and as a condiment in foods, as well as medicinally, as discussed below. The leaves were used for tea by Woods Cree of Saskatchewan, and both for tea and as a flavoring by Montana Indians (Nykänen et al. 1989; Kuhnlein and Turner 1991).

Uses

The typical scent of anise hyssop is like anise and mint. The leaves are dried and used in tea. The fresh or dried leaves complement peas, lamb, and other dishes, and can be added to flavor fruit salads and beverages. The flowers are also culinarily useful. According to Creasy (1988) "this is one of the tastiest of the edible flowers." The flowers have an anise flavor and can be used as a seasoning in baking and in teas (Facciola 1990), as well as in salads and as garnishes (Henning 1994). The flowers tend to have a lighter flavor than the leaves (Henning 1994).

Anise hyssop is grown as a tail ornamental, with attractive flowers that in some cultivars may bloom until a hard frost (Kublick 1990). The flowers can be dried to add color and scent to potpourri. The blooms are a nectar source for butterflies and honeybees. Indeed, anise hyssop was recently called the "wonder honey plant" (Ayers et al. 1994). It is cultivated in the U.S. as a honey plant, yielding an excellent light-colored honey (Mansfeld 1986; Widrlechner 1987). Some tests have shown that bees prefer it to white clover (Kublick 1990). Wild birds, especially finches, are also attracted to the seeds (Morton 1976; Widrlechner, personal communication).

Anise hyssop essential oil is a source of methyl chavicol, which is used in the manufacture of perfumes, liqueurs, some foods, and root beer (Anon. 1992*a*). Methyl chavicol can be chemically modifed to anethole and anisaldehyde, which are useful in color photography and in soaps, dentifrices and other preparations (Ayers et al. 1994).

Recipe Sources

Creasy (1988) presents recipes for: Lemony anise hyssop tea bread and Special treasure Chinese beef with anise hyssop. Barash (1993) has anise hyssop flower recipes entitled: Anise hyssop mushroom pizza, Salmon with anise hyssop beurre blanc, Anise hyssop butter cookies, and Anise hyssop flower custard with black pansy syrup.

Other recipes are: Anise hyssop flower drop cookies (Kublick 1990); Anise hyssop and almond butter cookies (Belsinger 1991)

Recipes are seldom encountered for anise hyssop. However, it can be used in dishes that are seasoned with anise (*Pimpinella anisum*) or mint (*Mentha* species), in place of these herbs (see lists of recipes for these in this book).

Importance

Anise hyssop has limited commercial importance as a culinary herb. It is found ocasionally in commercial tea mixtures (Galambosi et al. 1992). Anise hyssop is sometimes grown as a forage for honeybees. Several strains have been selected in Canada for their essential oil containing methyl chavicol (Anon. 1992*a*). The species has also been cultivated, at least experimentally, in Moldavia for essential oil production (Galambosi et al. 1992).

Cultivation Notes

Soil

Anise hyssop "adapts readily to any kind of soil" (Crockett and Tanner 1977), but performs best in well-drained, fertile soils containing well-rotted manure or compost (Lima 1986). Ayers and Widrlechner (1994*b*) observed that anise hyssop in its natural habitat thrives in soils that retain moisture but are not excessively wet.

Climate

Agastache foeniculum does best in cool weather. It will survive winter temperatures of at least-10°C without protection (Huxley et al. 1992), and has survived temperatures below -25°C in Manitoba (Mazza, personal communication). However, Galambosi and Galambosi-Szebeni (1992) found that under the conditions of South-Finland, wintering of anise hyssop is uncertain, although an annual crop can be raised. Although it tolerates light shade, anise hyssop does best in full sunlight (Crockett and Tanner 1977). Abundant moisture is required, especially during dry periods (Kublick 1990; Huxley et al. 1992). Under drought conditions, plants will stop flowering in late summer (Widrlechner, personal communication). On the other hand, excessive rainfall or irrigation can also be damaging.

Propagation and Cultivation

Propagation is by seeds planted indoors in the early spring and transplanted outdoors after danger of frost has passed. The seeds should be planted at a depth of 6 mm or less (Wang et al. 1993). Ayers and Widrlechner (1994*b*) state that because *Agastache* seeds are quite small, they

can successfully germinate only under a light soil covering, and should be planted either very near to, or actually on the soil surface. The seeds germinate well, emerging in 4-10 days. Seedlings transplant easily. The plant grows very slowly initially (Morton 1976), and often requires 2 years from seed to bloom (Crockett and Tanner 1977). Seeds can be planted in late fall, and allowed to lie dormant through the winter, to germinate in the early spring. Alternatively, new plantings can be established in the spring from divisions of established plants. Cuttings can be rooted from soft or semi-ripe stems (Huxley et al. 1992). This hardy perennial does not spread by rhizomes but may disperse from seeds if these are allowed to develop (Kublick 1990). Anise hyssop is offered both as seeds and as living plants in various Canadian and U.S. garden catalogs.

Harvest and Storage

The home gardener can harvest leaves at any time during the growing season. They can be used fresh, or may be air-dried and stored in air-tight containers. According to Henning (1994), the most pungent tea is brewed from fresh leaves or flowers, and drying the herb tends to reduce its flavor. Henning (1994) recommended harvesting the leaves early in the day during a sunny, rain-free period, in the belief that this promoted the highest concentration of oils.

Grown as an essential oil plant, it has been estimated that 50 kg of aromatic oils per ha can be expected (Mazza and Kiehn 1992; Ayers et al. 1994). Galambosi et al. (1992) found that, in South Finland, yields were 100-200 kg fresh and 10-25 kg dry, marketable, crumbled drug (herb) per $100m^2$.

Example Cultivars

The cultivar Texas American (= Texas American Pennyroyal) is available in the U.S. [Facciola 1990; this information is curious in that the species is not adapted to Texas (Widrlechner, personal communication)].Alabaster (or Alba) is a white-flowered cultivar (Henning 1994).

Additional Notes

Chemistry

The essential oil, obtained by steam distillation, ranged from 0.07-2.45% of leaves and up to 3% in flowers in ten accessions studied by Charles et al. (1991). The major constituent of the oil was usually methyl chavicol (6-94%), which imparts an anise-like flavor. Plants lacking methyl chavicol do not smell of anise (Widrlechner, personal communication). Methyl chavicol (estragol) is used in perfumes, and as a flavoring in foods and liqueurs, particularly root beer, and can be used as a starting material for compounds such as anethole, anisaldehyde, anisyl alcohol, and anisic acid (Mazza and Kiehn 1992). Other chemicals in the essential oil include spathulenol (10-49%; populations low in methyl chavicol tended to be high in spathulenol), bornyl acetate, -cadinene, -limonene, and ß-caryophyllene (Charles et al. 1991). For a more complete list of minor constituents, see Charles et al. (1991) and Mazza and Kiehn (1992). Root constituents are documented by Zou and Cong (1991). Great diversity has been demonstrated in essential oil composition of anise hyssop (Charles et al. 1991; Wilson et al. 1992).

Scientists with Agriculture and Agri-Food Canada have selected strains of anise hyssop with improved essential oil content and agronomic characteristics. Methyl chavicol, usually obtained from basil and tarragon, might be commercially obtained from *A. foeniculum* (Anon. 1992*a*; Mazza and Kiehn 1992).

Medicine

Medicinal uses by native Indians were outlined by Moerman (1986). The Cheyenne employed an infusion of the leaves for colds, chest pains from coughing, and a weak heart; the leaves in a steambath to induce sweating; and powdered leaves rubbed on the body for high fevers. The Chippewa used a root infusion for colds, chest pain, and cough; and a poultice of the leaves or stalks for burns.

Tarragon oil was recently found to be "genotoxic" or mutagenic (Tateo et al. 1989), and methyl chavicol, which is present in both tarragon and anise hyssop, may be partly responsible for this (Mazza, personal communication).

Nutrition

No information found.

Curiosities

• The genus name *Agastache* comes from the Greek *agan* and *stachys*, translating as "many ears of wheat," an allusion to the many tiny blossoms of the inflorescence (Henning 1995).

• Flowers of anise hyssop were often included in Cree medicine bundles (Kuhn 1987).

Problems and Potential

Anise hyssop has little commercial potential as a culinary herb. Strains of the plant were developed by Agriculture and Agri-Food Canada for possible use as a source of essential oil. The species may find a market as an interesting specialty honey plant (Anon. 1992*a*).

Selected References

Lima (1986); Kublick (1990); Henning (1994); Henning (1995).

Fig. 31.
Korean mint *(Agastache rugosa)*, prepared by S. Rigby. (Based on greenhouse plants from Richters.) The smooth leaf edges are not usual for this species. The drawing at extreme right shows leaves with serrated edges, which are more typical. Also note the heart-shaped appearance of the leaves, in contrast to the more lance-shaped leaves of anise hyssop (compare Fig. 29).

Agastache rugosa (Fisch. & C.A. Mey.) O. Kuntze

Scientific (Latin) Synonyms

Lophanthus rugosus Fisch. & C.A. Mey.

English Names

Korean mint
Also: Chinese giant hyssop, wrinkled giant hyssop
[This is known in China as "huo hsiang," and in Japan as "kawa-midori" (Mansfeld 1986).]

French Names

Menthe de la Corée (f)

[Name suggested by H.S. MacKee and E Jacquemoud (personal communications).]

Description, Taxonomy, and History

Korean mint is a herbaceous, bushy, short-lived perennial herb growing to 120 cm tall. Plants grown from seed often flower the first year. Korean mint has purple or rose-violet flowers, produced in late summer. The species is quite similar to anise hyssop, differing in having a slightly coarser habit, rougher leaves, and paler flowers. This is not a true mint (*Mentha* species, discussed elsewhere in this book). Korean mint is native to parts of eastern Asia, including India, eastern China, Japan and Indo-China (notably the highlands of northern Vietnam). It was introduced to the U,S. in 1947 (Muenscher and Rice 1955).

Uses

The fresh or dried leaves usually have an anise-like odor and flavor, and can be employed much like anise hyssop. They are used to season meats and dressings and can be added to any recipes calling for mint flavor (Phillips and Foy 1990). The leaves are also brewed for tea. The young shoots and leaves can be boiled and eaten (Facciola 1990).

Korean mint is considered a good plant for bees, like anise hyssop (Muenscher and Rice 1955).

Recipe Sources

My fifth vegetable soup (Rose 1979).

Importance

Korean mint is of minor economic significance. It is cultivated in eastern Asia and in the U.S. as a medicinal plant. Its culinary uses are familiar in eastern Asia, but scarcely known in North America.

Cultivation Notes

Soil

No information found. Probably the same soil conditions recommended for the previously described species, anise hyssop, are suitable for Korean mint.

Climate

Korean mint thrives in temperate areas (Morton 1976). It will survive winter temperatures of at least-10°C without protection (Huxley et al. 1992). The plants require a sunny location.

Propagation and Cultivation

Korean mint is grown from seeds. It is offered as seeds or living plants in some Canadian and American garden catalogs. In the U.S., *A. rugosa* grown experimentally for bee forage has appeared to be rather short-lived, and quite susceptible to a strain of the fungus *Verticillium* (Ayers and Widrlechner 1994*a*).

Harvest and Storage

For personal use of garden plants, see information for previous species, anise hyssop.

Example Cultivars

No information found.

Additional Notes

Chemistry

The essential oil, obtained by steam distillation of the leaves, comprised 1.5-2.7% of the leaves in four accessions studied by Charles et al. (1991). The major constituent of the oil was methyl chavicol which varied from 47 to 94% (Charles et al. 1991). The spicy odor of *A. rugosa* has been attributed to methyl chavicol in combination with some minor constituents, including anisaldehyde and *p*-methoxycinnamaldehyde (Weyerstahl et al. 1992). Other important constituents are -limonene (2-14%) and methyl eugenol (up to 15%) (Charles et al. 1991). Chemical races high in methyl eugenol do not smell of anise (Widrlechner, personal communication). Wilson et al. (1992) found that *A. rugosa* produced more volatile constituents than did *A. foeniculum*, but had less diversity among populations in its volatile composition. *Agastache rugosa* contains a fairly large amount of rosmarinic acid, which is responsible for tannic activity (Okuda et al. 1986).

Medicine

Korean mint is known in Chinese medicine as "one of Wong's 50 fundamental Chinese herbs" (Duke and Ayensu 1985). It has been used in traditional folk medicine to treat

fevers, stomach problems, angina pains and many other ailments (Perry and Metzger 1980; Foster and Duke 1990). An infusion of stems and leaves is used in China as a mouthwash, and as an antidote for consuming too much wine (Morton 1976). It is a component of a Chinese herbal mixture used to treat diarrhea and fever caused by AIDS (Henning 1994).

Nutrition

No information found.

Curiosities

• The two species of *Agastache* discussed in detail in this book suggest a well known classic geographical distribution pattern, whereby one species of plant found in eastern North America (*A. foeniculum* in this case) very closely ressembles a species of East Asia (*A. rugosa*). For other examples, see Curiosities for ginseng (*Panax*) and mitsuba (*Cryptotaenia*).

• Methyl eugenol, a component of Korean mint, provides an outstanding example of "insect chemotropism" (attraction of insects to certain chemicals). Methyl eugenol has proven to be extraordinarily appealing to the males of certain species of fruit flies (females may also be attracted, but very much less than the males). The male flies have been found to fly against a 13 km/h (8 miles/h) wind for more than a km in order to reach a sample of only 5 mL of methyl eugenol, sometimes achieving speeds of 32 km/h (20 miles/h). When they reach methyl eugenol, the flies apparently cannot stop feeding on it, despite its apparently complete lack of nutritional value. Commonly the flies kill themselves with over indulgence. In California, where exotic fruit flies are a major agricultural threat, insecticide has been added to traps baited with methyl eugenol to hasten the death of the flies (Steiner 1952).

Problems and Potential

Korean mint is primarily useful as a pharmaceutical crop, and has very limited crop potential in this regard in North America. Its experimental growth in the U.S. has shown a significant susceptibility to *Verticillium* wilt. From a culinary viewpoint it is an obscure herb to most North Americans. It is best known to eastern Asians, including those transplanted to North America. A limited specialty market can be developed in North America.

Selected References

Henning (1994, 1995).

Agrimonia

Family: Rosaceae (rose family)

Genus Notes

Agrimonia has about 20 species of rhizomatous, perennial herbs, mostly in north temperate regions. All species are found on the margins or in open spaces of woods and thickets. The fruit (technically an achene) is enclosed in a top-shaped, hardened case with spreading hooked bristles around the middle. These bristles easily catch onto passing fur or feathers, promoting wide seed dispersal.

Agrimonia eupatoria L.

English Names

Agrimony
Also: agremoine, aigremonie, agremony, church steeples (church-steeples), cockle-bur, cocklebur(r), common agrimony, eggremunny, egremony, egremounde, egrimony, garclive, garglive, goosechite, Greek's eupatory, harvest lice, liverwort, medicinal agrimony, rat('s) tail, stick seed, stickwort (sticklewort), white tansy, wild agrimony.
[This species should not be confused with hemp agrimony, *Eupatorium cannabinum* L., a plant used in folk medicine. Kline (personal communication) suggests that the name "Eupator's agrimony" could be used to avoid confusion with other North American species of *Eupatorium* that are also sometimes simply called agrimony.]

French Names

Family: Rosacées, famille de la rose (famille du rosier)
Aigremoine (f)
Also: aigremoine commune, aigremoine eupatoire, aigremoine gariot, eupatoire, eupatoire des anciens, eupatoire des Grecs, francormier, grimoino, grimonem, grimoueno, herbe de Saint-Guillaume (herbe de Saint Guillaume), herbe de Sainte-Madeleine (herbe de Sainte-Madeleine), thé du Nord, thé du bois, soubeirette, sourbeiret(t)o, toute-bonne.

Description, Taxonomy and History

Agrimonia eupatoria occurs in most of Europe, except the extreme north, in northern Africa, in Asia Minor, and in northern and central Asia. Three subspecies have been recognized in Eurasia (Skalický 1968). In North America, the species occasionally escapes cultivation and occurs in thickets in old fields or along roads. Agrimony has only been collected a few times growing wild in the U.S. - in Massachusetts, Minnesota, and Wisconsin. It is a some-

Fig. 32.
Agrimony *(Agrimonia eupatoria)*,
from Oeder et al. (1761-1883).

what aromatic, herbaceous perennial, growing 30-150 cm tall, and producing numerous, small, yellow flowers. In Europe, agrimony occurs naturally in dry grassy habits, hedges, thickets, borders of fields, and rarely in woods. Cultivars have been selected.

Fig. 33.
Agrimony *(Agrimonia eupatoria)*,
from Syme et al. (1863-1886).

The species has been used to treat numerous illnesses since the Middle Ages. It was considered to be especially useful as a vulnerary (a wound-curing agent). An early hand-gun, known as the arquebus, inflicted considerable damage in the 14th century, and *eau de arquebusade*, originally made from agrimony and other herbs, was used for centuries to treat injuries (Grieve 1931). Agrimony is rarely used in modern medicine.

Uses

The flowers of agrimony are honey-flavored and used to be added to mead and been Flowers, leaves, and stems are employed fresh or dried to make a pleasantly aromatic herbal tea.

The sweet scent of agrimony is reminiscent of apricots, and the plant is grown in herb gardens for preparation of sweet sachets and potpourri. A golden-yellow dye can be extracted from the whole plant, and has been used in the textile trade (le Strange 1977).

Recipe Sources

Botanic beer (Grieve 1933; Stuart 1979); Agrimony tisane (Crowhurt 1973); and Agrimony tea (Loewenfeld and Back 1974; Michael 1980; Marcin 1983).

Importance

Agrimony is occasionally cultivated commercially on a limited scale, as in Germany, for its tops used as a drug and tea. The tea is popular in France (Facciola 1990). The species has also been cultivated experimentally as a medicinal plant, although the drug is usually obtained from wild plants. Agrimony is present in a number of patented liver and bile teas, and stomach and bowel remedies (see Medicine).

Cultivation Notes

Soil

Although naturally adapted to lime soils, agrimony is undemanding in its soil requirements, and tolerates a wide range of soil types. North American species of *Agrimonia* are typically found on somewhat acid soils (Kline, personal communication).

Climate

According to Crockett and Tanner (1977), agrimony is easily cultivated in dry soil. However, Kline (personal communication) has found that the plants in her garden in northern Illinois dry up or fail to flower without frequent watering during dry periods. Bailey and Bailey (1976) suggest agrimony is suitable for shady borders. Although it tolerates slight shade, agrimony may be grown in full sun, provided that the soil is kept moderately moist.

Propagation and Cultivation

Agrimony is propagated by seeds, and by root division. Seeds must be stratified (provided with a cold period) to germinate; storage in damp soil in a refrigerator for 6 weeks will break dormancy (Kline, personal communication). Seeds that are not stored under cold conditions are viable for only 6-9 months (Kline, personal communication). Once established agrimony tends to self-seed. Division of the crown should include a live stem. Kline (personal communication) recommends spring as the best time for division and replanting, as this provides time for the winter buds to form.

Harvest and Storage

Leaves and flowering spikes for herbal use can be collected in early summer, air-dried in a warm, shaded area, crumbled, and stored in air-tight jars (Macleod 1968).

Example Cultivars

Sweet-scented (described in Facciola 1990)

Additional Notes

Chemistry

The fresh herb contains a glucoside alkaloid, a nicotinic acid amide, traces of essential oil and organic acids, ursolic acid, a derivative of -amyrin, agrimonolide, palmitic acid, stearic acid, ceryl alcohol, and phytosterols (Duke 1985). Dried flowering tops were found to contain an average of 7.4% tannins as a principal constituent by Carnat et al. (1992). The seeds contain 35% oil with oleic-, linoleic-, and linolenic-acids (Duke 1985). It has been said that the volatile oil is sometimes distilled; however, Carnat et al. (1992) state that it is erroneous to speak of the presence of essential oil in *A. eupatoria*, and that this represent confusion with *A. procera* Wallr. ("*A. odorata*" of various authors, but not of Miller), known as fragrant agrimony.

Medicine

Agrimony was best known in classical times as a cure for injuries, both internal and external. It was prescribed, in a mixture with pounded frogs and human blood, for all internal hemorrhaging (Grieve 1931), a formula not often encountered in modem medicine! It has also been used as a tonic, vermifuge, and to treat diarrhea, coughs, and skin problems (Grieve 1931). The plant has been used since ancient times for liver and gall conditions, but Watt and Breyer-Brandwijk (1962) concluded that "there is no basis in the chemical composition of the plant to account for any supposed benefit." Duke lists additional illnesses treated in folk medicine, including gout, snakebite, blood diseases, fever, throat inflammations, asthma, bronchitis, rheumatism, tuberculosis, and warts. Perry and Metzger (1980) review current uses in Asia, but it is not clear which species of *Agrimonia* are referred to. According to Keys (1976), agrimony is an excellent treatment for bleeding, an observation consistent with the high tannin content noted above (since tannins are astringent, stopping bleeding). Experiments by Swanston-Flatt et al. (1990) suggested that agrimony, a traditional plant treatment for diabetes, can retard the development of streptozotocin diabetes in mice. Gorunovic et al. (1989) concluded that the medicinal value of agrimony was limited. Bisset (1994) noted current employment as a mild astringent both internally and externally, against inflammation of the throat, gastroenteritis, and intestinal catarrh. However, Bisset noted that "insofar as the drug is a component of phytomedicines, it should be regarded with scepticism."

Agrimony has been reported to induce photodermatitis in some individuals (Duke 1985), i.e., a skin rash produced after exposure to sunlight.

Fig. 34.
Agrimony *(Agrimonia eupatoria)*, from Bulliard (1784).

Nutrition

No nutritional benefits of consuming agrimony have been identified. However, vitamins B_1, K, and ascorbic acid (vitamin C) are present (Duke 1985). Watt and Breyer-Brandwijk (1962) also noted the presence of small amounts of vitamin C, as well as vitamin K.

Curiosities

• According to Grieve (1931), the generic name *Agrimonia*, and the name agrimony, reflect the word *Argemone* (from the Greek *argema*, a fleck in the eye), which the ancient Greeks applied to plants useful for healing the eyes (Grieve 1931). Similarly Stearn (1992*a*) states that *Agrimonia* is apparently a misrendering of agremonia, from the Greek *Argemone*, the Greek name of a poppy-like plant, once reputed to cure cataract of the eye (*argemon* is Greek for cataract). The specific epithet *eupatoria* refers to Mithradates Eupator, ancient king of Persia, who was renowned as a herbalist (Stuart. 1979).

• In the Middle Ages the medicinal value of plants was commonly sought according to the "Doctrine of Signatures," a belief that each plant bore a "signature" showing what particular illness it would heal (Smith 1992). The name "liverwort" (literally liver-plant) arose from the interpretation that the yellow of the flowers resembled the tint of the skin during an attack of jaundice, and so the plant would cure liver diseases (Quelch 1946).

• The name "philanthropos" perhaps is related to the presumed beneficial medicinal properties of the plant (Grieve 1931).

• The names "stickwort" and "cockleburr" refer to the small fruits that attach themselves by their hooked bristles to animals and humans they contact (Grieve 1931).

• The name "church steeples" is an allusion to the long, pointed flowering stalks, reminiscent of a church steeple (Grieve 1931).

• Agrimony placed under one's pillow is said to induce sleep (Duke 1985).

Problems and Potential

Agrimony is an old-fashioned herb grown occasionally as a garden ornamental, and rarely (mostly in Europe) for culinary and medicinal purposes. Its culinary use is insignificant and will remain so, and it has almost no economic potential as a crop.

Selected References

Grieve (1931); Duke (1985).

Allium

Family: Liliaceae (lily family)

Genus Notes

Opinion varies on the size of the genus *Allium*, with estimates ranging from 400 to over 750 species (for recent reviews, see Hanelt et al. 1992; Steam 1992*c*). According to Steam (1992*c*) "the genus *Allium* comprises about 750 known species and is the largest genus of petaloid monocotyledons" (monocotyledons, notable for the grass and orchid families, are one of the two great divisions of flowering plants; "petaloid" is a reference to flowers with petals). The plants are perennial (with a few biennials in cultivation), mostly with bulbs, and are strongly or faintly odorous when bruised. The genus is widely distributed over the warm-temperate and temperate zones of the northern hemisphere, with its greatest concentration of species in northern Asia. The economically important species are mostly Old World, although chives (*A. schoenoprasum* L.) has circumpolar distribution and is native to Canada and the northern U.S.

Several interesting species are native to North America. Particularly attractive is wild leek (*A. tricoccum* Aiton), found in rich moist woods from Manitoba east to Nova Scotia, excluding Prince Edward Island, and south to Georgia, Tennessee, Illinois, and Iowa. Wild leek is considered by Gibbons (1962) to be the sweetest and best of the American onion bulbs. This plant was baked in ashes by North American Indians (Erichsen-Brown 1979). Moerman (1982) recorded that the Chippewa employed boiled wild leek to induce vomiting, the Iroquois ate it as a spring tonic and to rid children of intestinal worms, and the Cherokee consumed it for colds and as a mild laxative. The Menomini Indians of the Great Lakes region called this species *pikwu'tc sikaku'shia*, "the skunk;" the origin of the name for the city of Chicago traces to the word *shika'ko*, literally "skunk place," since these wild leeks used to be abundant in the region of Chicago (Fernald et al. 1958; Kindscher 1987).

Canada garlic (*A. canadense* L.) is known as wild garlic (and American wild onion, meadow leek, rose garlic and meadow garlic); the name wild garlic is ambiguous, since it is applied to other species, such as *A. oleraceum* L., a Eurasian species naturalized in North America. Canada garlic is usually collected as a wild food, but it is also sometimes cultivated. It occurs in thickets, woods and meadows from Ontario to New Brunswick in the north, south to Texas and Florida. It rarely flowers, and does not produce seeds in the northern part of its range (Kuhnlein and Turner 1991). The bulbs of Canada garlic are sweet and palatable after boiling (Gibbons 1962). The whole plant can be used like scallions before the flowers appear, and after flowering the top-setting bulbils of *A. canadense* var. *canadense* can be pickled (Facciola 1990). This asexual form of the species, with bulbils in the flowering head, is thought to have been distributed beyond its native range by American Indians (Steam, personal communication). According to Kindscher (1987), the Cheyenne call *A. canadense kha-a'-mot-ot-ke-wat*, meaning skunk testes, "probably a polite translation for something more derogatory."

The taxonomic relationships of *Allium* are controversial. Traditionally, it is placed in the Liliaceae, although it has also been put in the Amaryllidaceae on the basis of inflorescence structure. Many botanists segregate it and allied genera into a distinct family, the Alliaceae (Hanelt 1990).

There is generally a clear distinction between species of *Allium* employed as vegetables and those used as culinary herbs. The species used primarily as herbs (i.e., in restricted amounts to flavor food) are discussed below and include: *A. sativum*, garlic; *A. schoenoprasum*, chives; *A. tuberosum*, garlic chives or Chinese chives; and *A. proliferum*, Egyptian onion. The vegetable species include: *A. ampeloprasum* L., leek; *A. cepa* L., common onion; and *A. fistulosum* L., Japanese bunching onion. The vegetable species are described in detail in Munro and Small (1997).

An interspecific hybrid between garlic and common onion was recently created (Ohsumi et al. 1992, 1993). This was an unusual achievement because fertile clones of garlic (in subgenus *Riziridium* of the genus *Allium*) and onion (in subgenus *Allium*) are quite distantly related. The hybrid, which was sterile and incapable of setting seed, produced characteristically onion chemicals as well as characteristically garlic chemicals, and was intermediate in odor. This new vegetable resembled a bulbing onion.

In addition to the *Allium* species discussed below, others are important in Asia. *Allium chinense* G. Don, known as rakkyo, is native to central eastern regions of China. It is widely cultivated in China and Japan where it is mostly consumed as pickles, sometimes exported to North America (Toyama and Wakamiya 1990). The species has been cultivated occasionally in California (Mann and Stearn 1960).

Several species of *Allium* are weeds. The most harmful is the Eurasian *A. vineale* L., known as field-garlic (field garlic), (wild) crow garlic, stag's garlic and wild onion. This has become naturalized in the eastern U.S. and is occasionally found in southern Ontario and Quebec. Although

Fig. 35.
Field garlic *(Allium vineale L.)*,
from Beal (1915).

the leaves and (less often) the bulbs are sometimes collected as a wild food, this species is a noxious weed in lawns, fields and meadows. It has proven especially troublesome and costly as a wheat contaminant in the soft red winter wheat region of the southeastern-eastern central region of North America (Fenwick and Hanley 1985). Infestation in pastureland can lead to off-flavors in milk and meat, and even to severe anemia in stock animals (Fenwick and Hanley 1985).

The International Board of Plant Gene Resources lists all designated seed base collections for *Allium*. The two centres with global collections are the Institute of Horticultural Research, Wellesbourne, U.K., and the National Seed Storage Laboratory, Fort Collins, USA. (Astley 1990).

Chive and onion species are often collected from the wild and used as food. In western North America, amateurs may confuse edible *Allium* species with very toxic (sometimes lethal) death camus [*Zigadenus* (less desirably, *Zygadenus*), particularly *Z. venenosus* Wats., possibly also allied species], well known for poisoning livestock (Schofield 1989). Cheatham and Johnston (1995) discuss other poisonous plants in the U.S. that have been mistaken for wild onions or chives.

Allium Sativum L.

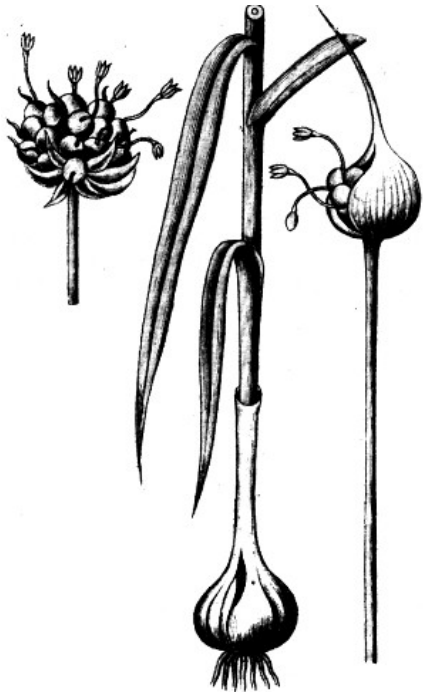


Fig. 36.
Garlic *(Allium sativum)*, from Hallier (1880-1888).

English Names

Garlic
Also: heal-all, rustic's treacle, poor man's treacle, stinking rose

[In addition to *A. sativum*, several wild species have "garlic" in their names. Canada garlic and crow garlic are discussed above. Several wild species of Europe and Asia are eaten as "garlics" (Facciola 1990). So-called "elephant garlic" is discussed below. Some African species of *Tulbaghia* are known and sometimes eaten as garlics (Facciola 1990). In northern North America some of these are grown in pots as ornamentals, while farther south they can be grown outdoors. *Tulbaghia violacea* Harv., society garlic, produces garlic-flavored leaves and flowers that can be used in soups, salads, and other foods (Facciola 1990). Barash (1993) provides two recipes that use the flowers.]

French Names

Family: Liliacées, famille du lis
Ail (m)

Also: ail blanc, ail commun, ail cultivé, ail de cuisine, ail ordinaire, ail potager, chapon, perdrix (also name of rough grouse in French), thériaque des pauvres, thériaque des paysans

Warning

Individuals regularly taking aspirin or other anti-coagulant drugs, or susceptible to low blood clotting conditions, should avoid consuming large amounts of garlic (see Medicine).

Description, Taxonomy, and History

Garlic is a herbaceous perennial known, for the most part, only in cultivation. Until the recent discovery of fertile clones in Central Asia (Etoh et al. 1988, 1992; Kotlinska et al. 1990) it was thought that all populations were sterile. In areas where garlic has long been cultivated, some forms are quite distinctive. The wild species considered most closely related to the cultivated garlic is *A. longicuspis* Regel, which is endemic to central Asia. Known as top-setting wild garlic, the bulbs of this species have good garlic flavor, and are sometimes collected from the wild and eaten (Facciola 1990). It is thought that garlic originated from wild garlic, perhaps in the desert of Kirghiz in western Asia (Farrell 1985). Taxonomists have not yet satisfactorily classified garlic (Takagi 1990). Several varieties have been recognized.

One of the most distinctive varieties of garlic is rocambole (*A. sativum* var. *ophioscorodon* (Link) Döll), also known as top-setting garlic, Spanish garlic, serpent garlic, and ophio garlic. (The name rocambole has often been applied in the past to another species, *A. scordoprasum* L.) Rocambole has distinctive flower stalks that twist and bend, first towards the soil surface and then skyward, with pea-sized bulbils produced at the end of the stalk (Cook 1990). The bulbs and bulbils are mildly garlic-flavored and are used to season food. The young leaves are delicately chive-like in taste. Several cultivars are becoming popular as gourmet items (Facciola 1990).

The garlic "bulb" is composed of swollen modified leaves like that of the onion. Unlike the onion, the leaves of the garlic bulb are organized into segments known as cloves or kernels. The cloves are joined to the central axis of the plant (Nonnecke 1989), and may or may not be encased in a membraneous sheath.

In commerce of the world, two general types of garlic have been recognized. "Creole garlic" has large cloves that are dark in color by comparison with "Italian garlic," which has small pinkish cloves with a stronger flavor (Oakley 1980). These are sometimes contrasted with a third type, "Tahiti garlic," which is not really a garlic, and is treated as the onion called "elephant garlic" in Munro and Small (1997).

A garlic recipe written in cuneiform characters and dated about 3 000 B.C. has been found (Weiss 1988). Garlic was consumed over 4 000 years ago by the early Chinese, Sumerians, and Indians, as well as the ancient Egyptians (Fenwick and Hanley 1990). Garlic was also used later by the Romans. Weiss (1988) suggested that garlic acquired an early reputation for improving physical performance because it is beneficial in amoebic dysentery, a condition common all over the East. Because of the antifungal and antibacterial activity of garlic, its addition to meat products and meat stews in the Middle Ages probably assisted in the control of microbial spoilage, at least to a small degree (Fenwick and Hanley 1990). Cortez (1485-1547), the Spanish conqueror of Mexico, brought garlic to North

Fig. 37.
Garlic *(Allium sativum)*, from Hatter (1988).

America. Today garlic is most highly prized in the southern parts of Europe and central Asia, where it is extensively consumed (Halpin 1978).

Uses

If used sparingly, garlic can be used to enhance the flavor of many foods. Garlic is consumed fresh, dried, or powdered. Fresh garlic is widely employed in cooking and as a flavoring, either whole or grated. Garlic is added to appetizers, stir-fries, pasta, meat dishes, poultry, seafood dishes, stews, casseroles, soups, and salads, salad dressings and sauces. One of the most delicious garlic-based preparations is garlic mayonnaise, *aioli* (*aïoli*). Originating from provincial France, this is a thick, golden, strong-tasting mayonnaise made with eggs, olive oil and crushed garlic (note Recipes). Garlic can be used with any vegetable compatible with onion. The cloves can be steamed or baked whole. Some authorities maintain that garlic should not be cut, but crushed with a strong blow from the fiat of a knife blade, or in a garlic press. However, aïoli needs to be pounded to a cream in a mortar for preparation, and other garlic preparations are commonly cut. To release as much flavor as possible, most authorities recommend mashing or chopping fresh garlic; alternatively, for a mild flavor, cook the garlic (heat destroys diallyl disulfide, described below). If oil or fat used to fry garlic is too hot, an acrid flavor is developed (Duke and duCellier 1993). Garlic becomes milder with cooking, but turns bitter if burned (Rinzler 1990). Rinzler (1990) suggested the following way of peeling fresh garlic without having the skin stick to one's fingers: drop the cloves in boiling water for 30 seconds, drain, cool, and peel.

Dehydrated garlic is available in several forms: powdered, minced, coarse, granulated, chopped, diced (Farrell 1985), and chips (large pieces of dried garlic) (Rinzler 1990). Dehydration is often accomplished using hot air (Lewis 1984). One part of dehydrated garlic is equivalent to 5 of fresh garlic; one fresh garlic clove or bulblet is equivalent to 2 mL (1/8 teaspoon) of garlic powder (Farrell 1985). Garlic is generally consumed fresh in the less developed countries, while in North America a very large percentage of garlic production is dehydrated (Yamaguchi 1983).

Garlic salt is a free-flowing, blended, dry mixture of non-iodized salt (not more than 81%), garlic powder (18-19%), and an anticaking agent such as calcium stearate or tricalcium phosphate (Fenwick and Hanley 1990; Rinzler 1990). Powdered garlic is extremely hygroscopic, taking up moisture unless kept in tightly sealed containers (Farrell 1985). Unless kept in a closed container, garlic salt also tends to become lumpy and hard. Starch is sometimes added to help prevent caking. Garlic salt is widely used by the meat packing industry for flavoring, and in the home kitchen for various culinary purposes. The high salt content means that it should not be used by persons who must avoid high sodium intake. A salt substitute recommended by the American Heart Association is made up of one part each of basil, black pepper, garlic powder, mace, marjoram, onion powder, parsley, sage, savory, and thyme, and one-half part of cayenne pepper (Fenwick and Hanley 1990).

In some countries, especially in the tropics, the leaves of young plants are chopped and added to food (Halpin 1978; Yamaguchi 1983). The mild-flavored young leaves can be added to salads, soups, egg dishes, and other foods (Facciola 1990). Seeds and sprouted seeds of garlic can also be eaten (Facciola 1990).

Garlic extracts have been used to flavor non-alcoholic beverages, ice cream, candy, baked goods, and chewing gum (Furia and Bellanca 1975).

Fig. 38.
Garlic *(Allium sativum)*,
from Vilmorin-Andrieux et C^{ie} (1883).

Garlic juice has been added to oil and sprayed on ponds to destroy mosquito infestations (Halpin 1978; Buishand et al. 1986). Extracts from garlic have been found to be very toxic to snails that serve as intermediate hosts for parasites attacking cattle and other livestock in parts of Northern India (Singh and Singh 1993).

Recipe Sources

Harris (1975) provides many recipes for garlic, including: Poached garlic with butter, Garlic goose, Garlic shrimp, Garlic mashed potatoes, Garlic croutons, and Garlic mango chutney. Kuo (1977) has recipes for: Sweet and sour "cured" garlic and Spareribs in garlic and black-bean sauce. Owen (1978) gives recipes for: Roast chicken stuffed with garlic and Snails with garlic butter. Mallos (1979) presents recipes for: Garlic sauce (two versions) and Grilled liver with garlic. Rose (1979) has recipes for:

Garlic bread and Garlic/onion salt. Anon. (1982*c*) gives recipes for: Tipsy garlic shrimp, Great garlic olives, and Grilled garlic bread. Morash (1982) has recipes for: Chicken with lots of garlic and Cream of garlic soup. Belsinger and Dille (1984) present 13 recipes, notably Indonesian chicken with garlic and peanut butter sauce, and Garlic honey lemon dressing. Algar (1985) gives recipes for: Sautéed eggplant with tomato-garlic sauce, and Lamb knuckles with yogurt and garlic. Thompson (1986) presents recipes for: Garlic-cream dressing, Pecan-garlic dressing, and Rib-eye steak with garlic-mushroom sauce. Hacker (1993) has recipes for: Garlic boursin and Garlic vinaigrette. Additional recipes are: Garlic French bread (Day and Stuckey 1964); Garlic-and-potato sauce (Nickles 1971); Potato garlic spread (Bryan and Castle 1974); Garlic and bread soup (Kennedy 1978); Stir-fried green beans with garlic (Chang et al. 1979); Barbecued fish with garlic (Garland 1979);Yogurt with garlic (Jaffrey 1981); Pulgogi or Pulkoki (Korean national beef dish) (Chantiles 1984); Aioli (Garland 1979; Hemphill and Hemphill 1984); Garlic soup (Brennan et al. 1985); Dorothy's garlic grits (Hughes 1985); Rack of lamb with mild garlic pureé (Tolley and Mead 1985); Pickled garlic (Jaffrey 1981; Batmanglij 1986); Tomato pasta with goat cheese and garlic (Levy 1987); Sardines barbecued in grape leaves with parsley and garlic (Holt 1989); Dog in Tahini [sesame] sauce (Simmons 1988).

Importance

A personal testimony to the culinary importance of garlic was given by Belsinger and Dille (1984): "If we were faced with the unhappy predicament of banishing all herbs but one from our kitchens, we would have to choose garlic as indispensable." Among the cultivated species of *Allium*, garlic ranks second in importance only to the common onion (*A. cepa*). Garlic consumption is low in northern Europe, the U.S., and Canada, and high in southern Europe, North Africa, parts of Asia and Latin America (Yamaguchi 1983).

World production of garlic was 7 029 000 t from 783 000 ha in 1991; 7 333 000 t from 783 000 ha in 1992; and 7 624 000 t from 802 000 ha in 1993 (FAO 1994). During this period China was by far the leading producer (with ca. 4 500 000 t yearly), followed by Korea (Rep.), India, Spain, Egypt, the U.S. (with ca. 190 000 t/year), Indonesia, and Tajikistan (FAO 1994). California supplies most of the U.S. need for garlic (Oakley 1980).

In Canada, scattered small commercial crops are grown in the most southerly regions. In 1993, Canada produced 34 900 kg of garlic (Sundue 1994). The two provinces that produce most of Canada's garlic, Ontario and Quebec, grow only about 200 ha, while Canada imports about 2.3 million kg annually, roughly 95% of consumption (Dietz 1991). Canada imported garlic bulbs valued at $7.2 million in 1989 (Coleman et al. 1991), of which Mexico provided $1.1 million. In addition, 1 151 t of dehydrated garlic valued at $1,299,000 was imported from the U.S. in 1988.

Verlet (1993) estimated the annual world value of garlic essential oil to be $1,200,000.00 (US).

Cultivation Notes

Soil

Garlic does well in a wide range of soil types, but prefers rich, well-drained, highly organic soils (Duke and duCellier 1993). It thrives in soils suitable for onion, the main requirements being good drainage and high organic matter content. Reported tolerated ranges of pH are 4.5-8.3 (Duke and Hurst 1975) and 5.5-8.5 (Hacker and Carolane 1982). Yields tend to be lower on sandy soils because these are drier and warmer (Yamaguchi 1983; Nonnecke 1989). Heavy soils may produce misshapen bulbs; sands and silt loams are preferable. On heavy soils the cloves can be planted in ridges to improve drainage. Because of the danger of residual diseases in onion fields, garlic should not be planted in soils where onions have recently been grown unless it is certain that the onions were disease-free.

Climate

Garlic needs a long growing season, and the leaves grow best where mean monthly growing temperatures are between 12 and 24°C. Cloves require prolonged temperature below 18°C in order to mature. The species is extremely hardy and survives long periods of freezing temperatures during the winter. Nevertheless, in most of southern Canada and comparably cold areas of the northern U.S., garlic can only be grown as an annual, planted either in the late fall or very early in the spring. In Canada, garlic can be over-wintered in much of British Columbia, Ontario, and the maritimes (Hacker 1993). Planted in late September or October, garlic may have tops showing above the soil and be well rooted by November, with growth resuming after the snow melts in the spring. Because of the need for a rather long growing season (at least 4 months), in temperate regions garlic should be planted as early as possible. Spring planting in northern areas may not leave a sufficiently long growth period for satisfactory yields. Bulbing in garlic is stimulated by lengthening photoperiods in the spring. Temperature is also important, 30-60 days at 0-10°C hastening bulbing under long photoperiods. The dormant cloves or young growing plants must be exposed to cold temperatures between 0°C and 10°C for 1 or 2 months to

initiate bulbing. Cloves stored above 25°C may not produce bulbs. For spring planting, the cloves should be held in cold storage for a sufficient period to induce the bulbing response. However, excessive exposure to low temperatures may induce sprouting of the cloves in the axils of the leaves near the bulb surface, causing the maturing bulbs to appear rough. Garlic usually does not bulb when grown in the warm, short days of the lowland tropics, and even at higher tropical elevations the bulbs are small and rough (Yamaguchi 1983). As garlic is shallow-rooted, irrigation may be required. Irrigation is particularly important when grown on light sandy soils (Brewster and Rabinowitch 1990*a*). However, too much humidity or precipitation can be harmful.

Propagation and Cultivation

Since garlic almost never produces seeds, it must be propagated vegetatively by cloves or bulbils. Garden firms and catalogs sell "garlic sets," which are simply bulbs. Autumn planting gives higher yields than spring planting. Individual cloves do not store well so separation is left to within a month of planting. Cloves are sorted and those that are small (less than 0.7 g), infected, or damaged are discarded. Cloves planted upside-down grow poorly or not at all. Cloves are planted about 5 cm below the surface of the soil or, in colder zones for overwintering, at least 8 cm deep (Hacker 1993). Machinery has been developed for separating, grading, and planting the cloves (Brewster and Rabinowitch 1990*a*). Because garlic is shallow-rooted, deep cultivation can damage the roots and retard growth.

Garlic can be grown in indoor windowsill gardens (Facciola 1990).

Harvest and Storage

Garlic is ready for harvest when the tops dry out and begin to collapse. Indeed, ripening can be speeded up by bending down the tops as they begin to turn yellow, in order to limit further growth of the plants (Crockett and Tanner 1977). In commercial production, irrigation is stopped and the entire planted area is allowed to dry. The plants are then loosened, pulled by machine or by hand, and left on the soil surface until drying is complete. If the weather is too wet, the plants must be dried under cover. After curing is complete, the tops and roots are removed. Yields of 4.5-8 t/ha have been reported (Hackett and Carolane 1982; Duke and duCellier 1993). Yields in southern Ontario have averaged about 3400 kg/ha (Opdecam 1991). Yields are usually about 10 times the weight of bulbs planted (Duke and duCellier 1993).

The home gardener can simply pull up the mature plants, dry them for a week, trim or braid the cloves and hang them in the shade to dry.

Garlic will store for up to 6 months if kept at 0°C and a relative humidity below 60%. Sprouting begins at 4.5°C. Takagi (1990) extensively discussed the effects of temperature and other factors on growth and storage. International standards for describing and classifying garlic for export are found in Anon. (1979).

Garlic should be stored dry, preferably in a cool, dark place, away from onions and potatoes (Oakley 1980). In the kitchen, unless garlic is kept in a closed jar its strong pungent odor penetrates all nearby food. For long storage while suppressing the odor, place cloves in a jar with a loose lid, and store in a dry, dark area at -I° C to -4°C (Oakley 1980).

Example Cultivars

Nonnecke (1989) noted that garlic cultivars are generally not easily separated, although three groups are generally recognized: California (early and late), Creoles, and Italian. Facciola (1990) described 25 common garlic cultivars available in North America, and 13 cultivars of rocambole (top-setting garlic). Bettencourt and Konopka (1990) listed institutions in various countries conserving garlic germplasm.

Additional Notes

Chemistry

Less than 0.2% of the fresh weight of the garlic is essential oil (Farrell 1985). The strong characteristic odor is due to the volatile oils, which contain sulphur compounds. Fresh garlic bulbs or cloves have little aroma. Crushing or cutting releases the typical odor of garlic. Upon rupture of the cells, a reaction takes place between an odor precursor, alliin, which is an odorless, sulfur-containing amino acid derivative, S-allyl-L-cysteine-sulfoxide (Tyler 1993), and an enzyme, alliinase. The substance allicin (diallyl thiosulphate, or diallyldisulfide-S-oxide) is formed, and this is responsible for the characteristic garlic odor. Allicin is chemically unstable, easily degrading by heat, or spontaneously degrading (Hamon 1987). Further enzymatic degradation forms other disulphides, which are responsible for the smell of cooked garlic (Lewis 1984). Allicin, or its chemically transformed products, are considered to be major flavoring ingredients, capable of enhancing the effect of monosodium glutamate in improving the taste of food (Ueda et al. 1990). Allicin is also antibacterial

against both gram-positive and gram-negative pathogens, and may account for some of the benefits, alleged and real, of garlic consumption (Tyler 1993).

Medicine

Garlic has been described as the world's second oldest medicine, after *Ephedra* (Castleman 1991; see introductory portion of Mexican tea, *Chenopodium ambrosiodes*). It has been used as a folk medicinal remedy since antiquity. The German Egyptologist Georg Ebers about 1874 discovered the world's oldest surviving medical text, a papyrus about 20 m long dating to about 1550 B.C. (Castleman 1991). This has come to be known as the Codex Ebers. It contains 876 therapeutic formulae, of which 22 are garlic prescriptions, including uses for heart problems, headache, bites, worms, and tumors (Block 1985). The Roman Pliny (23-79) declared garlic to be a remedy for 61 ailments (Oakley 1980). In Chinese medicine garlic continues to be used to treat abscesses, boils, cancer, diarrhea, diptheria, typhoid, hepatitis, ringworm, vaginitis, and other ailments (Duke and Ayensu 1985). Numerous traditional medicinal uses of garlic in Middle America are reviewed by Morton (1981). A variety of conditions treated with garlic in Asia are reviewed by Perry and Metzger (1980), and in Africa by Watt and Breyer-Brandwijk (1962). In reviewing historical medicinal uses of garlic, Hamon (1987) noted that there is some scientific evidence supporting the wisdom of using garlic to treat the following: general heart problems, hyptertension, blood clots, general wounds, gangrene, plague, cholera, typhus, meningitis, amoebic dysentery, intestinal worms, tumors, hypoglycemia, and stomach and intestinal ailments. Today, garlic is believed to have useful medicinal potential as an antimicrobial agent and for treating atherosclerotic disease and tumors [see Fenwick and Hanley (1985) and Hamon (1987) for a literature review, and for references to much of the following information].

Allicin and disulphide compounds of garlic have potent antibacterial properties against a wide selection of bacteria, and are also effective against many fungi. Garlic was considered a valuable antiseptic during World War I, used to combat typhus and dysentery, and especially to disinfect wounds. The British government ordered tons of the bulbs for such use. The raw juice was diluted with water and put on swabs of sterilized sphagnum moss. This treatment is said to have saved the lives of thousands of men by preventing wound infection (Grieve 1931). In World War II, garlic was also applied to battle wounds to prevent septic poisoning or gangrene. Unfortunately allicin possesses much of the odor of garlic, which limits its acceptance today as a natural antibiotic. It may be that isolated chemical constituents and synthetic analogues offer commercial potential as therapeutic agents in western medicine.

The low incidence of arteriosclerosis (thickening and hardening of artery walls) in parts of Italy and Spain has been attributed to heavy consumption of garlic (Foster and Duke 1990). Garlic components have been found to prevent fat-induced increases of plasma fibrinogen and reduce blood coagulation time. These effects are beneficial in cases of atherosclerosis (arteriosclerosis characterized by deposition of fatty substances in and fibrosis of the inner layer of the arteries), which is a predisposing factor in coronary heart disease, high blood pressure, and stroke. Often better results were obtained using raw instead of cooked garlic. The addition of onion or garlic to human diets was found to significantly prevent the elevation of serum cholesterol, ß-lipoprotein, and serum triglycerides, high levels of which are associated with atherosclerosis. This effect was retained after boiling of garlic. In one study, patients were given fresh garlic juice (0.5 mL/kg) once a day for 2 months. The mean cholesterol level fell from 305 to 218 mg/100 mL during that period. Liberal amounts of garlic (one to two cloves at least on a daily basis) seem necessary for reducing hypertension.

Some garlic compounds affect blood coagulation by forming the antithrombotic compound ajoene (Nonnecke 1989; Augusti 1990). The ability of garlic to provide protection against atherosclerosis, coronary thrombosis, and stroke is thought be related to its ability to inhibit aggregation of the blood platelets, due to ajoene, and not to allicin as earlier thought (Tyler 1993).

Garlic (and onion) contains substances that have proven capable of preventing the growth of tumors in experimental animals. It has been suggested that allicin may play an important role in tumor prevention. In China, lower frequency of gastric cancer has been associated with eating garlic.

Some studies have shown garlic to be a hypoglycemic (blood sugar reducing) agent (Nonnecke 1989; Augusti 1990).

Dried garlic preparations do not contain either the anti-bacterial principle allicin, nor the anticlotting agent ajoene, although they do contain aliin, the inodorous precursor of both (Tyler 1993). Conversion of aliin to allicin and ultimately to ajoene requires the enzyme alliinase. This enzyme may be present if garlic has been dried at low temperatures, but it is destroyed by stomach acid, so little enzymatic conversion occurs (Tyler 1993).

Moderate consumption of garlic seems to pose no health risks for most individuals, although some persons may experience allergenic reactions. Should the average person

consider eating more fresh garlic for therapeutic purposes? Five or more fresh cloves per day seem necessary for a therapeutic dosage, and this can result in heartburn, flatulence, and other gastrointestinal problems (Tyler 1993), to say nothing of social ostracism.

Garlic dust has been shown to cause contact dermatitis in some individuals. Garlic allergens appear to include diallyldisulfide, allylpropyldisulfide, allylmercaptan and allicin (Papageorgiou et al. 1983). Cases of asthma have also been reported (Mitchell and Rook 1979; Fenwick and Hanley 1985). Concentrated garlic essential oil can be irritating (Foster and Duke 1990). Garlic consumption reduces blood clotting time, which can cause medical problems in some individuals, particularly if they are taking aspirin or other anticoagulant drags (Tyler 1993). Garlic preparations have been fatal to children (Simon et al. 1984).

Nutrition

Fresh garlic has about 74% water, 20% carbohydrate, and small amounts of protein, fat, ash and fiber (Oakley 1980). Fresh garlic is considered nutritional for its content of protein and sugar (Hackett and Carolane 1982). The vitamins thiamin, riboflavin, niacin, and ascorbic acid, and the minerals calcium, phosphorus, iron and potassium are present (Hamon 1987). However, the vitamin content of the garlic bulb is not considered significant (Watt and Breyer-Brandwijk 1962). Duke (1977) characterized content of fiber, magnesium, phosphorus, potassium, protein, thiamin, and vitamin C as high. Additional nutritional information is given in Duke and Ayensu (1985) and Duke and duCellier (1993).

Curiosities

• The genus name *Allium* is thought to derive from the Celtic *all*, meaning pungent (Block 1985).

• The word garlic is derived from the Anglo-Saxon *gar*, lance (after the shape of the stem) and *leac*, pot-herb (Stuart 1979).

• For thousands of years in India, garlic was considered a good treatment for leprosy. After Britain colonized India, leprosy became known as *peelgarlic* because lepers spent much time peeling and eating garlic (Castleman 1991).

• The English word *treacle* doesn't just mean molasses. It is derived from the Greek *theriake*, an antidote against a poisonous bite, and indeed refers to a medicinal compound formerly widely used against poison. The extensive use of garlic as medicine by the peasantry led to the English names *rustic's treacle* and *poor man's treacle* (Castleman 1991).

• Garlic juice was widely used during World War I to treat battle wounds and to prevent and treat amoebic dysentery. Modem antibiotics, particularly penicillin, replaced garlic for these uses by World War II, but Russia had an insufficient supply, and Red Army physicians had to rely heavily once again on garlic. Hence garlic came to be called *Russian penicillin* (Castleman 1991).

• The ancient Egyptians loved garlic perhaps more than any people in history. They were called "the stinking ones" because of their garlic breath; swore solemn oaths on garlic as is done with the bible; and used garlic like money, for example purchasing a healthy male slave for about 7 kg of garlic (Castleman 1991).

• The Egyptian pharaohs were entombed with clay and wood carvings of garlic and onions to ensure their afterlife would be enriched with well seasoned meals (Block 1985).

• An ancient Egyptian papyrus dated at 1600 B.C. described a strike among the men working on the pyramids because their daily food rations did not include enough garlic (Weiss 1988). After Moses led the Hebrew slaves out of Egypt about 1200 B.C. (Numbers 11:5), they complained of missing the finer things of life in bondage, like garlic (Castleman 1991).

• The ancient Romans are said to have disliked garlic because of its strong odor, but fed it to their laborers to strengthen them, and to their soldiers to excite courage (Hedrick 1972).

• Upper-class Greeks and Romans, and the privileged classes in many civilizations since, viewed garlic breath as a sign of low birth (Castleman 1991).

• According to a Mohammedan legend, "when Satan stepped out from the Garden of Eden after the fall of man, Garlick sprang up from the spot where he placed his left foot, and Onion from that where his right foot touched" (Grieve 1931).

• In ancient times garlic was believed to have mystical properties, and was used against both known and unknown evils. Even today it is common mythology that garlic is a defense against vampires (Anon. 1982*c*; see legend of Dracula, below).

• Mediterranean sailors at sea carded cloves of garlic in the belief that it would prevent shipwrecks (Farrell 1985).

• The Turkish invasion of Europe was stopped at the siege of Vienna in 1683. The Turks kept huge stocks of coffee and garlic in their camps, which they left behind, and these were given to the people of Vienna. This is how the Viennese coffee houses originated. It also seems to have been a stimulus to the use of garlic in Europe (Weiss 1988).

• The legendary vampire Dracula is based on the Romanian tyrant Vlad the Impaler (ca. 1431-1476), known for his bloody cruelty, if not for his vampirism (Mercatante 1988). Vlad the Impaler is thought to have inspired the English writer Bram Stoker's 19th century *Dracula*, a novel that was the basis for numerous vampire films. Vlad the Impaler's father was called Vlad Dracul; Dracul means "the devil" in Romanian. It has been suggested that Count Dracula himself was responsible for spreading the reputation of garlic as a defense against vampires (Hintz 1992). Since it is clear that garlic is a blood-thinner, lowering the clotting action of blood, Count Dracula and other vampires would have feasted more easily on those who consumed garlic.

• According to legend, in 1721 four condemned criminals were recruited to bury those who died during a terrible plague in Marseilles (an alternative version of this legend holds that the criminals specialized in stealing from those who had died of the Plague). The gravediggers are thought to have drunk a secret concoction of macerated garlic in wine to become immune to the disease. This mixture became famous as *vinaigre des quatre voleurs* (vinegar of the four thieves), and is still available in France today (Block 1985). For those who wish protection from the Plague, the following old herbal recipe may be of interest: 1.5 oz each of tops of Sea and Roman Wormwood, rosemary, sage, mint and rue; 2 oz of lavender flowers; 0.25 oz each of sweet flag, cinnamon, cloves, nutmeg and garlic; 0.5 oz of camphor; all added to 1 gallon of red wine vinegar (Macleod 1968).

• According to an old European superstition, runners could prevent their competitors from passing them by chewing garlic; similarly, Hungarian jockeys fastened cloves of garlic to their horses in the belief that nearby horses would fall back as soon as they smelled the offensive odor (Grieve 1931).

• In England, parents placed garlic cloves in the stockings of children with whooping cough, in the belief that this would prevent further infection (Farrell 1985).

• The small town of Gilroy, California holds an annual garlic festival each August and calls itself the "garlic capital of the world." Indeed, nearly 91 000 t of garlic are grown in the surrounding area and in 1981, 130 000 people attended the festival. American humorist Will Rogers (1879-1935) was said to remark that Gilroy is "the only town in America where you can marinade a steak just by hanging it out on the clothesline" (Anon. 1982*c*).

• Rather surprisingly, garlic derivatives have been used in perfumery (Furia and Bellanca 1975).

• Contact with garlic by homemakers has produced a characteristic pattern of distribution of dermatitis on the fingers, illustrated below.

• Garlic has been described as "the atomic bomb of the vegetable world" (Oakley 1980).

• "Garlic therapy" as recommended by Weiss (1988) consists of starting to consume garlic Friday evening after work, and continuing to eat it until Sunday at midday, so that the greater part of the garlic smell will have disappeared by the time the patient returns to work on Monday.

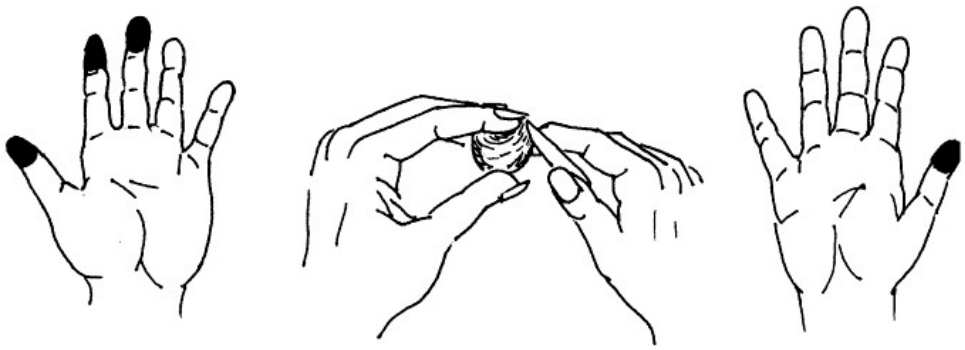


Fig. 39.
Characteristic distribution of garlic dermatitis on the hands [prepared by B. Brookes, after Watt and Breyer-Brandwijk (1962)].

• It has been claimed that garlic breath in only a problem for nongarlic eaters, since those who have eaten it cannot smell the odor on the breath of other garlic eaters (Fenwick and Hanley 1985).

• Many suggestions have been made as to how to remove garlic odor from the mouth. The following notes were recorded in Fenwick and Hanley (1985) and Mességué and Peter (1982). Rinsing the mouth and brushing the teeth with soap and water and even 30% alcohol have proven unsuccessful. Home remedies have included strong coffee, honey, yoghurt, or milk, and the chewing of coffee beans, cloves, cardamom seeds, parsley, chervil, mint-flavored chewing gum, and even slowly eating a grated potato with a few spoonfuls of honey. The most widely cited method is to chew parsley. Complete deodorization has been achieved by rinsing the mouth and cleaning the teeth and tongue with chloramine, apparently due to the liberated chlorine. A much more palatable cure is used by the French, who believe that red wine is especially effective; whether or not this works, the problem may seem less important.

• A recent treatment invented in Japan neutralizes most of the enzymes that cause "garlic breath." The flavor and nutritional value are retained. Garlic bulbs are soaked in a special pickling solution and curing takes 4-5 days. The product, called "Dr. Sakai Garlic," is now available in supermarkets in North America (Crowder 1992; cf. Anon. 1991, which suggests that much more than actually reducing garlic odor, the product is a marketing success, news of which is "spreading by word-of-mouth").

• Allicin, the substance responsible for the characteristic garlic odor, enters the blood stream when ingested, reaching all parts of the body. Elimination is not only by air exhaled from the lungs, but also via the skin, so that sweat acquires the odor of garlic (Weiss 1988).

• Rosin et al. (1992) conducted a study to see which of the following situations people would find the least repulsive: Imagine sitting in a bus when a strongly smelling person sits down next to you. Which of the following odors would you find *least* annoying: garlic, sweat, alcohol, and perfume (on women) or aftershave (on men). Garlic was chosen by the majority as the least objectionable, sweat and alcohol as the most unpleasant.

• In 1993, sales of herbal supplements in the U.S. were the second-fastest growing category in dollars sales for food and drugstores combined. Garlic was the leading supplement, and sales rose 67% over the previous year (Anon. 1994).

Problems and Potential

Garlic appears naturally adapted to warmer regions than found in Canada and the northernmost parts of the U.S., and much research is needed to make garlic production competitive in these regions. Opdecam (1991) discussed the use of garlic as an alternative crop for tobacco growers in southern Ontario. It has been estimated that 400 to 800 ha would need to be planted to satisfy the domestic market in Canada.

Selected References

Hackett and Carolane (1982); Yamaguchi (1983); Block (1985); Fenwick and Hanley (1985); Hamon (1987); Brewster and Rabinowitch (1990*a*); Brewster and Rabinowitch (1990*b*); Takagi (1990); Duke and duCellier (1993); Tyler (1993); Brewster (1994).

Allium Schoenoprasum L.

Scientific (Latin) Synonyms

A. tenuifolium Salisb., *Cepa schoenoprasa* Moench., *Porrum schoenoprasum* Schur, *Schoenoprasum vulgare* Fourr.

English Names

Chives
Also: chive, cive, civegarlic, cives, civet, common chive, ezo-negi, onion chives, schnittlauch (German, sometimes encountered in English)
[Steinmetz (1957) gives rocambole as another synonym; this was discussed earlier as *A. sativum* var. *ophioscorodon*.]

French Names

Ciboulette (f)
Also: ail ciboule, ail ciboulette, ail civette, appétit, ciboule, ciboulet, cive, civette (des jardins), échalote fausse, fausse échalote, grande ciboule, oignon de Florence, petit porreau

Description, Taxonomy, and History

Chives is a perennial herbaceous plant with slim, hollow leaves rising from thick tufts to 70 cm or more. Slender, white-sheathed bulbs develop in dense masses at the base of the plant. Rose-purple or mauve flowers are produced in a small, round cluster at the end of a leafless stalk. The species grows in several habitats, but prefers moist soil conditions such as wet meadows and edges of rivers and lakes. The wild plants are circumpolarly distributed in the North Temperate zone, extending as far south as southern

Fig. 40.
Chives *(Allium schoenoprasum)*, from Hallier (1880-1888).

Europe, Iran, India, and China. In North America, the species occurs as far south as northern New York to northern Colorado and Oregon. Several wild forms from Eurasia and North America have been given taxonomic recognition (Fernald 1970; Scoggan 1978-79; Poulsen 1990; Kuhnlein and Turner 1991). The domesticated selections are little changed from the wild forms. The taxonomy of chives requires further work. Two varieties that are cultivated are noted in the following paragraphs.

Variety *schoenoprasum* is the more commonly grown of the two cultivated varieties. When it was first raised is uncertain, but this likely occurred in Europe. This variety is found as a garden escape that persists in northern areas of North America, such as in Ontario and Quebec (Scoggan 1978-79).

Variety *sibiricum* (L.) Garcke (= var. *sibiricum* (L.) Hartm. (Scoggan 1978-79), var. *alpinum* DC. of some authors) is known as large chives, giant chives and Siberian chives.

It has a stronger garlic flavor than common chives, and has occasionally been cultivated. The leaves and bulbs are pickled and used as a condiment (Facciola 1990). This native of Eurasia is found in Asia Minor, Siberia, and the former Yugoslavia (Huxley et al. 1992). In Canada, it occurs in most provinces (except perhaps P.E.I. and Alta.) and both territories as far north as the Mackenzie River delta

Fig. 41.
Chives *(Allium schoenoprasum),*
from Thomé (1903-1905).

(Scoggan 1978-79). It is also found in Alaska, and from northern New England through Michigan and Minnesota to Colorado, and in Washington (Fernald 1970).

According to Farrell (1985), chives have been known for at least 5 000 years, but little was recorded until the 19th century. Chives has been collected from the wild since antiquity but was probably not cultivated until the Middle Ages. Wild chives were a popular food among Indigenous Peoples of North America (Kuhnlein and Turner 1991). The plant has been cultivated in Europe at least since the 16th century, cultivation thought to have originated in Italy, spread to Germany, and then to other European countries (Poulson 1990). Chives was listed in English seed catalogs in 1726, and was known in American gardens in 1806 (Hedrick 1972). During the 19th century chives became very popular in Europe, particularly in French *haute cuisine* (Farrell 1985).

Uses

Chives has a delicate onion flavor. The tender, mild leaves are eaten raw or cooked in many dishes, including salads, soups, vegetables, sauces, meats, eggs, fish, butter, and cream cheese. Chopped chives make an exceptional garnish for salads and potato dishes, such as with sour cream on baked potatoes. However, Mességué and Peter (1982) recommend cutting chives with scissors, and never chopping it. Chives is a traditional accompaniment for vichyssoise. The flavor of chives is destroyed with prolonged heat, and so it is best added to cooking foods during the last 5 to 10 minutes (Hemphill and Hemphill 1984). The processing industry freezes, freeze-dries and dehydrates chives for use in packaged foods such as soup mixes, salad dressings, cocktail dips, sour cream, and cottage cheese products (Poulsen 1990). The bulbs are often pickled. The flowers are consumed in egg, cheese and fish dishes, or used as a garnish (Facciola 1990). Barash (1993) warns against the temptatation to pop a whole chive inflorescence into one's mouth, as the pungency in that quantity can be overwhelming, and she recommends breaking the inflorescence into its individual florets for garnishing and in cooking.

Chives is sometimes grown simply as an ornamental plant. The inflorescences can be used in cut-flower arrangements.

Recipe Sources

Smith (1973) gives recipes for: Chive shrimp [with chive petals] and Chive omelet [with chive petals and leaves]. Bryan and Castle (1974) present recipes for: Shrimp with gorgonzola and chives, Chive-cheese spread, and Spaghetti with chive sauce. Hériteau (1975) has recipes for: Vichyssoise and Vinaigrette sauce with chives.

Belsinger and Dille (1984) present nine chive recipes, notably: Caviar and chive omelette, Chive avocado soup, Crab with chive mousseline, and Potato and turnip purée with sour cream and chives. Levy (1987) has recipes for: Broccoli and mushroom soufflé with chives, Carrot soup with chives, and Creamy mushroom tart with chives. Brobst (1988) presents recipes for: Chive cakes and Chive blossom vinegar. Owen (1978) gives recipes for: Chive scalloped potatoes and broccoli, and Chive soup. Hutson (1987) presents recipes for: Chicken breasts stuffed with chives and fresh herbs and Chive vinegar. Richardson (1991) has 13. chive recipes, notably: Chive consommé, Salmon soufflé with chives, Oyster chowder with chives, Herb blossom salad, and Chive and parsley omelette. Barash (1993) has seven chive flower recipes, including Fava beans with bacon and chives and Grilled chived chicken salad.

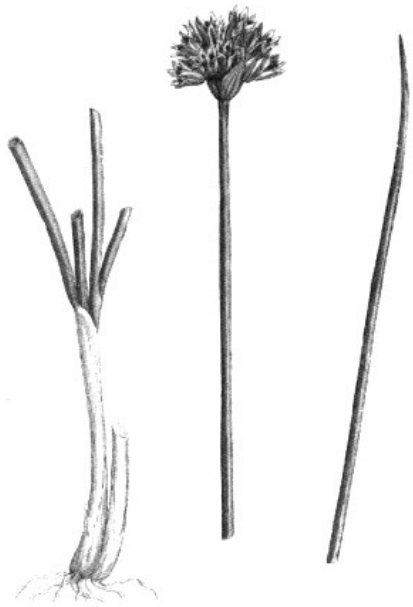


Fig. 42.
Chives *(Allium schoenoprasum)*,
from Syme et al. (1863-1886).

Other recipes are: Soft yogurt cheese with chives and parsley (Jaffrey 1981); Chive sauce (Hawkes 1984); Spring fillets of plaice with chive flowers, lettuce hearts and chives (Leggatt 1987); Sea bass with ginger and chives (Bremnoess 1988); Filet of salmon with tomatoes, rock salt, and chives (Creasy 1988); and Cheese brioche with chive butter (Holt 1989).

Importance

Chives has never been of great economic importance. Although among the most universally grown of herbs, only about 1000 ha/year are produced commercially word wide (Poulsen 1990). Denmark harvested about 1100 t of chives in 1985, 95% of which was freeze-dried (Fenwick and Hanley 1990). This represented about one third of the world production. Chives is grown commercially for fresh leaves, for processing, and for seed production. In North America it is cultivated widely in home gardens as a perennial crop. Chives is occasionally found in market gardens and fresh produce sections of stores.

Cultivation Notes

Soil

Chives can grow in a variety of soils. However, well drained, organic, fertile soils are preferred. Chives grows naturally in damp meadows, and should be kept moist throughout the growing season, particularly if the soil is light and sandy. Reported tolerated ranges of pH are 5.0-8.3 (Duke 1978) and 5.0-8.2 (De Baggio 1987). Crockett and Tanner (1977) recommend that the soil should have a pH of 6.0-7.0.

Climate

Chives is a hardy perennial that grows naturally in north-em North America, where home gardeners should have little problem in growing it. In any event, chives can be grown as an annual. The optimum temperature for growth is 19-23°C. In the field it does not flower the first year sown unless started indoors in January (Poulsen 1990). Chives tolerates light shade.

Propagation and Cultivation

Chives is started from seed or from division of existing clumps. Seedlings are small and more reliably established if grown indoors and transplanted, preferably with several seedlings in a fiber pot to establish a "clump" as quickly a possible. Seeds should be planted at a depth of 6 mm or less, with seedling emergence usually in 7-12 days (Wang et al. 1993). Dividing old clumps is the easiest method for the home gardener.

The growing of chives in fields for direct harvest and marketing is of limited economic importance. Leaves are hand harvested most conveniently. from clumps, and machine-harvested from rows. Of course, direct marketing of fresh chives from fields is only possible during the summer.

In most commercial production (especially in Germany) bulbs are grown for forcing during the winter in greenhouses, thus providing fresh leaves continually. The seeds are sown at a rate of 30 kg/ha by tractors, resulting in 15 million plants per hectare. The bulbs are lifted in autumn, stored in cool temperatures (for up to 2 years), and are then forced for leaf production (Poulsen 1990). In commercial practice, it is now common to break dormancy by immersion in warm water or exposure to warm air, at precise times of development, temperatures, and durations of temperatures (Poulson 1990; see below).

Growth occurs from axillary buds at the base of the plant, and large clumps are formed. The clumps of this perennial plant will increase in diameter each year as new side bulbs are continuously produced. Occasional division of these prevents overcrowding, and the dying out of the central portions of the clump. The divisions can be replanted. Established beds of chives should be lifted and divided about every 3 years. Flower stalks should be cut away to prevent the plants diverting their energy into flower and seed production. In commercial production, the unpalatable flower stalks are removed at the end of the flowering period. It is also important to remove the stalks in the home garden to prevent reseeding, as well as to maintain the vegetative vigor of the plants. The plants can spread by seeds from the original location.

The home gardener may grow chives as a windowsill plant during the winter, for a constant supply of fresh herb. The cultivar Grolau (also known as Windowsill Chives) is particularly suitable for culture as a windowsill plant (Facciola 1990). For this purpose, a clump of chives should be transplanted in late summer into a pot (about 12 cm is ideal) that is sunk into the ground. After a killing frost, the tops are trimmed off, and the pot is kept in a cold area for about 3 months to satisfy the dormancy requirement. The pot is then placed in a sunny window sill indoors, and kept watered.

Hemphill and Hemphill (1984) advise that chives are preferably not harvested by cutting the leaves with scissors, as this causes some dieback, leaving an unattractive brown edge; the leaves should be picked off at their base by using one's fingers.

Harvest and Storage

Commercial production of chives is orientated either to leaves for marketing as bunches, or for the production of bulbs for forcing. Leaves for bunching may be cut by machine but are often hand-harvested during the summer months. Bulbs for forcing are lifted by machine and are then exposed to cool temperatures. As many roots as possible are left on the bulbs. Forcing is initiated commercially by immersing the bulbs in water at 40°C, which is cooled to 25°C over a 16 hour period. Forcing can start in mid-October of the same year. Many bulbs are placed in small pots and sold in local markets. Using modern facilities the dormant bulbs can be stored for up to 2 years, allowing forced chives to be marketed at all times of the year (Poulsen 1990).

Chives intended for processing are cleaned, sorted and trimmed, and are then transversely cut into uniform pieces 3 mm long. Freeze-drying has proved the best method for preserving the delicate flavor and aroma (Farrell 1985). The chives are flash-frozen and then freeze-dried. Reconstitution with water is usually not necessary as there is sufficient moisture in products to which dehydrated chives is added to rehydrate chives in less than 1 minute. Dehy-drated chives is usually packaged in nitrogen-flushed, polylined containers to retain its flavor and colon Cool, dry storage at 21°C is recommended (Farrell 1985).

In the home garden chives can be harvested at almost any time during the growing season. Only the leaves should be picked, as flower stalks may be tough. The leaves are best fresh, but can be stored dry or frozen. Commercial dried material is always freeze-dried because of the

Fig. 43.
Chives *(Allium schoenoprasum)*, from Vilmorin-Andrieux et C^{ie} (1883).

significant loss of taste and color when air-dried. Accordingly, the home gardener is advised that chives is not suited to drying like most herbs.

Example Cultivars

Blush, Dwarf, Extra Fine Leaved, Forscare, Fruhlau, Pink (described by Facciola 1990); Shepherds Crook, Schnittlauch (noted in Huxley et al. 1992)

Additional Notes

Chemistry

Several disulphides are responsible for the flavor of chives including dipropyl disulphide, diallyl disulphide, and methylallyl disulphide (Lewis 1984). Propenylcysteine sulfoxide is the most important sulphur compound in chives; the lacrimatory chemical propenylsulfenic acid is produced from it when the leaves are crushed (Poulson 1990). A summary of the chemistry of chives is presented by Poulson (1990).

Medicine

Chives has been used in Europe and North America as a vermifuge (Watt and Breyer-Brandwijk 1962). By comparison with garlic, the sulfur compounds in chives have relatively limited antibiotic effect (Poulson 1990).

Chives is known to cause contact allergic dermatitis in people and animals. Even an ointment containing compounds from chives has caused dermatitis (Mitchell and Rook 1979). In Japan, horses have been poisoned after ingesting the leaves, which emerge in early spring before other forage becomes available (Kobayashi 1950).

Nutrition

The leaves of chives are high in vitamin C (Yamaguchi 1983) and contain 20-34% protein, 3.4-7.5% fat, and 54-67% carbohydrate (Duke and Ayensu 1985). Duke (1977) characterized fiber and potassium content as high, and content of vitamins A and C as very high.

Curiosities

• The species epithet *schoenoprasum* is formed from the Greek *skhoinos*, meaning rush, and *prason*, meaning leek, a reference to the rush-like leaves of the plant (Poulson 1990).

• Chives became so popular in Holland during the 19th century that farmers are believed to have fed them to their cattle to produce a flavored milk (Farrell 1985).

• A widespread belief, tracing to Romanian gypsies, is that bunches of chives suspended from ceilings or hung on bed posts have great powers to ward off evil spirits (Brobst 1988).

Problems and Potential

In North America, chives is likely to remain a herb crop grown in small quantities for the local market.

Selected References

Brobst (1988); Poulsen (1990); Brewster (1994).

Fig. 44.
Chives *(Allium schoenoprasum)*,
from Harter (1988).

Allium tuberosum Rottl. ex Spreng.

Scientific (Latin) Synonyms

Allium uliginosum G. Don; misidentified by some authors as *A. odoratum* L.

English Names

Garlic chives
Also: Chinese chives, gow choy, ku ts'ai, nira, Oriental garlic
[According to Facciola (1990), flowering stalks of garlic (*A. sativum*) are sometimes called "garlic chives," and are used for flavoring, and occasionally sold in bunches in oriental stores. Such usage of course confuses two quite different species.]

French Names

Ail du Japon (m)
[The above name is current in New Caledonia according to H.S. MacKee (personal communication).]
Also: ail chinoise, ail civette de Chine, ciboulette chinoise
[all from Kays and Silva Dias (1995)]

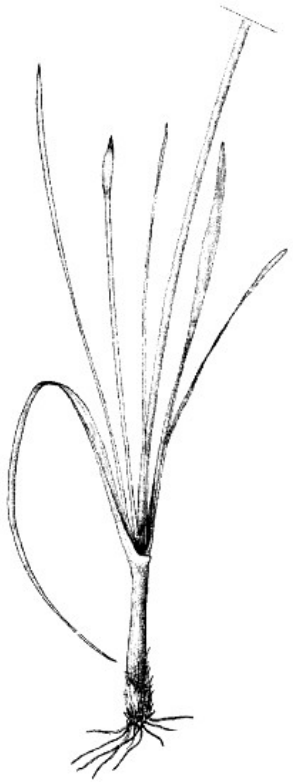


Fig. 45.
Garlic chives *(Allium tuberosum)*, prepared by M. Jomphe. (Based on Clausen H541 at Agriculture and Agri-Food Canada herbarium, Ottawa.)

Description, Taxonomy, and History

Garlic chives is a perennial herb, growing to 50 cm in height. Each "stem" generally produces two or three leaves, which resemble the leaves of chives, but are flat and solid, not hollow like those of chives. The flavor is reminiscent of garlic, hence the name "garlic chives." Although some bulbs may be produced, and may be large enough to propagate the plant from season to season, the rhizome rather than bulbs is the main storage tissue. The plant develops one or several tubers on the rhizome (also sometimes called a horizontal rootstock). The species is native to the central and northern parts of Asia, including subtropical China, India and the East Indies. Seeds are mostly apomictic (produced exclusively from tissues of the mother plant, not by sexual recombination) (Kojima et al. 2992). The cultivated form is essentially the same in appearance as the wild plants. (Huxley et al. 1992 state that this is a cultigen of unknown wild origin, i.e., that truly wild plants are unknown.) Cultivation of garlic chives is believed to have originated in China and the species is now widely grown in parts of eastern Asia (Saito 1990).

Uses

The leaves of garlic chives are eaten in western dishes much as those of chives, but with more discretion in view of their stronger taste. They are added to salads, soups, vegetables and meat dishes (Saito 1990). The cut leaves can be mixed with cottage cheese or yoghurt, and make a flavorful addition to omelets and hard-boiled stuffed eggs. Garlic chives is only used fresh in Asia, typically fried with vegetables and meat, or simply employed as a seasoning for meat (Saito 1990). This herb is especially used in miso soup. Blanched leaves, called *gau wong*, chive shoots or yellow chives, are eaten as a delicacy with pork or poultry, or in noodle dishes (Facciola 1990). The leaves should be added during the last few minutes of cooking as they become stringy if overcooked. According to Morton (1976), cooking destroys the flavor.

The small bulbs can be eaten like garlic. Garlic chive bulbs are more delicate in flavor than those of true garlic. They can be crushed and mixed with vinegar as an addition to salads. The bulbs can also be added to soups or spread as a garnish on vegetable and meat dishes (Harrington 1978). Blanched leaves are placed in chow mein dishes in the Orient (Herklots 1972).

The flower buds can be eaten fresh or dried. The flower stems are also edible. The cultivar Flowering (= Chinese Leek Flower, Gow Choy Fah, Tenderpole) was selected for its edible flower buds and long flower stalks, and is widely grown in south China and Southeast Asia (Facciola 1990). Young flower stalks of the cultivar Vietnamese, and both flower stalks and buds of the cultivar New Belt are also often eaten (Facciola 1990).

Garlic chives are attractive in a perennial borden They usually produce white flowers that can be used as long-lasting cut flowers (the cultivar Mauve has attractive mauve flowers).

The seedheads are also edible, and oil from the seeds is used as food in Asia (Facciola 1990).

Recipe Sources

Barash (1993) has five recipes with garlic flower chives, including Tostada with garlic chives and Grilled lamb with garlic chives and mustard.

Other recipes are: Stir-fry mussels with chives (Claiborne and Lee 1972); Herb omelet (Mallos 1979); Bo Jai Choi (bean curd, pork, and mushrooms) (Dahlen and Phillipps 1983).

Importance

Garlic chives is cultivated commercially mainly in eastern Asia from China and Japan south into Thailand and the Philippines (Saito 1990). In Japan in 1987, 66 100 t were produced from 2 600 ha (Rabinowich and Brewster 1990*a*). Some is grown commercially in California (Yamaguchi 1973; Buishand et al. 1986). This plant was recently introduced to Canadian gardeners through seed catalogs.

Cultivation Notes

Soil

Garlic chives develops well in most soils, but rich, well-fertilized soil produce best growth (Saito 1990) and soils should be well drained (Barash 1993). The tolerated pH range is 4.5 to 8.3 (Duke 1978).

Climate

The optimum temperature for garlic chives culture is 20°C, and it grows well in cool climates (Saito 1990). Garlic chives grow best in full sun. It is advisable to restrict watering during the first season to promote root growth.

Propagation and Cultivation

Plants of garlic chives are initially started by seeds, but subsequently reproduced by rhizomes. Some strains produce small bulbs but the main storage organ is the rhizome. During the summer, lateral vegetative bulbs form at flowering time. To reproduce the plants clumps can simply be divided (Harrington 1978). Seeds must he used the spring following harvest because seed viability is short-lived (Saito 1990). In China, garlic chives are grown as a perennial crop with a longevity ranging from 7 to 30 years. During the first year the leaves are not cut, to promote development of a good root system (Saito 1990). Before the plants produce flowers, the leaves may be blanched by placing an inverted pot over the clump. Barash (1993) advises that if the plants become woody in appearance, the shoots should be severely pruned back to within a few centimetres of the ground.

Garlic chives are grown in greenhouses for winter production in parts of Asia. However, greenhouse plants are regarded as inferior to field-produced plants. According to Creasy (1982) regular chives is preferable to garlic chives as a windowsill plant during the winter as garlic chive plants tend to go dormant.

Harvest and Storage

In China, garlic chives is not harvested the first year, to allow a maximum build-up of food reserves for the first dormancy period. Decayed leaves are removed every spring. Sometimes the plants are transplanted to a permanent site during the second growing season. Leaves can be harvested throughout the growing season but it is often preferable to make three or four cuts a year when the leaves reach about 20 cm long. Seeds are taken from plants that have flowered in their third and fourth season. Flowers are harvested at the bud stage and marketed (Yamaguchi 1983).

For the home gardener, the leaves can be clipped back once they are about 15 cm long. However, some leaves should be left to allow the plants to grown well and to form the edible flower buds. In the autumn, a clump can be divided to provide a pot of garlic chives for indoor use over winter (Harrington 1978; however as noted above dormancy may be a problem, and regular chives may be preferable for windowsill plants).

The leaves of garlic chives are very soft and can lose freshness rapidly. They cannot be stored for longer than 3 days, and even then must be kept at 0 to 2°C (Saito 1990). Marketing of garlic chives, therefore, requires refrigeration immediately upon harvest and rapid delivery, sale and use.

Example Cultivars

Broad Leaved, Green Belt, Hanzhong (all described by Facciola (1990); also see cultivars mentioned in Uses).

Bettencourt and Konopka (1990) listed institutions in various countries conserving germplasm of garlic chives.

Additional Notes

Chemistry

Garlic chives appears to have a different balance of volatile flavor components from chives. Methylpropyl disulfide prodominates in garlic chives, whereas propyl disulfide predominates in chives (Yamaguchi 1983).

Medicine

Garlic chives has long been used as a herbal medicine in China, being considered effective for fatigue (Saito 1990). It has also been prescribed as an antidote for ingested poisons, and as a way to control excessive bleeding (Harrington 1978). The leaves and bulbs are applied to bug bites, cuts, and wounds, and the seeds are used to treat kidney, liver, and digestive system problems (Duke and Ayensu 1985). In Japan the plant is used as an intestinal tonic and to treat problems of the urethra (Duke and Ayensu 1985).

Nutrition

Saito (1990) provides nutritional information for garlic chives. There is much vitamin C and carotene (provitamin A), and significant content of vitamins B_1 and B_2. Vitamin C content is reduced to about one third of fresh content by boiling. Carotene content falls to less than half the original value after only a few days of cold storage. Garlic chives is rich in minerals, especially calcium and iron. The fresh leaves contain 3% sugars, and taste rather sweet.

Curiosities

• A common method employed in Taiwan to blanch the leaves of garlic chives, hence increase their tenderness, is to make a sort of pup-tent by placing a bamboo pole on cleft bamboo stakes, and on this straw mats to exclude light (Herklots 1972).

Problems and Potential

This plant is probably destined to remain, even more than chives, confined primarily to the home garden. The very short storage life of garlic chives makes marketing it difficult in western countries, accustomed to products with much longer storage qualities.

Selected References

Herklots (1972); Harrington (1978); Saito (1990).

Allium ×proliferum (Moench) Schrad.

Scientific (Latin) Synonyms

A. cepa L. *A. fistulosum L., A. cepa* var. *prolifera* (Moench) Alef., *A. cepa var. viviparum* (Metzg.) Alef.; *A. fistulosum* var. *viviparum* Makino

[The varietal name *viviparum* is a reference to Egyptian onion's habit of vivipary (budding of plantlets in the inflorescence).]

English Names

Egyptian onion
Also: catawissa onion, garden rocambole, top onion, topset onion, tree onion, walking onion
[Many common names have been applied to this plant. The origin of the name "Egyptian onion" is unclear. It is called "top onion" or "tree onion" because of the bulbils which form on top of the stem. It has been called the "garden rocambole" in the U.S. but this should not be confused with "rocambole," discussed earlier as a form of garlic. See Curiosities for an explanation of the name walking onion.]

Fig. 46.
Egyptian onion *(Allium ×proliferum)*,
from Harter (1988).

French Names

Oignon d'Égypte (m)
Also: oignon catawissa, oignon rocambole

Description, Taxonomy, and History

Egyptian onion is a perennial herbaceous plant, 0.6-1.0 m tall, found only in cultivation. It has recently been recognized as a natural hybrid between common onion, *A. cepa* L., and Japanese bunching onion, *A. fistulosum* L. In the past it has been assigned by some authorities to a variety of one of its parents (see synonyms).

The place of origin of Egyptian onion is uncertain. As this is a natural hybrid it might have arisen more than once, wherever the two parent species occurred together. It was first noted in Europe in 1587 (Dalechamp, cited in Hedrick 1972). This herb was likely introduced into Canada by early French Colonists. It was then brought from Canada to England in 1820, and sometimes called "Canada onion." It is now cultivated in North America, Europe, and Asia (Organ 1960; Mansfeld 1986).

This hybrid plant is sterile, with most or all. of the flowers in the inflorescence developing into bulbils or topsets about the size of hazelnuts. Normal flowers, if they develop, are sterile. The bulbils are initially green, and become a brownish-red color. These may sprout while still on the mother plant, particularly in the form called "catawissa onion." The catawissa onion is distinguished by the vigor of its growth and the rapidity with which some bulbils begin to sprout and form a second tier of bulbils which, in turn, grow sprouts (Grieve 1931). The plant produces offsets from the base of the plant which are used for propagation (Inden and Asahira 1990).

Fig. 47.
Egyptian onion *(Allium ×proliferum)*, from Vilmorin-Andrieux et C^{ie} (1883).

In addition to the Egyptian onion, there are other kinds of hybrids between *A. cepa* and *A. fistulosum* (Brewster 1994). These include the Wakegi onion, grown for centuries in Japan and China as a green salad onion crop; and several American hybrid varieties including Beltsville Bunching, Louisiana Evergreen, and Delta Giant.

Uses

The sideshoots (offsets) of Egyptian onion are eaten raw or cooked. The new green tips can be used as a garnish like chives. The white lower stalks can be chopped raw for salads like common onions and the young stalks, when thinned from the parent plant can be consumed like scallions. The coarser main stalks or fat hollow leaves are sometimes gathered when tender in the spring, slit, and stuffed with cottage cheese. The bulbils (topsets) that form in the inflorescence are cooked or eaten raw. However, they have a strong flavor and should be used sparingly. The bulbils are also pickled as they have a richer flavor than other onions (Halpin 1978; Stephens 1978).

Recipe Sources

Beef with Egyptian onions (Organ 1960).

Importance

It is uncertain if Egyptian onion is grown commercially anywhere in the world. Basically it is grown as an oddity of home gardens.

Cultivation Notes

Soil

Egyptian onion grows in most soils but performs best in well-drained, fertile sandy loam and loam soils. The pH should be 6.0 to 7.0 (Crockett and Tanner 1977). The plants benefit from annual addition of well-rotted compost or manure (Halpin 1978).

Climate

Egyptian onion is winter-hardy as far north as the southern part of Canada. Catawissa is a very hardy cultivar of Canadian origin (Facciola 1990). Egyptian onions require full sunlight for proper growth. Supplementary water is beneficial during dry periods (Halpin 1978).

Propagation and Cultivation

Propagation is by division of the offsets which form at the base of the plant or by planting the bulbils that develop in the inflorescence. Both offsets and bulbils will readily root once placed in the soil. The best time for propagation is in late summer, so that the plants will become well established before winter, although springtime planting is also acceptable. The offsets or bulbils are planted 10-15 cm apart in rows separated by at least 25 cm. If the bulbils are quite small, the whole cluster of bulbils should be planted without breaking them apart. Occasional weeding may be necessary (Halpin 1978). The bulbils develop on top of a stem which naturally bends over, thereby depositing the bulbils a short distance from the parent plant. It is important to support these stems until the bulbils are large enough for harvest. Otherwise, they sprout after contact with the soil (Organ 1960).

During the growing season, the plants will multiply by sending up side shoots, which can be harvested as onion greens. These side shoots as well as the bulbils that develop can be replanted as described above to expand the bed of Egyptian onions. The bed should last indefinitely once established, but should be thinned out periodically.

Harvest and Storage

The side shoots (offsets) can be removed from the parent plant for consumption anytime during the growing season. If they are not used immediately they should be stored under refrigeration. The bulbils (topsets) which form in the inflorescence can be harvested individually and eaten immediately or dried. The entire head can be severed, and hung up to dry in a dark place (Halpin 1978). This method allows the bulbils to be stored for extended periods.

Example Cultivars

Beltsville Bunching, Catawissa (Catawissa Onion), McCullar's White Topset, Moritz Egyptian, Norris Egyptian (all described by Facciola 1990)

Bettencourt and Konopka (1990) listed institutions in various countries conserving Egyptian onion germplasm (as *A. cepa* var. *viviparum*).

Additional Notes

Curiosities

• In the U.S. the Egyptian onion is sometimes called "walking onion." This refers to the interesting way that the plant propagates vegetatively. Bulbils form on top of a stem, sprout, and when the stem bends over to ground level under the increased weight of the head, the bulbils root, thus taking a "step" away from the base of the parent plant (Halpin 1978).

• Again because of its peculiar characteristic of developing bulbils, it is called "kitsune negi" in Japan, meaning "foxy" or "mysterious" onion (Yamaguchi 1983).

Problems and Potential

Egyptian onions are likely to remain an edible landscape of home gardens. They are an attractive addition to the perennial garden as an extremely hardy, picturesque curiosity that has a variety of uses in cooking.

Selected References

Halpin (1978); Stephens (1978).

Aloysia

Family: Verbenaceae (vervain family)

Genus Notes

Aloysia has about 40 species of aromatic shrubs or small trees native to the warmer part of the Americas.

Aloysia citriodora Palau

Scientific (Latin) Synonyms

A. triphylla (L'Hérit.) Britt., *Lippia triphylla* (L'Hérit.) Kuntze, *L. citriodora* Kunth, *Verbena triphylla* L'Hérit. [The nomenclature of this species was clarified by Armada and Barra (1992), who consistently retain the epithet *citrodora*, as (mis)spelled when the name was first published; i.e., acccording to these authors the name is spelled *A. citrodora*. However, the International Code of Botanical Nomenclature allows for correction of certain kinds of orthographic errors, and *A. citriodora* is the almost universal way this name is now spelled.]

English Names

Lemon verbena
Also: cidron, herb Louisa, lemon-scented verbena, limonetto, real vervain, sweet verbena, sweet-scented verbena, verbena, verveine citronella

French Names

Family: Verbénacées, famille des verveines
Verveine citronée (f)
Also: aloyse citronée, citron(n)elle, lippie, thé arabe, verveine ä trois feuilles, verveine citron(n)elle, verveine des Indes, verveine du Pérou, verveine odorante (citronelle)
[See lemon balm, *Melissa officinalis*, for a discussion of other species called citronelle. See lemon grass, *Cymbopogon citratus*, for a discussion of the French name verveine (verbena). According to Bianchini and Corbetta (1977), *verveine odorante* refers to a popular tisane served in bars and cafés in France. Montes et al. (1973) used the name "cedrón" in their article in French, but this name is Spanish, and is common in many South American countries.]

Note

The mature leaves of the following species are tough and, when used in cooking, should be removed before serving.

Description, Taxonomy, and History

This native of Argentina, Chile, Peru, and Uruguay is highly aromatic with an intense lemon scent. It is a deciduous shrub which can be semi-evergreen in warm climates. It grows as tall as 5 m in climates with mild winters, but is usually 1-1.5 m high in northern gardens, or 0.5-1 m when grown in pots. The leaves grow in whorls of three or four, are dotted with oil glands on the underside, and are pleasantly aromatic. The plant produces filmy spikes of small white and purple flowers in summer and autumn.

Lemon verbena was taken to Spain by the Spanish conquistadors in the 1700's and became naturalized in parts of Europe. It has been cultivated in the Mediterranean region since the end of the 18th century (Skaltsa and Shammas 1988). About the same time it was introduced into North America by a New England sea captain who brought it from Chile. It is found as an escape in South Africa and parts of Asia where it is sometimes cultivated for its essential oil (Mansfeld 1986).

Uses

Lemon verbena is grown mainly for its foliage which is used for culinary purposes. The leaves can be used fresh or dried to impart a sweet lemon-lime flavor and aroma. Macleod (1968) stated that the foliage of lemon verbena "has the most delicious fragrance of all the lemon-scented herbs." The sharp, long-lasting fragrance has also been described as "more lemony than lemons themselves," so that when it is substituted for other lemon herbs only half the usual amount need be used (Miske 1994). The leaves are especially desirable for making an excellent tea, used alone or in combination with other herbs, including common black or English tea. So-called "yerba Louisa" tea, sweetened with honey, is a popular drink in parts of Europe. [*Yerba Louisa* should not be confused with *hierba luisa*, a Spanish name used in South America to designate *Cymbopogon citratus* (discussed in this book).] Whole leaves are used to add lemon flavor to cold drinks, salads, dressings, fruit cups, sauces, marinades, jellies, soups, omelettes, vegetables, fish, and meat dishes. Leaves are placed at the bottom of a cake pan to flavor a cake while baking, and removed before serving. Occasionally the young leaves are eaten like spinach. Fresh leaves are tough, and should be minced finely if they are to be consumed rather than used simply to impart their flavor. Dried leaves can easily be crumbled finely.

Fig. 48.
Lemon verbena *(Aloysia citriodora)*, from Curtis (1787-present; #367).

The essential oil has been used to make flavoring for soft drinks, liqueurs, perfume, toilet water, and eau de cologne (El-Hamidi et al. 1983). The oil is expensive, however, and has largely been replaced by other less-expensive essential oils with similar properties (Morton 1976). The oil has been used to make a "health tea" in Italy, France, and Spain (Morton 1981).

The dried leaves of lemon verbena can also be added to a potpourri for scent (Kublick 1990). Although long-lasting, the scent often fades in about 6 months and should be replenished (Morton 1976). The species is grown as a garden ornamental in warm climates, such as in the southern U.S. An ornamental variegated form is available.

Recipe Sources

Muenscher (1978) gives eight lemon verbena recipes, including: Lemon verbena fruit cup, Lemon verbena pudding, Lemon verbena cake, and Lemon verbena cookies. Tolley and Mead (1985) present recipes for: Fingerprint cookies with lemon verbena jelly, Fruit and spice herb tea, and Lemon verbena jelly. Hutson (1987) has recipes for: Sangría (Spain's sassy wine cooler), Velvety lemon verbena flan, Lovely lemon verbena poundcake, Lemon verbena glaze, and Lovely lemon vinegan Gilbertie (1988) has three lemon balm recipes, including Blueberry lemon verbena muffins. Holt (1991) has recipes for: Nectarine and lemon verbena ice cream in rose chocolate cases, Iced Ear Grey and lemon verbena tea, and Apricots preserved in eau-de-vie with lemon verbena.

Other recipes are: Apple jelly with lemon verbena leaves (Hériteau 1975); Lemon verbena tea (Marcin 1983); Vanilla and lemon ice cream (Bonar 1985); and Lemon verbena and lime cordial (Bremness 1988).

Importance

Lemon verbena is of minor economic importance. The culinary use is most developed in Latin America (Duke 1985). The species is widely cultivated in home gardens in Mediterranean Europe, Africa, India, and other mild climates (Morton 1976). In France, more than 300 t of dried leaves are consumed annually, of which only 2 t are produced in France itself (Maghami 1979). Lemon verbena is only occasionally cultivated commercially for its essential oil, in southern France and North Africa (Algeria and Tunis) according to Guenther (1965) and Simon et al. (1984); mostly in South Africa and parts of Asia according to Mansfeld (1986); in Mediterranean Europe and Africa, and in East Africa and Chile according to Morton (1981). "The yield of oil, however, is so poor that the price of the oil by far exceeds its value" (Guenther 1965).

Cultivation Notes

Soil

In warm regions the plants are grown in moderately fertile, moisture-retentive, but well-drained soils. When grown in pots, the soil should be a loam-based mix with good drainage (Huxley et al. 1992). Crockett and Tanner (1977) recommend a mixture of equal parts of loam, sand, and leaf mold. Addition of fertilizer may increase the size of the leaves but can decrease the flavor (Hutson 1987).

Climate

Lemon verbena is suitable for subtemperate or subtropical regions. It is sensitive to cold (El-Hamidi et al. 1983), but is said to tolerate winter temperatures of-10°C overwintered outdoors as far north as Tennessee (Fitz-Gerald 1942), but farther north the plants should be sheltered indoors during the cold season. According to Crockett and Tanner (1977), lemon verbena will remain green year-round in U.S.D.A. climatic zone 9 and can be grown in zones 7 and 8, but will lose its leaves each winter. Lemon verbena grows best in full sun. Potted plants should be kept moderately moist outdoors during the summer, but almost dry when held indoors during winter, with a minimum temperature of 5-7°C. Crockett and Tanner (1977) recommend that indoor potted plants be given at least 5 or 6 hours of direct sunlight daily, day temperatures of 21-24°C, and night temperatures of 10-13°C.

Propagation and Cultivation

Seed formation is infrequent (Marcin 1983), but if seeds are available, they can be sown in late spring at a depth of 6 mm or less (Wang et al. 1993). Propagation is usually by cuttings, taken from new softwood growth in the spring (Huxley et al. 1992) and from stem cuttings in mid to late summer (Wang et al. 1993). According to Marcin (1983), mature plants tend to wilt temporarily after cuttings are taken, but Miske (personal communication) advises that she has never observed this. The cuttings are placed in a moist, well-drained medium soil, with gentle bottom heat if possible. The plant can also be reproduced by dividing the roots in the spring. Lemon verbena is offered as living plants in several North American garden catologs.

If grown outdoors at its northern cultivation limit, lemon verbena should be provided with good drainage; a warm, sunny position; protection from cold winds; and heavy winter mulching. It may be necessary in the spring to cut away branches that have died during the winten In France and North Africa, plants are hilled up to protect them from the cold of winter (Guenther 1965). Experiments in western North Carolina carded out by Davis (personal communication)

showed that winter survival was considerably increased by cutting plants back to a height of 5-8 cm above ground, and then covering with a commercial white copolymer-backed thermoblanket 0.6 cm thick. By contrast, coveting the plants with soil did not increase winter survival. Davis notes that the foam packing sheet material used to ship glass items also works well.

Lemon verbena is best treated as a house plant in the cooler areas of North America. This frost tender perennial can be grown outdoors in summer and brought indoors before frost. Plants transferred indoors may lose their leaves. This is normal as lemon verbena is deciduous. The plant may be cut back about February to stimulate growth (Marcin 1983), and repotted in a fresh soil mixture every 2 or 3 years (Crockett and Tanner 1977). The pot should be watered sparingly and kept cool until new growth appears. Temperature should be maintained at a minimum of 7°C. During active growth the soil should be kept moist but not soggy (Kublick 1990). Lemon verbena is highly susceptible to infestations of white flies and spider mites (Miske 1994), and aphids (Ugás, personal communication).

Harvest and Storage

Leaves can be harvested at any time but are at their most flavorful just as the flowers are coming into bloom. According to Van Brunt (1972), mature plants are preferable because the lemon fragrance becomes stronger with age. Harvested leaves can be dried in a dark, warm, airy place. The dried leaves retain their flavor and scent for years if stored in a cool dark place in an airtight jar (Garland 1979). Leaves can also be frozen in ice cubes trays to make flavorful decorative ice cubes (the same technique can be used with other lemon-flavored herbs).

When grown commercially in warm climates, two to three harvests are possible in a year, with total annual yields of 3.6-4.5 t/ha fresh herb (El-Hamidi et al. 1983), or 4-6 t/ha according to Guenther (1965). Commercial crops are usually harvested for oil in early summer at full bloom, and again in late fall just before cold, killing temperatures (Simon et al. 1984). Yields of oil are very low: fresh leaves produce 0.072-0.195%; leaves and twigs have yielded 0.0118%; and leaves, twigs, and blossoms have produced 0.65% (Guenther 1965).

Example Cultivars

Named cultivars are generally unavailable in North America.

Additional Notes

Chemistry

Leaves and stems respectively contain about 0.4-0.65%, and 0.35%, essential oil. The essential oil is rich in citral (about 35% in some lines, lower in others), with some borneol, cineol, dipentene, geraniol, limonene, linalool, nerol, citronal, verbesone, acetic acid, - and ß-caryophyllene, myrcene, and pyrollic- and isovalerianic-acid (Montes et al. 1973, Duke 1985). Montes et al. (1973) found the main constituents were *d*-limonene, citral, and *p*-cymol. The essential oil is called oil of verbena, a name also used for the essential oil of *Cymbopogon citratus*, discussed elsewhere in this book. The high-priced lemon verbena oil is often adulterated with other plant oils (Simon et al. 1984). Alternatively, essential oil components from other sources are skilfully blended in about the same proportions in which they occur in the natural verbena oil (Guenther 1965). So-called "Spanish verbena oil" is derived from *Thymus hiemalis* Lange and perhaps also *T. hirtus* Willd. (Guenther 1965). Mean levels of 5.3% (dry weight basis) of the phenolic compound verbascoside were found in lemon verbena by Lamaison et al. (1993).

Medicine

Morton (1981) lists a number of medicinal uses in Middle America of the tea resulting from boiling the leafy stems of lemon verbena. Perhaps most notable is its use as an antidote for bites of poisonous animals in Argentina. Other ailments treated with lemon verbena include asthma, colds, fever, flatulence, headache, migraines, nausea, rabies, stomach cramps, and vertigo (Duke 1985, Skaltsa and Shammas 1988). Tea made from lemon verbena is fairly widely used in South America to relieve acidity, indigestion, and flatulence (Ugás, personal communication). The tea is also employed as a stimulant for lethargy and depression (Phillips and Foy 1990). A survey of plants employed as a folk medicine to reduce anxiety in Porto Alegre, Brazil, showed that lemon verbena tea was one of the most widely used preparations (Wannmacher et al. 1990*a*). However, effectiveness in reducing anxiety could not be demonstrated (Wannmacher et al. 1990*b*). Lemon verbena is also employed in folk medicine in France (Lamaison et al. 1993).

In susceptible individuals, handling lemon verbena or eating foods flavored with it may cause contact dermatitis (Rinzler 1990). According to Bremness (1988), "long-term use of large amounts of leaf may cause stomach irritations."

Nutrition

No nutritional information was found.

Curiosities

• The genetic name *Aloysia* commemorates Maria Louisa, wife of King Charles IV of Spain (Stuart 1979).

• In 1864, the Emperor Maximilian (1832-67, emperor of Mexico 1864-67) and his empress, Carlotta, planted lemon verbena in the royal gardens of Montezuma's palace in Mexico, naming it "yerba Louisa" after Carlotta's mother, the queen of Belgium (Van Brunt 1972).

• In the movie "Gone with the wind," lemon verbena is mentioned as a fragrance favored by Scarlet O'Hara's mother (Kublick 1990).

Problems and Potential

There is no commercial potential for lemon verbena as an outdoor crop in the cooler areas of North America, where it is likely to be grown simply as an interesting, edible house plant that can be moved outdoors for the summer.

Selected References

Guenther (1965); Garland (1979); El-Hamidi et al. (1983); Lima (1986); Kublick (1990).

Fig. 49.
Dill *(Anethum graveolens)*, from Thomé (1903-1905).

Anethum

Family: Umbelliferae (carrot family)

Genus Notes

Anethum is made up of as many as three species of herbaceous plants from the Old World (Cheatham and Johnston 1995).

Anethum Graveolens L.

Scientific (Latin) Synonyms

Peucedanum graveolens (L.) C.B. Clarke

English Names

Dill
Also: American dill, common dill, Danish dill, dill seed, European dill, garden dill

French Names

Family: Ombellifères, famille de la carotte
Aneth (m)
Also: aneth fenouil, aneth odorant, écarlade, écarlate, fauxanis, fenouil bâtard, fenouil puant

Description, Taxonomy, and History

Dill is a herbaceous, yellow-flowered annual (sometimes biennial), 30-120 cm tall (usually about 50 cm), grown for its thread-like edible leaves and seeds. Cultivated and wild plants are quite similar. Two forms of cultivated dill are recognized (Mansfeld 1986, Huxley et al. 1992), as noted below.

The familiar garden dill, also known as American or European dill, is sometimes classified as subsp. *graveolens*. It is cultivated in sub-tropical and temperate areas around the world.

So-called Indian dill (grown in India) and Japanese dill (grown in Japan) are often considered to comprise a separate species. This is often termed *A. sowa* Roxb. ex Fleming. Indian dill is called *A. graveolens* subsp. *sowa* (Roxb. ex Fleming) Gupta (=*A. sowa* Roxb. ex Fleming) by Mansfeld (1986) and this nomenclature is followed here. This sub-species differs slightly from subsp. *graveolens* (so-called European dill) in the shape of the seeds. Those of Indian dill are longer, narrower, and have paler ridges. According to Facciola (1990), Indian dill tends to be taller than garden dill, sometimes reaching heights of 1.2 m. The seeds also have a higher dillapiole and lower carvone content, a chemical combination that is considered less desirable (Greenhalgh 1979; Lewis 1984). The seeds of Indian dill are more pungent and bitter than those of garden dill, but are preferred as an essential ingredient of curry powder (Facciola 1990). Indian dill is grown primarily for its seeds, whereas the European dill is primarily grown for harvest of the tops (Mazza 1991*a*).

Early historical references to dill are uncertain because of possible confusion with other cultivated Umbelliferae. Dill was apparently first mentioned in an Egyptian list some 5000 years ago, making it one of the oldest known medicinal herbs (le Strange 1977). It was cultivated in ancient Palestine, and in classical Greece and Rome. Often mentioned in old writings, the words "dill" and "till" were used in Germany and Switzerland as early as 1000 A.D. Dill was cultivated in England in 1570, but was not used commercially in the U.S. until the early 19th century (Rosengarten 1969).

Dill originated in southwestern Asia and has become naturalized in Europe and the northern U.S. It is an occasional garden escape in parts of Canada, including southwestern British Columbia, Alberta, and the southern parts of Manitoba, Ontario, and Quebec (Scoggan 1978-79). In the U.S. it has similarly been recorded locally in widely scattered localities, notably in the northeastern U.S. (Fernald 1970).

The so-called "seeds" of dill are actually dry half-fruits called schizocarps. The commercial practice of referring to these as seeds is followed here.

Dill herb is easily confused with that of fennel. Dill is more delicate, with finer thread-like leaves.

Uses

The most familiar use for dill is for flavoring and seasoning, especially in pickled vegetables. For these purposes, dill is cultivated for three different products: fresh or dehydrated herb; dill seed; and dill oil. The whole plant with immature seeds (fresh or dehydrated) is known commercially as dill weed and baby dill (the harvested vegetative plant, just the leaves alone, or the top of the fruiting plant may also be referred to as dill weed).

Leaves are usually finely chopped and added fresh or dried to soups, salads, seafood dishes, poultry, eggs, meats, stews, casseroles, vegetables, dressings, sauces, herb butters, sauces, sour cream, cream cheese, and dips. Fresh leaves are considered to have a much better flavor than the seeds. Leaves should be added to foods at the last minute to retain

Fig. 50.
Dill *(Anethum graveolens)*, from Hallier (1880-1888).

their distinctive flavor, which is reduced through cooking. Dill has been described as having "an unmistakable, indescribable gentle flavor of its own" (Larkcom 1984).

Dill seed is used most frequently as a condiment, either whole or ground. The aroma of the seeds is reminiscent of caraway, but not as pronounced, while the taste is warm, pungent, slightly sharp, and persistent. Rinzler (1990) suggests that dill seeds taste sufficiently like caraway seeds that when out of the latter, dill seeds may be substituted in rye bread. The seeds are used extensively to flavor pickled cucumbers, and are also added to vegetables, breads, pastries, soups, sauces, and gravies. In India, sowa seed (subsp. *sowa*) is an ingredient of curry powder. In Indonesia, sowa seed is added to pastries and beverages. Dill seeds are generally added early in cooking as they require some time for their flavor to permeate the dish.

In addition to seeds alone, the immature fruiting top (i.e., dill weed), or the mature top with its seeds, is used to flavor dill pickles, especially popular in North America.

Dill vinegar is made by soaking the seeds or dill weed in vinegar for several days (Greenhalgh 1979). Sprouted seeds are eaten in breads, soups, and salad dressings (Facciola 1990). Tea can be brewed both from leaves and seeds, the latter milder in taste (Facciola 1990). Dill flowers can be used like the seeds: to flavor pickles, gravies, mustards, stews, and breads (Facciola 1990).

The majority of the world's dill crop is used for two types of dill oil. The unripe fruits and the leafy tops are the source of what is termed dill weed (dill herb) oil. This is steam-distilled for flavoring and seasoning by the food industry for such products as pickles, condiments, meat preparations, potato chips, sauces, dips, chewing gum, and candy. Dill weed oil made from the herb at the immature fruiting stage has largely replaced both dill leaf and dill seed oil in commercial food usage. However, some ripe seeds are distilled for dill seed oil, which is used in perfumery and soap-making. Oleoresin from dill seed oil is used in infusions, tinctures, and fluid extracts, which are of limited commercial importance (Greenhalgh 1979). In the U.S. 80 to 85% of the dill oil in commercial trade is used as flavoring in the pickling industry. The other 15-20% of the oil is used as a general flavoring or seasoning (Craker 1987).

Recipe Sources

Day and Stuckey (1964) present the following recipes: Dilly onion bread, Pickled dill beans, Dilled rutabagas with bacon, and Dilly beef with sour cream. Owen (1978) has recipes for: Crisp dilled cucumbers, Potato and cucumber salad with dill, Shrimp with dill sauce, Liver in dilled sour cream sauce, Dilled veal blanquette, Mama's hot semi-kosher dill pickles, and Dill pickled green beans. Rose (1979) presents recipes for: Steamed fish with dill, and Lime-dill ling cod (or other white fish) fillets. Jaffrey (1981) gives recipes for: Yogurt with dill, and Chickpea, cabbage, and dill soup. Belsinger and Dille (1984) present 13 dill recipes, notably: Dilled yellow squash, Mussel and potato salad with dill, and Eggs with avocado dill sauce. Hutson (1987) gives recipes for: Dilly butter, Dilly vinegar, Dilly potato salad, and Creamy dill and mustard sauce. Wiley et al. (1989) have the following recipes: Beef balls in dilly cream, and Quick dilly corn muffins. Richardson (1991) has 14 dill recipes, notably: Dilled

grilled salmon steaks, Salmon quiche with dill and parsley, Shrimp with beer and lemon-dill butter, and sautéed cucumber with dill. Barash (1993) has dill flower recipes entitled: Dilly soup, Dilled potato salad, and Mussels with tomato and dill florets.

Other recipes are: Artichoke with dill (Mallos 1979); Dill tea (Marcin 1983; recipes for both seeds and leaves are given);American dill pickles (Larkcom 1984);Artichokes in dill (Algar 1985); Fancy dill sauce (Hughes 1985); Dill sauce (Jeanneret 1987); Hot salmon and dill mousse (Holt 1989).

Importance

Dill is one of the more important herbs grown commercially. The major dill producers are India and Pakistan, with substantial amounts also grown in Egypt, Fiji, Mexico, the Netherlands, the U.S., England, Hungary, and Germany (Simon et al. 1984). Most dill in the U.S. is produced in the Pacific Northwest (Oregon and Washington) and in Nevada (Craker 1987), but it can be raised almost everywhere, including Florida. Few statistics seem available on commercial production of dill weed. Dill weed produced in the U.S. is preferred in Europe because of its flavor and bright green colon About 20% of U.S. dill weed production is exported (Greenhalgh 1979).

Production of Indian dill seed (subsp. *sowa*) was between 2500-3000 t per annuum in the mid-1970's. Most dill seed that is exported internationally is Indian dill seed. In 1986, the U.S imported over 750000 t of dill (Craker 1987). In 1988 the U.S. imported 364 t of dried dill weed and seed valued at $600,000 (Simon 1990). Import value of seeds to the U.S. averaged $731,200 annually over the period 1990-94 (Buzzanell et al. 1995).

Verlet (1993) estimated the annual world value of dill essential oil to be U.S.$2,800,000.00, while the essential oil from dill seed was worth only $75,000.00 annually. In 1984, countries leading in dill essential oil production were the U.S. (70t), Hungary (35t), and Bulgaria (20t), with total world production of 140 t. Dill is the third most important essential oil crop in the U.S., after spearmint and peppermint (Ference 1989). Most commercial dill for essential oil is produced in Washington and Oregon, with a small amount in Indiana (Ference 1989). In 1988 the U.S. produced 70 t of dill oil (Simon 1990).

From 1974 to 1988 Canada, mostly Manitoba, was a major producer of dill oil, producing 14-15 t, or 10-15% of the world's annual production (Mazza 1991*a*). In 1989, depressed prices resulted in Manitoba dill farmers discontinuing production (Mazza 1991*a*). In 1989, 2.4 ha of dill weed valued at $15,188 were grown in Alberta (Anon. 1990*b*). There are local markets in Canada for fresh dill weed and for the fruiting heads used for dill pickles.

Cultivation Notes

Soil

Dill will grow on organic soils but performs best on deep, well-drained, fertile, sandy loam. In the garden, it is desirable to supplement the soil with compost or manure (Crockett and Tanner 1977). The desirable pH range is 5.5-6.5 (Stephens 1978), with a pH tolerance range of 4.5-8.2 (De Baggio 1987). Nitrogen and phosphorus fertilizer levels affect oil content and total dill weed yield (Garrabrandts and Craker 1987; Singh et al. 1987).

Climate

Dill is regarded as a cool weather crop. The desirable temperature range for growth is 6-26°C. Dill must be grown in full sunlight and requires irrigation during dry periods. Long days are needed for highest quality. Supplementary water is best applied as overhead sprinkling from the seedling stage until the plants reach about 60 cm in height. Subsequently furrow irrigation is preferred, as airborne water droplets increase the risk of mildew becoming established on damp seed heads (Craker 1987). Hot weather causes dill to flower, reducing the production of leaves. Stresses like low moisture, hail, strong winds, and hard rains during flowering and seeding are detrimental (Simon et al. 1984). In a garden, dill is preferably planted in a protected location to prevent the hollow stalks, when they become top-heavy with seeds, from being knocked over by the wind (Crockett and Tanner 1977).

Propagation and Cultivation

Dill is usually grown as an annual crop. Indian dill (subsp. *sowa*) is grown as a perennial herb (Simon et al. 1984).

Dill is propagated by seeds planted 5-10 mm deep (6-13 mm according to Wang et al. 1993). The seeds usually germinate within 2 weeks. Germination may require some light, and temperatures are best in the range 15-21°C (Wang et al. 1993). Putievsky (1980) found that, for commercial purposes, dill seed is efficiently germinated by providing a daily cycle of 10-15°C for 8 hours and 28-33°C for 16 hours. Dill readily self-sows. Dill seed can overwinter outside as far north as the warmer parts of Canada, and will germinate in the garden the following year. Transplanting of seedlings is not recommended since they have a long taproot that is easily damaged. Commercially, the plants are direct-seeded in rows about 20-40 cm apart

with seedlings often thinned to about 12 cm (Craker 1987). However, recent studies in Massachusetts (Garrabrandts and Craker 1987) found the highest yield from narrow rows (15 cm) and close spacing (10 cm between plants).

It is advisable to use uniform-sized seed for crops destined for commercial seed production. This results in plants that reach harvest simultaneously. Fields can then be combined and harvested with minimum seed loss through shattering. Some cultivars grow to 1 m in height before the fruits mature. Occasional weeding is required (Stephens 1978). Yields average 1.1-1.6 t/ha (Craker 1987).As noted in fennel Curiosities, when seed for propagating dill is desired, plants should not be grown near fennel as the two species cross and hybrid seed is produced which may not generate satisfactory plants. According to Crockett and Tanner (1977) "the flavor of the resulting seeds and leaves is impossible to predict."

Dill can be grown indoors as a potted house plant, for a continuous supply of fresh leaves. A cultivar appropriate for leaf, not seed production should be chosen, as seed production by house plants is not likely. As an indoor plant, dill requires at least 5 hours of direct sunlight or 12 hours of bright artificial light (Crockett and Tanner 1977). A high-nitrate fertilizer (such as 30-10-10) is recommended (Elbert and Elbert 1974). Trimming 5-10 cm only from the stems at one time limits damage to the plants. For good regrowth, leave at least 10 cm of stem at the base. The useful life of indoor dill plants is unlikely to exceed 3 months.

Harvest and Storage

Dill herb destined for the table is best gathered before flowering begins. Fresh leaves are regarded as more flavorful than dehydrated material. However, the leaves can be dried at low temperatures (no more than 38°C) for later use. Pääkkönen et al. (1989) studied odor and taste deterioration in freeze-dried dill, and recommended storage in vacuum packages under cool conditions. Fresh dill weed is occasionally locally marketed but is most commonly sold in a dried form. Home gardeners can obtain fresh dill weed through the growing season by planting successive crops and picking as needed. The flavor of dill is best preserved by freezing.

Commercial dill herb destined for oil production is mechanically harvested, usually at or just after flowering. Studies in India (Singh et al. 1987) have indicated that this is the time of maximum oil content. The dill is often left to wilt for 24 h, which reduces the moisture content and enables more efficient packing of the chopped plant material in the distillation tanks. Wilting has little effect on the total amount of extracted oil but increases the content of carvone, the most desired volatile oil constituent (Chubey and Durrell 1976*a*). Large stills are used to obtain the oil. Good yields from relatively fresh plant material are 0.3-0.6% (Lewis 1984). In experiments in Manitoba, yields of 0.60% were achieved (Chubey and Durrell 1976*a*).

Dill seed is harvested when the fruits begin to turn yellowish-brown, usually 7-9 days after petal drop. The oil content has been found to be highest when the fruits are green but fully developed. To minimize loss from shattering, cutting is done in early morning or late evening when the plants are moist with dew. The plants are mown and stacked in the field to wilt or dry. They are then threshed and the dill seeds are dried artificially at moderate temperatures, or in trays in the sun in some countries (Lewis 1984). Under good conditions yield can be 550-780 kg/ha (Rosengarten 1969).

To obtain dill oil, the seeds are crushed between heavy rollers and subjected to steam or hydrodistillation. The yield varies from 2-4% depending on factors such as agronomic conditions, maturity of seeds, geographical origin, and freshness (Lewis 1984). In commercial tests, an average of 84.7 kg/ha of dill oil was obtained from seeds in Manitoba (Chubey and Dorrell 1976*b*).

Example Cultivars

Bouquet and Mammoth Long Island are the leading cultivars of dill planted in the U.S. (Craker 1987). Fernleaf is a "dwarf" cultivar (less than 0.5 m in height) which apparently resists flowering longer than other cultivars, making it better for dill weed production. Cultivars described by Facciola (1990) include Aroma (for dill weed), Bouquet (good for seeds), Dukat (for leaves), Dura (for flower clusters for pickling), Sari, Tetra (for leaves), and Vierling (for flower clusters for pickling, and for leaves).

Bettencourt and Konopka (1990) list institutions in various countries conserving dill germplasm.

Additional Notes

Chemistry

Dill oil is composed of at least 10 different aromatic compounds. Carvone, limonene, and a-phellandrene constitute approximately 90% of the total oil content. Carvone content of the seeds can reach 60% (Simon et al. 1984). Dill oil with less than 20% carvone is considered to most closely resemble the true aroma of dill herb, preferred for dill pickles (Farrell 1985). Nevertheless, in North America the dill trade requires a carvone content of at least 30%,

with some manufacturers preferring higher levels (Chubey and Dorrell 1976*a*). The dill-like odor and flavor is chiefly due to -phellandrene; the higher the content, the more the oil resembles fresh dill herb (Farrell 1985). Indian dill (subsp. *sowa*) has a relatively high content of dillapiole and a low carvone content (Simon et al. 1984), a combination ideally suited for dill pickles. Dillweed oil is milder than dillseed oil, and has less carvone and more -phellandrene, once again the chemical profile preferred for the finer and more appetizing flavor appreciated in dill pickles (Farrell 1985).

Principal dill seed oil components include *d*-carvone, *d*-limonene, *d*-phellandrene, -pinene, diterpene, *d*-dihyrocarvone, ß-phellandrene, ß-pinene, 1,8-cineole, ß-myricene, *p*-cymene, and -thujone (Simon et al. 1984). Dill herb oil has *d*-alpha-phellandrene, terpinene, limonene, carvone, dillapiole, isomyristicin, and myristicin (Simon et al. 1984). Quality of dill oil fluctuates considerably, depending on the maturity of seeds. However, even under the northern conditions of Alberta, the chemical constituents of dill seed and weed have proved to be close to international standards, although at harvest time the dill fruits are unevenly matured (Embong et al. 1977*b*). Hälvß et al. (1992*a, b*, 1993) found that oil content increased with light intensity and temperature, and often did so with longer photoperiod; and that exposure to far-red light increased oil production and also altered relative chemical composition of the oil. Commercial oleoresins, prepared to reproduce the flavor of the whole herb, are produced from a combination of dillseed and dillweed oil; one part of the oleoresin is equivalent to 20 parts of ground dill (Farrell 1985).

Medicine

Dill was once used medicinally to cure hiccoughs, sooth stomach aches, ease digestion, and freshen breath. In medieval times, injured knights are said to have placed burned dill seeds on their open wounds to speed healing (Grieve 1931). Dill seeds, leaves and flowers are sometimes still used in folk remedies to cure tumors and treat bruises, colic, cough, hemorrhoids, insomnia, jaundice, scurvy, sores, and stomach problems (Duke 1985).

Today, dill is little used for medicinal purposes in western medicine, although dill water or syrup is sometimes given to babies. Oil of dill is optimistically administered in water or with sugar syrup as a remedy for flatulence (Greenhalgh 1979). Dill is still considered a medical plant in China (Duke and Ayensu 1985). In Vietnam it is used to treat intestinal diseases (Nguyêñ-Xuân-Duñg and Dà-Tât-Loi 1991). The essential oil is considered a fairy potent vermicide against hookworms (Perry and Metzger 1980).

For some individuals, dill may cause contact dermatitis, and also photodermatitis [dermatitis produced only upon exposure to sunlight (Simon et al. 1984)]. As noted in Curiosities, dill may have some psychoactive and hallucinogenic properties.

Nutrition

Analysis of nutrients of dill seed is provided in Duke (1985) and Duke and Ayensu (1985). Because the seed is consumed in minor amounts, it does not add notably to a balanced diet. According to Sychev and Shmanaeva (1989) dill (herb) has a high vitamin C content, which is consistent with past use as a treatment for scurvy.

Curiosities

• The name dill is derived from the Old Norse "dilla," meaning to lull, because of the herbs purported affect on crying babies (Rosengarten 1969).

• Because of its alleged magical properties, dill was employed as protection against witchcraft and as an ingredient of exotic love potions and aphrodisiacs (Rosengarten 1969).

• In ancient Greece and Rome, dill was strewn on the floors of banquet halls so that its fragrance would counteract the heavy food smells (Kublick 1990).

• The classical Romans believed that dill had fortifying qualities, and so they covered the food given to gladiators with the herb (Toussaint-Samat 1992).

• Brides in Flanders wore sprigs of dill on their wedding dresses to ensure a happy marriage (Kublick 1990). It was also an old German custom for the bride to carry dill (Fox 1933).

• Dill, like several other members of the carrot family (including caraway, carrot, fennel, lovage, parsnip and parsley) contains the alleged "psychotroph" (mood-altering chemical) myristicin (Duke and Ayensu 1985).

• A mixture of dill, dried honey, and butter was once prescribed to treat madness (Perry and Metzger 1980).

• Fruit flies exposed to the insecticide parathion showed only 8% mortality, but when certain dill compounds were added (notably *d*-carvone) 99% of the flies were killed (Duke and Ayensu 1985).

Problems and Potential

Growing dill for herb, seed, and oil production is well established in parts of the U.S., with growth potential largest for dill oil. Dill oil might appear to be a promising crop in northern North America, since the relatively cool climates are thought to boost oil yields from members of the carrot family. Ference (1989) analysed the economic feasibility of growing dill for oil in Canada, based on experiences with

the crop in Manitoba. Potential domestic commercial production of dill destined for oil has been estimated at less than 250 ha in Canada (Chubey and Dorrell 1976*b*). Ference concluded that profitable market niches for additional production are unlikely in the foreseeable future.

With the increased interest in eating ethnic dishes, there is some potential for increased commercial production of dill in northern North America, both for dill weed and dill seeds.

Selected References

Chubey and Dorrell (1976*a, b*); Greenhalgh (1979); Craker (1987); Garrabrants and Craker (1987).

Angelica

Family: Umbelliferae (carrot family)

Genus Notes

Angelica, found on all continents of the Northern Hemisphere, has about 50 species of biennial or perennial species. *Angelica archangelica* is discussed in detail below as a cultivated culinary herb.

In North America, a few wild species are sometimes collected as wild food. *Angelica atropurpurea* L. is known as Alexanders (a name better reserved for *Smyrnium olusatrum*, discussed in this book), American angelica, purple(-stem) angelica, or masterwort (a name also applied to *Heracleum sphondylium* L., as pointed out in *Rheum* Genus Notes). Its young spring shoots and leafstalks are added to salads and its roots have been candied. A medicinal use of this plant is given in Curiosities. *Angelica sylvestris* L. of Eurasia and North America is known as woodland angelica or wild angelica. The leaves and young stems have been eaten as a vegetable.

Angelica lucida L. occurs along western North America from Oregon to Alaska, and into Siberia, and also is found sporadically across northern Canada and in the Maritimes (Kuhnlein and Turner 1991). This close relative of *A. archangelica* is sometimes collected by wild food foragers. The Western Eskimo of Alaska are reported to incorporate its leaves into "Eskimo ice cream" (a mixture of animal fat, greens, berries, oil, fish eggs and sugar) (Kuhnlein and Turner 1991). Schofield (1989) reported undocumented evidence that *Angelica* hybridizes with the poisonous water hemlock (*Cicuta maculata* L.), and indeed that wild angelica in Alaska might be influenced by such hybridization. These reports require confirmation. Water hemlock is similar to *A. lucida*, and the two are easily confused.

Several Asian species are also collected there from the wild and eaten, particularly in China and Japan (Tanaka 1976, Mansfeld 1986, Huxley et al. 1992). These include *A. acutiloba* (Seib. & Zucc.) Kitag., *A. dahurica* (Fisch.) Benth. & J.D. Hook ex Franch. & Sav., *A. decursiva* (Miq.) Franch. & Sav., *A. genuflexa* Nutt. ex Torr. & A. Gray. *A. japonica* A. Gray (= *A. ursima* Maxim.), *A. keiskei* Koidz., *A. polymorpha* Maxim., and *A. pubescens* Maxim.

Several species *of Angelica are* used in traditional folk medicine (Simon et al. 1984; one use is given in the Genus Notes for ginseng, *Panax*). A few species are sold through garden catalogs for use in wildflower gardens and ornamental borders.

Angelica Archangelica L.

Scientific (Latin) Synonyms

A. officinalis Hoffm.

[According to Schofield (1989), the name *A. archangelica* Gmelinii refers to *A. lucida* L., mentioned above.]

English Names

Angelica
Also: archangel, European angelica, garden angelica, Holy Ghost, root of the Holy Ghost, wild parsnip (better reserved for wild *Pastinaca sativa* L.)
[Several species in the Araliaceae family have "angelica" in their names, particularly in the genera *Aralia* and *Acanthopanax*.]

French Names

Family: Ombellifères, famille de la carotte
Angélique (f)
Also: angélique archangélique, angélique commune, angélique cultivée, angélique de Bohême, angélique des confiseurs, angélique des jardins, angélique officinale, archangélique (officinale), grande angélique, herbe aux anges, herbe des anges, herbe du Saint-Esprit, racine du Saint-Esprit
[Angélique is also used for the aquatic medicinal plant sweet flag (*Acorus calamus* L.), sometimes used as a flavoring herb despite its toxicity.]

Warnings

(1) Although widely consumed, angelica contains chemicals that may cause dermatitis in susceptible individuals, and have been shown to be dangerous in laboratory animals (*see* Medicine). Some authorities recommend that only moderate amounts of angelica should be consumed, others that it should be avoided entirely. (2) Many members of the carrot family are difficult to distinguish. Attempting to collect angelica from the wild could lead to confusion with deadly poisonous plants such as water hemlock mentioned above.

Description, Taxonomy, and History

Angelica is a herbaceous biennial or short-lived perennial, native from northern and eastern Europe through central and east Asia and the Aleutian Islands. It has a long, thick, fleshy root, greenish-white flowers, and a long hollow

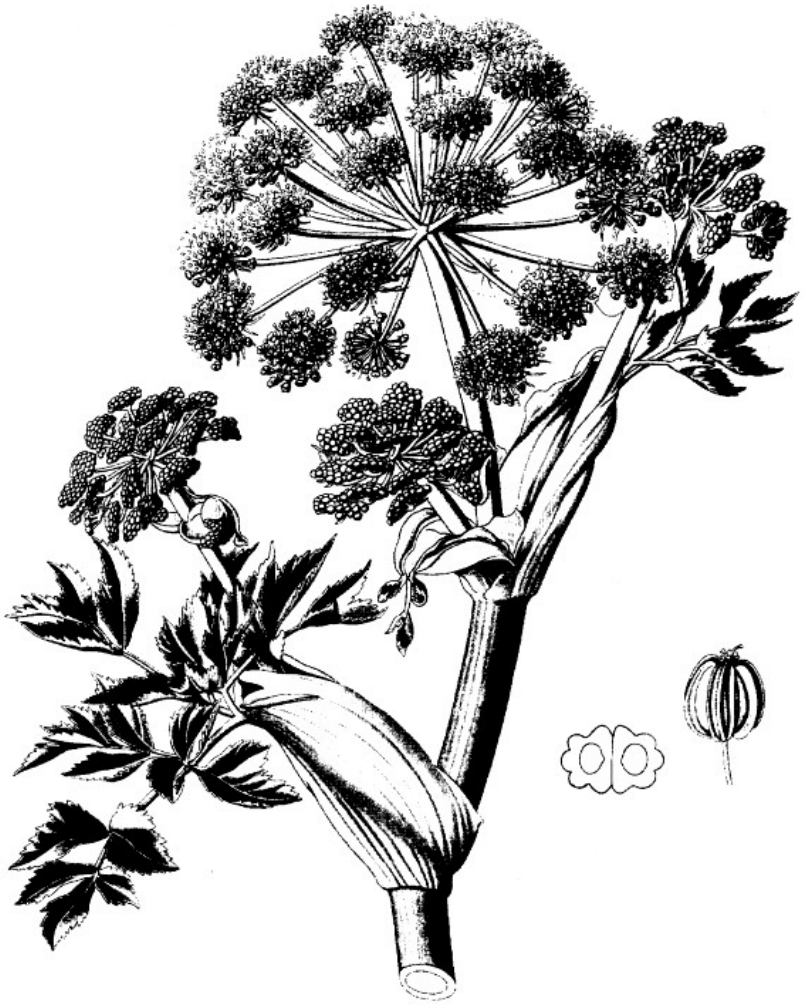


Fig. 51.
Angelica *(Angelica archangelica)*, from Köhler (1883-1898).

stem. All parts of the plant are aromatic and have a licorice taste. Under optimum conditions flowering plants can be as high as 3 m. Flower stalks usually develop in the late spring of the second year of growth. In cooler, northern areas, where angelica grows slowly, flowering may be delayed until the third or fourth year. Two subspecies are sometimes recognized in the literature (Mansfeld 1986). Subspecies *archangelica* is the common garden form cultivated in temperate regions of the Northern Hemisphere. It has been collected in Quebec and Newfoundland (Scoggan 1978-79), presumably escaped from cultivation. Wild plants of seashores of northern Europe are placed in subsp. *litoralis* (Fries) Thell. The wild subspecies is occasionally cultivated. Wild and cultivated angelica are rather similar in appearance.

Where angelica was domesticated is uncertain, perhaps northern Europe or Syria (Stobart 1977). It does not seem to have been cultivated in antiquity, although it may have been collected from the wild. Angelica has a long history of use for food and medicine in northern Europe and Asia. In the Nordic countries, the roots have been used for medicinal and flavoring purposes, and the shoots as vegetables, for hundreds of years (Ojala 1986). Farmers in Norway were encouraged to grow it in gardens as early as 1154 (Hälvä 1990*a*). It was used in 15th century Europe as a

Fig. 52.
Angelica *(Angelica archangelica)*,
from Lamarck and Poiret (1791-1823).

flavoring agent and was introduced to England by the early 16th century (le Strange 1977). Today, angelica is cultivated commercially mainly in Europe.

Uses

Some find the juniper-like flavor and bitter aftertaste of angelica disagreeable, although the plant does contain a very pleasant-smelling aromatic oil. All parts of the plant - stem, leaves, seeds, and roots, are consumed. The stems are occasionally cut and eaten as a vegetable, steamed and buttered like asparagus, or cooked and prepared like rhubarb. Chopped stems can be used to flavor roast pork. Laplanders have traditionally harvested the hollow stems and flower stalks to eat fresh or in prepared dishes (Hälvä 1990*a*). Young stems are crystallized for confectionary decoration on cakes and trifles. They are also cooked with rhubarb to alleviate the tartness of the latter. The young shoots are consumed in salads. The chopped leaves can be used in soups, salads, herb mixtures, and in a bouillon for fish and shellfish. The flavoring is considered desirable in some marmalades and in rhubarb jam. Angelica is an ingredient of many liqueurs or aperitifs, with the flavor introduced by maceration or from the essential oil. The juniper-flavored seed can be substituted for real juniper berries in making gin (Crockett and Tanner 1977). Absinthe, anisette, Benedictine, chartreuse, gin, and vermouth may contain angelica (Stobart 1977, Hälvä 1990a, Huxley et al. 1992). The seeds have been used to prepare herbal tea. Essential oil, mostly from the seeds, has been used, mainly in Europe, as a flavoring of ice cream, candy, non-alcoholic beverages, custard, pudding, gelatin, bread and other baked goods (Grieve 1931; Furia and Bellanca 1975; Morton 1976; Duke 1985). Seed extracts other than the oil have found similar uses (Furia and Bellanca 1975).

There are also several non-culinary uses for angelica. Oil from the seeds or roots has been employed as an insect attractant, for example for the Mediterranean fruit fly (Duke 1985). The essential oil from angelica has also been used as an aromatic agent in perfumes (Simon et al. 1984) and in creams, soaps, salves, toothpaste, medicine, shampoos, and cigarettes (Hälvä 1990*a*). "Angelica water," made from the leaves, was once highly regarded as a perfume (Muenscher and Rice 1955). Angelica is grown as a tall garden ornamental. It is a good source of nectar and is attractive to bees.

Recipe Sources

Grieve (1931) presents recipes for Angelica confection (stems) and Angelica liqueur.

Other recipes are: Angelica jam (Grieve 1933); Rhubarb jam (with angelica) (Baer 1943; Lima 1986); Candied angelica stems (Macleod 1968; Garland 1979; Rose 1979; Rinzler 1990); Angelica cheesecake (Garland 1979); Angelica liqueur (Rose 1979); Candied angelica (Stuart 1979; Holt 1991);Angelica tea (Marcin 1983); Shortbread with candied angelica (Creasy 1988); Angelica and mint sandwich (Bremness 1988); Fruit gratin with angelica (Holt 1989); Angelica and almond cake (Holt 1991).

Importance

Few statistics seem available on the production of angelica. It is grown commercially in Belgium, France, Germany, Hungary, Spain, and several other countries (Stobart 1977; Hälvä 1990*a*). This herb is of very minor importance in North America.

Essential oil produced from angelica is of minor value. Verlet (1993) estimated the annual world value of angelica essential oil to be U.S.$490,000.00.

Cultivation Notes

Soil

Angelica grows best in deep, fertile, moist but well-drained organic soils. A pH tolerance range of 4.5-7.4 has been reported (De Baggio 1987). Neutral to slightly acidic soil is best (Hälvä 1990*a*), Crockett and Tanner (1977) recommending a pH of 6.5 to 7.0. Boron and other micronutrients may need to be added in commercial plantings (Hälvä 1990*a*).

Climate

Angelica grows well between 5 and 17°C, and has proven hardy beyond the Arctic circle in Finland and Norway (Lima 1986). It should therefore be hardy in most parts of southern Canada and the northern U.S. It develops best under light shade. The soil should be kept moist throughout the growing season as angelica is naturally adapted to wet areas (Hälvä 1990*a*). The species seems to be day neutral, with onset of flowering not influenced by day length.

Propagation and Cultivation

Initial propagation is by seeds, sown when the ground can be worked in the spring. Seeds should be planted about 1.3 mm deep; they take 10-25 days to emerge (Wang et al. 1993). The seeds require exposure to sunlight to germinate, so the soil layer covering the seeds should be kept thin. Seeds sown in the fall will receive a required cold treatment during the winter; otherwise, the seeds should be given a cold treatment for 4-5 weeks at 0-3°C (Hälvä, personal communication). The soil must remain moist until well after germination. Commercial plantings may be established in nursery beds, and transplanted, rather than directly seeded in the field where they are to be grown (Hälä 1990*a*). The species can also be propagated by root division or by cutting off the offsets (which develop at the end of the first year, and also sometimes at the base of 2-year-old plants). However, plants grown from seeds are considered superior. Angelica can grow to 2 m or more in height, and therefore requires considerable garden space. Under good cultural conditions it usually flowers the second year and dies after seeding. However, removal of flowering stalks may sometimes allow the plant to survive for three or more growing seasons (Grieve 1931; Stobart 1977). Plants grown commercially for oil from the roots require removal of the flowering stems, to prevent diversion of the energy of the plant into seed production. This can be very labor intensive (Hälvä 1990*a*). Lima (1986) recommends allowing angelica to go to seed the second year, and scattering the mature seeds on the ground to produce new plants the following spring. The seeds are not long-lived. They remain viable for about 6 months according to Wang et al. 1993, and should be stored at about 5°C. Letchamo et al. (1995) found that angelica can easily be grown under greenhouse conditions, either hydroponically or in soil media. Angelica can be grown as a house plant over the winter, but probably will not flower (Erichsen-Brown 1975).

Harvest and Storage

The young stems and leaves are collected early in the second year of growth. Plants in their second year are among the first spring culinary herbs to appear, providing an early harvest. The stems are usually eaten fresh. The leaves are also usually consumed fresh, although dried leaves have been employed as a tea. After flowering (usually in the second year), the plants can be discarded, unless seeds are desired. Seeds are collected when ripe.

Commercial harvesting of roots for obtaining the oil has been discussed by Hälvä (1990*a*). This is generally done in the fall of the second year of growth, but sometimes in the fall of the first year (Simon et al. 1984). Collection is carried out mechanically in large fields, but pitchforks can be used in small plots. The roots are carefully loosened to prevent breakage, washed, and dried at temperatures of less than 40°C to preserve the volatile compounds. Roots contain 0.4-0.8% oil, and can weigh 0.7 kg. Average commercial yields are 13 500 kg/ha. single roots can weight 200-400 g (Hälvä 1990*b*).

Example Cultivars

Named cultivars seem unavailable for angelica.

Additional Notes

Chemistry

The aroma of angelica comes from the essential oil, for which more than 60 chemical compounds have been identified (Hälvä 1990*a*). Compounds recorded for the essential root and seed oil include *d*- -phellandrene, -pinene, osthenole, osthole, angelicin, -thujene, and camphene (Simon et al. 1984), as well as ß-phellandrene, limonene, myrsene, and sabinene (Hävä, personal communication). The main constituent of the root essential oil is ß-phellandrene (Simon et al. 1984), although Kerrola et al. (1994*b*) found that ß-phellandrene was the main root essential component of wild angelica in Finland, whereas sabinene was the main component of domesticated angelica. The fruits have a higher percentage of oil than the roots, and are rich in coumarins, but the root oil is considered superior (Simon et al. 1984). The most important aroma chemical is a lactone of 15-hydroxypentadecanoic acid (Duke 1985). Roots and seeds contains several furocoumarins, umbelliprenin, and various phenols (Duke 1985). Some potentially toxic chemicals of angelica are discussed below.

Medicine

The medicinal virtues of angelica are recorded in the folklore of many northern European countries. It was regarded as protection against disease, beneficial for the blood, and good for curing innumerable maladies (Grieve 1931). In his 17th century herbal entitled "Paradise in sole," John Parkinson put angelica in the forefront of all medicinal plants because it was angelically able to ward off evil spirits, spells, witchcraft, and enchantments (Lima 1986). Infusions of angelica have been prescribed for indigestion, chronic bronchitis, and general debility. The leaves have been employed as poultices (Grieve 1931). Angelica was often given for cases of flatulence or "corrupt air," as it was known (le Strange 1977). Duke (1985) describes angelica as reported to be medicinally useful for various conditions, including flatulence, gastritis, insomnia, rheumatism, and ulcers. Hälvä (1990*a*) notes that it has been used as a treatment for nervous diseases, stomach ills, fever, respiratory infections, and (in America) tobacco addiction. Simon et al. (1984) record that it has also been used to treat headaches, fever, skin rashes, wounds, and toothaches. Tyler (1993) comments that angelica's reputation as a counterirritant, antiflatulent, stimulant of urination, sweating and menstrual flow, and as an abortifacient, all seem unjustified medically. American colonists used large doses of angelica to induce abortion (Castleman 1991). Severe poisoning has resulted from such attempts (Tyler 1993).

Angelica is known to cause photodermatitis in susceptible individuals (development of rashes upon exposure to sunlight). This is presumably due to content of furocoumarins (psoralens), compounds known to increase skin sensitivity to sunlight, leading to the condition (Hälvä 1990*a*).

The coumarins of angelica are known to thin blood, perhaps providing a rationale for some traditional medical uses (Hälvä 1990*a*). However, larger quantities can dangerously thin blood, resulting in internal bleeding, the blood leaking from capillaries and vessels (Hälvä 1990*a*). The coumarins have been found to be mutagenic and carcinogenic in laboratory animals (Tyler 1993).

"For safety reasons, only moderate amounts of angelica plants and plant products should be consumed" (Hälvä 1990*a*). Tyler (1993) more conservatively states "Investigators have now concluded that psoralens present risks of such magnitude to man that unnecessary exposure to them (via consumption or contact) should be avoided."

Nutrition

Angelica is high in vitamin C and potassium (Hälvä, personal communication).

Curiosities

• Central European peasants used to sell angelica flower-stems while marching through the villages and singing a chant in words whose meanings were lost in antiquity (Grieve 1931).

• It is uncertain where angelica received its rather heavenly botanical and common names. One interpretation is that it was revealed to have potent, magical powers by the archangel Raphael (Hälvä 1990*a*).

• Another interpretation is that the revelation was by an angel in a dream of a monk, for the purpose of curing the bubonic plague which decimated Europe in 1665 (le Strange 1977). After this it was regarded as "the antidote" to the Plague. Angelica water formed part of a royal prescription published in a pamphlet in 1665, the year of London's Great Plague. The prescription was entitled "The King's Majesty's [Charles II] Excellent Recipe for the Plague." The mixture was taken twice a day by thousands of desperate Londoners (le Strange 1977).

• Still another explanation of the name is that angelica flowers (in parts of Europe) on the day of Michael the Archangel (May 8, old calendar) and is therefore important against evil and witchcraft. Indeed, this plant has been held in such esteem that it was called the "root of

the Holy Ghost" (Grieve 1931). [Regarding the May 8 celebration of "The Apparition of St. Michael," Macleod (1968) cautions "not to be confused with St. Michael and All Angels, September 29th."]

• European peasants once placed angelica leaf necklaces on their children to protect them against witches (Castleman 1991).

• "Carmelite water" was a medieval drink of the 16th and 17th centuries that included crushed angelica roots. Among its alleged virtues, it was believed to protect against witches' spells (Castleman 1991).

• Angelica was believed to be the only herb witches did not use, and it's presence in a woman's garden or kitchen was once used as a defence against accusations of witchcraft (Castleman 1991). Sprinkling angelica root powder in one's home was thought to frighten away witches (Schofield 1989).

• According to the medieval Doctrine of Signatures, a herb's appearance revealed its healing benefits. Hollow-stems are suggestive of an air-intake system, and hollow-stemmed plants like angelica were believed to be beneficial for respiratory problems. According to Castleman (1991), there is some evidence that angelica relaxes the windpipe. Europeans used angelica to treat respiratory ailments, particularly tuberculosis. Remarkably, European colonists found Indian tribes in Noah America using the American species *Angelica atropurpurea* for the same purpose (Castleman 1991).

• Laplanders once crowned their poets with angelica, believing it inspired them; in the early part of this century they chewed and smoked it in the same way as tobacco (Baer 1943). Laplanders believed that chewing dry angelica root promoted long life (Schofield 1989).

• Siberian Eskimos wore angelica root as an amulet for protection from polar bears (Schofield 1989).

• As noted above, angelica has been used superstitiously as a protection against a wide range of threats, including witches, the plague, and bears. There is reason, however, to believe that it has at least some protective value. In a test of the antibacterial properties of 50 plant essential oils against 25 genera of bacteria, angelica proved to be the most effective, inhibiting 25 of the genera (Deans and Ritchie 1987).

• Regularly consuming an infusion of the root of angelica is reputed to cause an aversion to alcohol (Jacobs 1972).

Problems and Potential

Due to its limited appeal, and content of potentially dangerous chemicals, angelica will likely remain of very minor importance as a food plant in North America, mostly grown as a curiosity of home gardens. Nevertheless the facts that it is grown commercially in northern Europe, and can supply essential oils, suggest that one day a commercial crop could be grown successfully in northern North America. Letchamo (personal communication) suggests that angelica has good commercial potential for North America, providing root oil as an antibiotic agent, and extracts for use in the food, beverage, pharmacological and chemical industries.

Selected References

Grieve (1931); Stobart (1977); Lima (1986); Ojala (1986); Hälvä (1990*a*); Tyler (1993).

Fig. 53.
Angelica *(Angelica archangelica)*,
from Vilmorin-Andrieux et C^{ie} (1883).

Anthriscus

Family: Umbelliferae (carrot family)

Genus Notes

Anthriscus is made up of about 12 annual, biennial, or perennial herbaceous species, found in Europe, Asia, and northern Africa. *Anthriscus cerefolium*, described below, is the only species of much economic importance.

Fig. 54.
Wild chervil *(Anthriscus sylvestris)*,
from Syme et al. (1863-1886).

The Eurasian *Anthriscus sylvestris* (L.) Hoffm., known as woodland chervil, wild chervil, beaked parsley, and cow parsley, is a biennial or perennial that has been naturalized in North America. It is sometimes collected as a wild food. The young leaves are eaten as a potherb, and fresh or dried leaves are employed to season baked potatoes, bean dishes, casseroles, omelets, salads, and soups (Facciola 1990). Recommendations have been made to improve the plant for its edible roots (Facciola 1990). The species is considered a noxious weed in parts of the U.S. (Roché 1991).

Anthriscus Cerefolium (L.) Hoffm.

Scientific (Latin) Synonyms

Scandix cerefolium L.

English Names

Chervil
Also: beaked parsley, garden chervil, French parsley, gourmet parsley, salad chervil
[Turnip-rooted parsley, *Chaerophyllum bulbosum* L., is a biennial herb of the carrot family, whose edible, black-skinned root is eaten as a vegetable, mostly in Europe.]

French Names

Family: Ombellifères, famille de la carotte
Cerfeuil (m)
Also: cerfeuil commun, cerfeuil cultivé, cerfeuil des jardins, cerfeuil officinal

Description, Taxonomy, and History

Chervil is an annual, white-flowered, sweet-smelling, herbaceous plant with finely divided, aromatic foliage. Its leaves resemble those of parsley, but are a lighter green and more feathery. It grows as tall as 70 cm in height. Chervil is native to southern Russia, the Caucasus, and perhaps the Middle East. Wild plants, still found in their original range, are sometimes separated as var. *longirostris* (Bertol.) Cannon (Mansfeld 1986). Cultivated plants are sometimes separated as var. *cerefolium* (Mansfeld 1986), but are little changed from the wild plants (although curly-leaved cultivars do appear rather different). This small, generally low-growing plant is cultivated for its sweetly aromatic foliage. Chervil foliage resembles that of parsley, but is more delicate.

Chervil was apparently cultivated by ancient Syrians, who ate it both boiled and raw. It reached the northern shores of the Mediterranean about 300 B.C. and was

Fig. 55.
Chervil *(Anthriscus cerefolium)*, from Thomé (1903-1905).

probably first brought to western Europe and England by the ancient Romans (Farrell 1985). Chervil has been cultivated in western and central Europe since the end of the 16th century (Mansfeld 1986). Wild-growing chervil, either escaped from cultivation or simply introduced as the wild plant from the Old World, is now found in various temperate parts of the world. In North America chervil occurs outside of cultivation as far north as parts of Ontario and Quebec (Scoggan 1978-79).

Fig. 56.
Chervil *(Anthriscus cerefolium)*,
from Syme et al. (1863-1886).

Uses

Chervil is grown for its leaves which are subtly anise-flavored with a slight tint of pepper The young leaves are not as strong-tasting as the older ones, and are to be preferred. The taste is reminiscent of parsley (several names partly based on "parsley" are noted above); indeed chervil has been called the "gourmet's parsley" (Rosengarten 1969). The subtle, anise-like fragrance and flavor are volatile and the leaves are best used fresh (although they are also often used in dried form); in cooking they should be added only at the last minute. Chervil is an important ingredient in French cuisine. Indeed, it is indispensable for many French sauces such as "bechamel" and "ravigote" that complement soups and seafood dishes. Chervil is commonly used to intensify the flavor of other herbs (Simon et al. 1984). It is one of the usual components of the standard French herb blend "fines herbes," along with parsley, chives, and tarragon. Chervil is often substituted for tarragon when the latter is unavailable. The fresh leaves are combined with chives in warm potato salads. Chervil leaves are also added to green salads and "tabouleh," a zesty Lebanese salad. Unlike many herbs, chervil leaves may be used generously in many salads. The fresh leaves can be made into a fine herb butter The leaves also flavor cottage cheese well, alone or in combination with chives and dill (Lima 1986, Prakash 1990). Chervil is used as a garnish on vegetable dishes, particularly peas, and on meats and fish. It is often added to goulashes, meats, poultry, eggs, soups, stuffings, stews, and specialty cheeses such as Liptauer. Chervil is used in dressings, and chervil sauces are standard for poultry and chops (Morton 1976). In commercial production, chervil has been used to flavor instant soups, baked goods, condiments, ice creams, and non-alcoholic beverages (Farrell 1985).

Chervil flowers are sometimes used as a seasoning, and the roots are also occasionally eaten (Facciola 1990).

Recipe Sources

Hériteau (1975) gives recipes for: Green salad with chervil and Chervil herb mixture for egg dishes and chicken. Owen (1978) has recipes for: Cold mussels with chervil mayonnaise, and Chopped chicken livers with chervil. Garland (1979) has recipes for: Chervil sauce, and Soft chervil rolls. Boxer and Back (1980) have recipes for: Cauliflower soup with chervil and Chicken pancakes with chervil. Mességué and Peter (1982) have recipes for Eggs with sorrel and chervil, and Sorrel and chervil cream soup. Belsinger and Dille (1984) present 12 chervil recipes, including: Chervil and asparagus soup, Cherry tomatoes

with chervil salmon mousse, Chervil avocado papaya salad, Snowpeas with chervil cream cheese, Chicken breasts with chervil, Baked yams with parmesan and chervil, Carrots in chervil vinaigrette, Jicama chervil cucumber salad, Pasta and chervil salad with spring vegetables, and Honeydew chervil sorbet. Bremness (1988) gives recipes for: Carrot and chervil soup, and Chervil stuffed trout. Gilbertie (1988) has recipes entitled: Whole lobster with chervil dressing, Grilled eggplant salad with fresh chervil, and Salmon scallops with fresh chervil sauce. Richardson (1991) has 11 chervil recipes, notably: Scrambled eggs with chervil, Cauliflower with chervil mayonnaise, Chervil rice, Chervil baking-powder biscuits, Chervil egg salad, and chervil quiche with ham.

Other recipes are: Chervil jelly (Day and Stuckey 1964); Chervil-baked chicken breasts (Rosengarten 1969); Oysters with chervil (Simmons 1969); Chervil soup (Sanecki 1974; Muenscher 1978; Jeanneret 1987); Potato soup with chervil (Bonar 1985); Chervil biscuits (Muenscher 1978); Curried chervil dip (Rogers 1983); Spiced stuffed eggs with chervil and anchusa (Leggatt 1987); Fillets of John Dory with chervil (Holt 1989) [John Dory is a fish prized by French chefs; flounder or sole can be substituted].

Importance

Chervil is a minor herb that is commercially grown in France, Holland, Italy, Russia, Spain, and occasionally in the western United States (Farrell 1985). It is much better known in Europe than in North America, especially in France where it is usually a component of *fines herbes* mixtures (Morton 1976). No statistics seem available on production of chervil on a worldwide basis.

Cultivation Notes

Soil

Chervil does best in rich loamy well-drained soils (Huxley et al. 1992). Crockett and Tanner (1977) recommend a light, moist garden soil supplemented with compost or manure. A pH tolerance range of 5.0-8.2 has been reported (Duke 1979). Crockett and Tanner (1977) recommend a pH of 6.0-7.0.

Climate

Chervil is an annual that is grown in all temperate climates. It will survive outdoors in regions with winters as cold as -10°C (Huxley et al. 1992), and above this temperature will stay green all winter (Morton 1976). Growth occurs between 4 and 24°C, and the plants can tolerate light frost. The species grows best in partial shade. Irrigation is beneficial during dry periods. Protection from strong wind is desirable; this can be provided by interplanting with taller vegetables or herbs. Chervil tends to flower during hot, dry conditions, and does not grow well in areas with hot dry summers (Lima 1986; Huxley et al. 1992). It is harmed by high humidity (Crockett and Tanner 1977). Best growth is usually under cool spring or fall conditions (Wang et al. 1993). The lack of tolerance to intense summer heat, full sun, and high humidity are reasons why chervil is not widely grown in most regions of North America.

Propagation and Cultivation

Propagation is by seeds. The seeds can be planted early in the spring, and also later for a fall crop, when the cool weather makes for good growth. The seeds should be planted at a depth of 6 mm or less, with seedling emergence usually in 7-12 days (Wang et al. 1993). However, as with many other members of the carrot family, the seeds may take 2-3 weeks to germinate. The soil should be kept evenly moist until after germination. It is advisable to plant new seeds every few weeks to obtain a constant supply of fresh leaves throughout the growing season (Lima 1986). The seeds must be sown where the plants are to grow because chervil has very delicate roots and does not transplant well. According to Elbert and Elbert (1974), the seeds of chervil are viable for only a short time, and should be used fresh.

Nordestgaard (1990) studied commercial seed production of chervil in Denmark.

Chervil grows well in pots, and can be cultivated indoors for winter use. In this case, 4 or 5 hours of direct sunlight or 12 hours of strong artificial light should be provided, as well as cool temperatures, under 16°C (Crockett and Tanner 1977).

Harvest and Storage

The outside leaves of chervil are hand-harvested, leaving the inner leaves to continue growing. Chervil should be harvested frequently, thus encouraging continued leaf growth and suppressing flowering. Crockett and Tanner (1977) recommend harvesting the leaves at least before the flowers open. In commercial harvests, the plants are cut almost to ground level about 90 days after sowing. The leaves must be carefully dried to prevent loss of flavor. To retain the green color, the leaves are dried at a moderate temperature of 32°C (Prakash 1990). However, the leaves are best consumed fresh, as they lose aroma when dried and do not store well (Mességué and Peter 1982). The leaves also wilt quickly after cutting. Not surprisingly, dried leaves are seldom found on market shelves. The home

gardener who insists on drying leaves may do so by spreading them in a thin layer on screening in a warm room, and drying them as rapidly as possible without excess heat. A much better way of preservation is to harvest tender young leaves and freeze them (Reay 1965). Hemphill and Hemphill (1984) suggest freezing finely chopped fresh leaves with a little water in ice cube trays.

Example Cultivars

Brussels Winter, Crespo, Cripsum, Curled (Curly, Cerfeuli Frisé), Lettuce leaf, Vertissimo [most of these are described by Facciola (1990)].

Additional Notes

Chemistry

Petri et al. (1993) reported the following. Chervil contains apiin flavonglycoside, bitter principle and essential oil. The herb contains 0.3% essential oil, with about 0.9% in the seeds. Main essential oil components are methyl chavicol (estragol), the isomer of eugenol-methyl-ether known as 1-allyl-2, 4-dimethoxy-benzene, and undecane. Relative amounts in the herb differ depending on stage of maturity.

Medicine

Chervil is rarely mentioned in herbal medicine (Rinzler 1990). It was suggested as a cure for hiccoughs in the 1st century A.D. (Rosengarten 1969). The leaves are reported to be useful for promoting urine flow and relieving stomach problems (Prakash 1990). The plant has also been used to treat eczema, to lower blood pressure, as an expectorant, and as a general stimulant (Simon et al. 1984).

Nutrition

Chervil is high in calcium, with 1346 mg/100 g of leaf (Farrell 1985). It is low in calories and protein (Duke 1977).

Curiosities

• Legend has it that chervil makes one merry, sharpens a dull wit, prods the memory, and gives the aged the dash of youth (Farrell 1985).

• Chervil symbolizes sincerity (Farrell 1985).

• Because chervil was alleged to have powers of rejuvenation, many Europeans sipped it on the Christian Holy Thursday to symbolize the resurrection of Christ (Belsinger and Dille 1984).

• Chervil was one of the "nine sacred herbs" of early herbalism (the others were mugwort, plantain, water-cress, chamomile, nettle, crabapple, fennel, and a plant identified only as *Atterlothe*) (Macleod 1968).

• One of the names by which chervil has been known in the past is *Cerefolium cerefolium* Britt. Such binomials (known as "tautonyms") with the specific epithet exactly the same as the genus name cannot be used today by present rules of botanical nomenclature (even names like *Nasturtium nasturtium-aquaticum* are inadmissible). However, trinomial combinations with "autonyms" (explained in the Introduction to this book) like *C. cerefolium* van *cerefolium* are quite acceptable. Tautonyms can be used in zoological and bacteriological nomenclature (Jeffrey 1989). For example, the scientific name of the American buffalo is *Bison bison*. In zoology, one can even have the same word repeated three times, for examples, *Bison bison bison* (i.e., *Bison bison* subsp. *bison*) and, for the lowland gorilla, *Gorilla gorilla gorilla*. (The word subspecies in *Gorilla gorilla* subsp. *gorilla* is unnecessary in zoological nomenclature since it is the only rank recognized below the species, unlike botany which recognizes several ranks.)

Problems and Potential

Chervil has limited commercial possibilities in north-em North America. It will likely remain a herb grown in home gardens on this continent.

Selected References

Rosengarten (1969); Farrell (1985); Prakash (1990).

Fig. 57.
Chervil *(Anthriscus cerefolium)*,
from Vilmorin-Andrieux et C^{ie} (1883).

Fig. 58.
Wild celery *(Apium graveolens var. graveolens)*, from Hallier (1880-1888).

Apium

Family: Umbelliferae (Apiaceae) (carrot family)

Genus Notes

Apium occurs in Europe, temperate Asia, North America and the circum-Antarctic zone including Australia and New Zealand. Estimates of the number of species vary from about six (Clapham et al. 1987) to 20 (Bailey and Bailey 1976; Huxley et al. 1992), or even 30 (Cheatham and Johnston 1995). The genus includes annuals, biennials and perennials.

Apium Graveolens L.

The wild form of the species, var. *graveolens*, is a strong-smelling biennial of damp places, native to Europe, southwestern Asia, Macronesia, and North Africa (Mansfeld 1986). Two vegetable cultigens have been selected for use as vegetables: var. *dulce* (Mill.) Pers., celery, and var. *rapaceum* (Mill.) Gaud.-Beaup., known as celeriac and turnip-rooted celery. These are discussed in detail in Munro and Small (1997). Another cultigen, var. *secalinum*, is a culinary herb and is discussed below.

Apium Graveolens L. var. Secalinum Alef.

English Names

Leaf celery
Also: ache, cutting celery, cutting mustard, green celery, smallage, soup celery, wild celery
["Wild celery" also refers to *Vallisneria spiralis* L., a perennial aquatic plant.]

French Names

Family: Ombellifères, famille de la carotte
Céleri à couper (m)
Also: ache, ache des marais, céleri à côtes, céleri odorant, céleri sauvage, persil des marais

The name "leaf celery" is somewhat misleading, since celery (var. *dulce*) is also harvested for leaf material. A leaf is made up of a blade and a petiole (the leaf stalk). In many members of the carrot family the leaves are divided into segments, which are sometimes erroneously thought to be individual leaves. Celery has somewhat swollen, tasty petioles, while leaf celery has tasty blades.

The name wild celery applied to cultivated celery is also somewhat misleading, for although this form of celery is reminiscent of wild-growing celery, and is closer to genu-

Fig. 59.
Leaf celery *(Apium graveolens var. secalinum)*,
from Lamarck and Poiret (1791-1823).

inely wild forms than the considerably domesticated celery and celeriac, it nevertheless has undergone domestication and is not "wild."

Description, Taxonomy and History

The taxonomic ranking of leaf celery is unclear. It is recognized as var. *secalinum* Alef. by some authors (Orton 1983, Mansfeld 1986) while others regard it as merely a wild or semi-wild celery variant. Varietal rank is adopted here to emphasize the distinction of leaf celery from the vegetables celery and celeriac. Leaf celery has been cultivated for many years in Western Europe for flavoring purposes and as a leaf garnish. It is like the wild form in that it lacks the swollen, solid petioles of common garden celery (var. *dulce*), instead producing an abundance of erect-growing leaves with hollow leaf stalks that are thin, tender, and brittle. The celery seed of commerce is also generally

produced from this variant of celery, the so-called "smallage" form. Leaf celery is often a rather bushy type of celery.

Leaf celery was a herb known to the ancient Romans. Writers of the day often mentioned both a wild and a cultivated sort. However, it is uncertain if this form of smallage was eaten, although it was likely planted for medicinal use (Hedrick 1972). Smallage is similar to wild celery and is considered to be the form that was used to select common garden celery (with its solid, less bitter, edible stalks). This selection was carried out mainly by Italians during the 17th century (Stobart 1977). Leaf celery is still used today in many parts of western Europe, Israel, and Asia (Buishand et al. 1986). It is not well-known in North America.

According to Farrell (1985), while celery seed has been known for over 3,000 years, the earliest recorded use of celery seed to season food is not until 1623, in France. In earlier years, celery seed oil was used for medicinal purposes.

Uses

Leaf celery leaflets are employed as flavoring for stews and soups. The petioles are usually too bitter to be eaten.

The seeds (technically half-fruits) are used as a spice or flavoring (Nonnecke 1989). They have a celery-like odor, and a tangy, slightly bitter, warm flavor with a hint of nutmeg and parsley. The seeds are used for flavoring soups, chowders, tomato dishes, sauces, pickles, canapés, dips, fish, bread, pastries, sauerkraut and other savory dishes, egg dishes, meat loaf, hamburger, in stuffings, and as a garnish with cole slaw, salad dressings and pickles. The seeds are an important ingredient in mixed spices. They are occasionally employed as a bird seed (Rinzler 1990).

Celery salt is a mixture of ground celery seed, celery seed oleoresin, or ground dried celery stems and free-running table salt. According to Canadian standards, celery salt should not contain more than 75% salt while celery pepper no more than 70% pepper. Except in salt-restricted diets, celery salt may be used where celery seed is called for, but since it contains salt, the amount of salt required in the recipe should be reduced.

Celery flakes are dried leaves (i.e., blades), but also often include some stalk; celery flakes may be used in soups, stews, tomato juice cocktail, sauces, pot pie, stuffings, and in preparing such meat and fowl as pot roast, roast duck, and goose.

Crushed seeds are steam distilled to produce celery oil, which is considered superior to celery leaf (or herb) oil obtained from leaves and stems for most purposes. [Arctander (1960) points out that the herb oil is "fresher" and more representative of the taste of the entire plant than the seed oil.] The essential oil, oleoresin and seeds extracts are employed for flavoring many products, such as sauces, meats, condiments, liqueurs, perfumes, cosmetics, and are also used in soaps, creams, and lotions (Furia and Bellanca 1975; Greenhalgh 1979; Simon et al. 1984).

Recipe Sources

Rosengarten (1969) presents recipes for: Calico salad with celery seed, Celery seed sour cream dressing, and Spring coleslaw with celery seed and celery. McCormick (1979) has a recipe with celery seeds called Celery seed dressing.

Importance

Leaf celery is commercially produced in western Europe, Israel, and parts of Asia (Buishand et al. 1986). It is widely used in France. This form of celery is only a curiosity of home gardens in North America.

Celery seed is grown commercially in France, the U.K., Hungary, Japan, India, the Netherlands and the U.S. (Farrell 1985). India dominates the world exports of celery seed

Fig. 60.
Leaf celery *(Apium graveolens var. secalinum)*,
from Vilmorin-Andrieux et C^{ie} (1883).

and the U.S. is the major world market, importing more than half of India's exports, a total of 2 183 t, valued at $1,730,000(US), in 1988 (Anon. 1989*a*). Import value of celery seed averaged $1.7 (U.S.) million over the period 1990-94, 90% coming from India (Buzzanell et al. 1995). Canada is another major market for celery seed, importing 132 t of celery seed valued at $88,000 from India in 1976 (Greenhalgh 1979). The world's production of celery seed grown for flavoring may reach 6 000 t in some years, with India producing in excess of 3 000 t (Greenhalgh 1979; Lewis 1984). Verlet (1993) estimated the annual world value of celery essential oil to be $1,875,000.00 (U.S.).

United States celery seed, grown in California, is intended for the vegetable seed trade, while seeds considered inferior in germination are sold for flavoring (Greenhalgh 1979).

Cultivation Notes

Soil

Leaf celery grows best in fertile, sandy loam soils (Lewis 1984). Nonnecke (1989) reports a pH range from 6.0 to 7.5. A wider pH tolerance range, from 4.2 to 8.3, has been reported for var. *dulce* (Duke 1978), so that probably leaf celery's range is broader than reported.

Climate

Low temperatures cause the plant to develop slowly, and temperatures above 24°C are detrimental. Juvenile plants subjected to 2-10°C for about 2 weeks will bolt, forming seed stalks. Early bolting tends strongly to result in small plants with low seed yields. Nevertheless, this bolting feature could be useful for production of celery seed in colder climates such as those in Canada. The plants also require abundant moisture because celery is naturally a shallow-rooted wetland plant. Celery seed germinates only in soils at or near field water holding capacity. It is often desirable for home gardeners to start the plants in flats indoors, where temperature can be controlled. However, germination is best when temperatures fluctuate from 15 to 25°C (Anon. 1988; Nonnecke 1989). Some celery cultivars must have light to germinate (Larkcom 1984; Rubatzky, personal communication).

Propagation and Cultivation

Propagation is by seeds sown indoors and transplanted after danger of frost, or simply direct-seeded in the field. Presoaking the seeds may be beneficial because they are very small and slow-growing (Anon. 1988). Leaf celery is grown like parsley. It usually requires weeding because its slow growth makes it uncompetitive with weeds (Rubatzky, personal communication).

Leaf celery is subject to similar diseases as common celery including such pathogens as *Septoria* late blight and *Cercospora* early blight, as well as *Fusarium* yellows. Insects such as tarnished plant bug and leafminers may also attack the plants.

Harvest and Storage

In Europe, the young leaves are cut off at ground level and marketed loose or tied in bunches (Buishand et al. 1986). In the home garden, the leaves can be harvested in the same manner. The leaves can be cut close to the ground more than once during the season (Facciola 1990), although this should be avoided during the hottest parts of the growing season. Home gardeners can take the first cutting about a month after planting, or when the plants are about 20-25 cm tall.

Recently picked leaf celery will store in the refrigerator for a few days, and will remain fresh for up to 2 weeks at -1°C in high humidity (Buishand et al. 1986).

Celery intended for seed production requires a warmer climate than found in Canada, because the seed stalk is not usually produced until the second season and the plants would likely be winter killed in all but the most temperate parts of Canada. In celery seed production areas such as California the celery seedlings are started in the summer for fall transplantation. In colder areas the plants are sometimes well-mulched with straw for frost protection. The following August the stalks are cut and, after preliminary drying in the field, the seeds are threshed and thoroughly dried. A good yield is 620 kg/ha (Lewis 1984).

Example Cultivars

Facciola (1990) describes Afina, Amsterdam Fine, French Dinant, Golden Medium Early (Chinese Golden Medium Early, Golden Leaved), Heung Kunn (Chinese Celery, Kintsai), Par-Cel, Smallage, and Zwolsche Krul. Tricolor, described in Huxley et al. (1992), is an ornamental, not a culinary cultivar.

Bettencourt and Konopka (1990) note institutions in various countries conserving *Apium graveolens* germplasm.

Additional Notes

Chemistry

The volatile oil content of celery seeds averages 3% and consists primarily of 60% *d*-limonene, 10-20% selinene, sesquiterpene alcohols, sedanolide and sedanonic anhydride (Simon et al. 1984). The odor is due to anhydrides, such as sedanonic anhydride (Simon et al. 1984). The aroma is tangy, spicy, slightly fatty, fruity, and

persistent. The oil causes a burning sensation and is very bitter. The two major producers of the oleoresin of celery seed are France and India. The French type is relatively sweet with a persistent taste, while the Indian product has a slight lemon-like aroma. While both are quite bitter, the French type is considered more pleasing. Approximately 1 kg of oleoresin is the equivalent of 21 kg of freshly ground celery seed in aroma and-flavor (Farrell 1985).

Medicine

Celery seed was once prescribed as an aphrodisiac, to expel gas from the alimentary canal, and to promote urination. Celery seed oil was used in England in the 19th century to treat rheumatism, and is still employed in India as a tonic and nerve stimulant (Rosengarten 1969). Eating the roots of leaf celery as well as ingesting the oil were once recommended to alleviate nervousness (Grieve 1931). Celery has also been used to combat asthma, bronchitis, rheumatism, and worms (Simon et al. 1984). Duke (1985) lists additional illnesses that celery has been claimed to cure. Celery leaf is still used as a medicinal plant in China (Duke and Ayensu 1985). In Vietnam, the plant is used as a blood pressure regulator (Nguyêñ-Xuân-Duñg and Dô-Tât-Loi 1991). In the Philippines celery seed is used as a stimulant, to aid digestion, and to treat spasms resulting from asthma and bronchitis (Perry and Metzger 1980). A chemical extracted from celery, 3-*n*-butyl phthalide, has lowered blood pressure in rats by 12-14% and lowered cholesterol by 7%. This has yet to be demonstrated to be useful in humans [although Duke (1985) notes that celery juice has proven experimentally capable of reducing blood pressure in man]. Over-ingestion of the oil should be avoided as large amounts are toxic (Anon. 1992*b*).

Celery tops with 3-8% nitrates have poisoned dairy cattle (Simon et al. 1984). Celery workers may develop both contact dermatitis and photodermatitis (stimulated by exposure to light) (Simon et al. 1984). Wild celery is considered poisonous, and to pose a considerable risk of causing dermatitis.

Celery has occasionally been found to have hazardous concentrations of three photoactivated, carcinogenic, linear furanocoumarins: psoralen, 5-methoxypsoralen (bergapten) and 8-methoxypsoralen (xanthotoxin) (Diawara et al. 1995). A study of various plant parts of two American cultivars showed that only the leaf blades (not the celery stalks or petioles, which are normally consumed) proved to have sufficiently high levels to threaten human and animal health (Diawara et al. 1995). There do not appear to be reports to date of whether or not leaf celery blades have dangerous concentrations.

Nutrition

Celery seed contains vitamins A and C, and about 18% protein, while leaves contain thiamine, riboflavin, niacin, and ascorbic acid (Duke 1985). Duke (1985) characterized content of shoots (leaves + stems) of calcium, fiber, riboflavin, and vitamin C (ascorbic acid) as high. Rinzler (1990) notes that celery contains about 40 mg sodium in an average serving, and is considered a high-sodium food, excluded from sodium-restricted diets of people with high blood pressure or heart disease. Celery seeds, however, do not add much sodium to diet (Rinzler 1990).

Curiosities

• Mercatante (1988) relates the story of a pig named Celery in Buddhist folktale number 286 of the *Jatakas* (Birth-Stories of the Former Lives of the Buddha). The Buddha was born as an ox named Big Redcoat. He had a younger brother named Little Redcoat, who was very jealous of Celery. The pig was being fed rice porridge, did no work, and was given superior sleeping quarters out of the rain. When Little Redcoat complained of the hard work he had to do and the poor grass and straw he was fed, the Buddha explained that Celery was being fattened for a wedding feast. When the pig was dragged out, killed, and butchered, Little Redcoat stopped complaining.

• The classical Greeks rewarded winning athletes with celery wine (Castleman 1991).

• Celery has been held to be strongly aphrodisiac, as evidenced by the following (Mathias 1994). Celery root oil was recommended to restore sexual potency. A 15th century medical book advised smearing the male sexual organs with a mixture of honey and celery. There is a French saying "If a woman knew what celery does to a man she would go looking for it as far as Rome." Bridal couples were advised to stick a celery root in the pocket or shoe.

• The celery plant has been considered to provide good luck, and was used as a suspended talisman protecting small children, keeping pigs quiet, and preventing cows from producing curdled milk (Mathias 1994).

• An old tradition held that celery should be planted on the first evening of the moon, but not on the day that the moon changes (Mathias 1994).

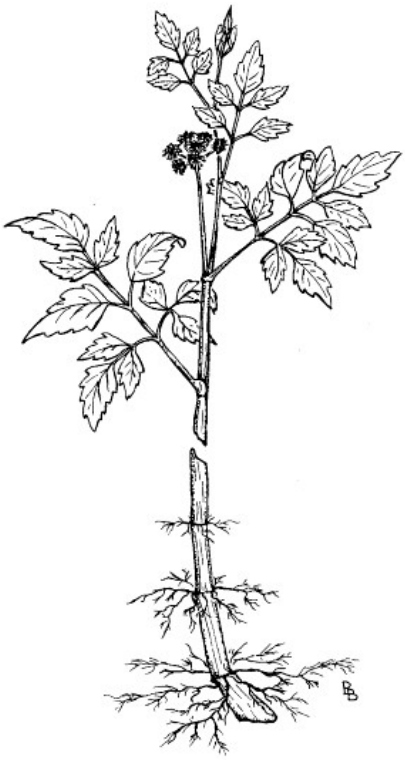


Fig. 61.
Water celery *(Oenanthe javanicum)*. Prepared by B. Brookes, based on Togasi and Kubo 97, at Agriculture and Agri-Food Canada herbarium, Ottawa.

• Dr. Brown's Cel-Ray-Soda is a celery-flavored soft drink (Castleman 1991).

• Celery seeds are one of the smallest of all seeds used as flavorings; about 1 675 500 are required to make 1 kg (Rosengarten 1969).

• "Water celery," "water dropwort," or Vietnamese parsley," *Oenanthe javanica* (Blume) DC. (= *O. stolonifera* Wall.) is a popular Asian flavoring herb which much resembles celery and is considered by many to be extremely delicious. In Japan, by tradition, this plant and six other herbs are boiled in rice gruel on January 7th (Tanaka 1976). This creeping perennial aquatic plant, which grows like watercress (see *Nasturtium*) has been grown experimentally in Florida (Morton and Snyder 1978). In the Bradford Marsh area of Ontario, it has been cultivated by immigrants of Asian origin (R. Cerkauskas, personal communication). One cultivar, Flamingo, can be used as a groundcover for wet situations in hot climates (Huxley et al. 1992). A related species, *O. crocata* L., is an extremely poisonous plant found in some countries, including the United Kingdom.

Problems and Potential

Leaf celery is likely to remain a curiosity of home gardens in northern North America. It could be marketed as a celery substitute available earlier in the growing season, but it would be necessary to indicate that it should be cooked to avoid bitterness. There is little potential for the production of celery seed in Canada and comparably cold regions of the U.S., although as noted above, the plants bolt and produce flowering stalks the first year if subjected to low temperatures. However, varieties suitable for seed production in the colder parts of North America have not been described.

Selected References

Rosengarten (1969); Greenhalgh (1979); Lima (1986).

Fig. 62.
Horseradish *(Armoracia rusticana)*, from Syme et al. (1863-1886).

Armoracia

Family: Cruciferae (Brassicaceae) (mustard family)

Genus Notes

Armoracia has three species of perennial herbaceous plants native to north temperate Europe and Asia (Hultén and Fries 1986). One of these, discussed below, is used as a condiment.

Japanese horseradish or wasabi is *Eutrema wasabi* (Sieb.) Maxim. [also known as *Wasabia japonica* (Miq.) Matsum., *W. pungens* Matsum., *Cochlearia wasabi* Sieb., and *Alliaria wasabi* (Sieb.) Prantl]. The Japanese name "wasabi" means "mountain hollyhock" (Tsuji 1980). This grows wild along streams in Japan and eastern Siberia. It has been cultivated in Japan for over a thousand years in cool streams or artificial water beds, much like watercress (*Nasturtium officinale*), discussed in this book. Its rhizome is used in Japan as a condiment like the root of common horseradish. "It is considered to have a distinct flavor and pungency that is superior to common horseradish" (Facciola 1990). The same glucoside that produces the pungency of horseradish, sinigrin, is responsible for the pungency of Japanese horseradish (Hodge 1974). Wasabi powder is sold in shops specializing in Oriental foods, but the fresh rhizome is superior, the flavor deteriorating rapidly after cutting (Huxley et al. 1992). Wasabi powder normally contains ground yellow mustard to improve the pungency (Mazza, personal communication). To reconstitute wasabi powder, combine one part powder and 3/4 part water, and use soon (Rinzler 1990). Shepard (1979) presents several recipes using wasabi powder. Numerous recipes using wasabi are given in Tsuji (1980). Based on climate, wasabi could be grown in the mountains of the Southeast and in the Pacific Northwest of the U.S. (Hodge 1974). There have been at least two reports in the U.S. of serious adverse reactions to wasabi, involving paleness, confusion, profuse sweating and collapse after eating a large serving; both reports suggested the response may be serious for those with weakened blood vessels in the heart or brain (Rinzler 1990).

Armoracia Rusticana P. Gaertn., B. Mey. & Scherb.

Scientific (Latin) Synonyms

Armoracia lapathifolia Gilib., *Cochlearia armoracia* L., *C. rusticana* Lam., *Nasturtium armoracia* (L.) Fries, *Radicula armoracia* (L.) B.L. Robinson, *Rorippa armoracia* (L.) A.S. Hitchc.

English Names

Horseradish
Also: German mustard, horse-radish, redcole (a name once current in England; also red-cole), stingnose (a name reportedly used in some parts of the U.S.)

French Names

Family: Crucifères (Brassicacées), famille de la moutarde
Raifort (m)
Also: armoracia à feuilles de patience, armoracie raifort, armoraire rustique, cochléaria, cran, cran de Bretagne, cran des Anglais, cranson armoricain, cranson de Bretagne, cranson rustique, effort, grand raifort [to distinguish "raifort des Parisiens," the black radish (Fournier 1947-48)], mérédic(h), moutarde de l'Allemagne, moutarde des Allemands, moutarde de(s) capucin(s), moutarde des moines, moutardelle, radis de cheval, raifort des jardins, raifort sauvage
[The original name used in France was moutarde des Allemands (mustard of the Germans), reflecting wide use as a condiment in Germany in the 16th century (Grieve 1931).]

Description, Taxonomy, and History

Horseradish is a long-lived, perennial, herbaceous plant which probably originated in southern Russia (Hultén and Fries 1986), although many authors suggest southeastern Europe as the probable place of origin (Courter and Rhodes 1969; Huxley et al. 1992). It is now found in the temperate parts of Europe, Asia, and North and South America, as well as north Africa and New Zealand. In North America, escaped horseradish has spread as far north as all Canadian provinces and the Yukon territory [it may be absent in Newfoundland and may be present in the District of Mackenzie (Scoggan 1978-79)]. In the U.S. it is found naturalized throughout the East and Midwest, and is considered a troublesome, tenacious weed in some places (Kingsbury 1964). In the wild, it is typically found in moist places, in habitats such as cool woods, damp meadows, and the margins of streams.

Horseradish rarely sets viable seeds (Stokes 1955; Courter and Rhodes 1969), and this sterility has been interpreted as an indication that the species originated as an interspecific hybrid.

The horseradish is a stout, hardy, erect plant, 60-130 cm high, with long-stalked leaves. The stems are branching, growing from a main rootstock. The inflorescence bears a

mass of small, white flowers. The economic part of the plant is the stout, perennial, hard-fleshy taproot, about 30 cm long and 12 mm thick, with smaller roots branching from it. The root is white internally, and corky-tan externally. Horseradish roots can reach depths of 5 m below the soil surface. Bruised roots emit a strong odor, considered by some to be more obnoxious than freshly cut onions, and the hot, biting taste of the fresh root is well known and widely cherished in condiments.

There are two variants of horseradish which were recognized by the 16th century, and these still persist because the plant is propagated by root cuttings. The "smooth" or "Bohemian" form has narrow leaves with an acute leaf base and solid petioles. It lacks good root quality and yield, but has important disease resistance characteristics. The "crinkled" or "Maliner Kren" form has broad leaves with a cordate leaf base and hollow petioles, and is the most widely grown type. The name Maliner Kren is used by some to refer also to the smooth leaf form, due to the importation of horseradish from the town of Malin, an area of Bohemia. Some modem cultivars are intermediate (Courter and Rhodes 1969; Nonnecke 1989).

Horseradish was consumed by the ancient Greeks and Romans. Because it is propagated vegetatively, conceivably some of the clones grown today may have survived in cultivation for 2 millennia. The species has been cultivated in central Europe since the 12th century, brought there by Slavic peoples (Mansfeld 1986). Cultivation of horseradish was often associated with use as a medicinal plant, until the Middle Ages. The roots were sliced thin and mixed with vinegar as a sauce for meats in 16th century Germany, and shortly thereafter usage as a condiment was noted by writers in several European countries. Early settlers brought the horseradish to North America, planting it around cabins, from where the plants commonly escaped to the wild (Angier 1978). Horseradish was often found in American gardens by 1806 (Grieve 1931; Hedrick 1972).As pointed out by Rollins (1993), "its present distribution is a relic of its having escaped from disparate gardens in former times."

Uses

Horseradish root is employed as a condiment in sauces. The roots are prepared by washing, cleaning and scraping them outdoors or in a very well-ventilated area. The highly pungent, penetrating odor that is emitted can cause extreme tearing or even nausea (Halpin 1978). The roots are grated and often mixed with vinegar and spices to prepare the familiar horseradish sauce used on roast beef. The root is also mixed with ketchup or tomatoes to make seafood

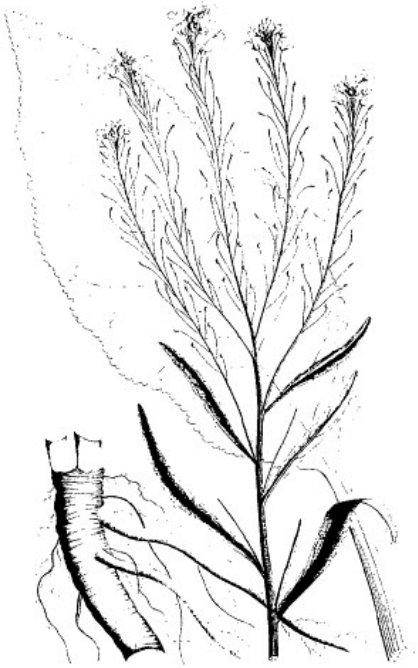


Fig. 63.
Horseradish *(Armoracia rusticana)*, from Oeder et al. (1761-1883).

sauce used on fish and shrimp cocktails. A few drops of the juice can be used to spice up cole slaw, applesauce, prepared mustards, cottage cheese, dips, appetizers, and relishes. When mixed with whipped cream, horseradish makes a delicious sauce for ham, tongue, beef, and broccoli (Farrell 1985). In fact, it has been suggested that the adventurous gourmet try grating horseradish over everything (Schneider 1986). Once grated, horseradish should be immediately used or mixed in vinegar, as the root darkens and loses its pungency, and becomes unpleasantly bitter if exposed to air and heat. The addition of vinegar tends to preserve color and strength. Cider vinegar causes horseradish to discolor and should not be used. The addition of cream extends the keeping period from days to

months. Refrigeration also considerably prolongs shelf life, and commercial horseradish mixtures are stored and shipped under refrigeration. Dehydrated horseradish in granular form is becoming popular. High quality dried commercial horseradish is available, particularly from Sweden and the United States. It retains its pungency and color much better than bottled horseradish (Stobart 1977). Water must be added to rehydrate the product in order to release the pungent flavor (Rosengarten 1969).

Sliced horseradish roots are cooked like parsnips in Germany (Facciola 1990). Sprouted seeds are eaten in salads according to Facciola (1990), but since seeds are very rarely produced this cannot be a frequent occurrence. The young spring leaves or blanched leaves forced in the late autumn are also eaten (see Harvest and storage on following page). When they are about 5 cm long, the leaves are pleasantly flavored and can be added to salads (Larkcom 1984).

Attractive strains of horseradish with variegated leaves are sometimes grown as ornamentals (Pailler 1993). Other non-culinary uses include the following (Pailler 1993): an infusion of the roots has been sprayed on apple trees to

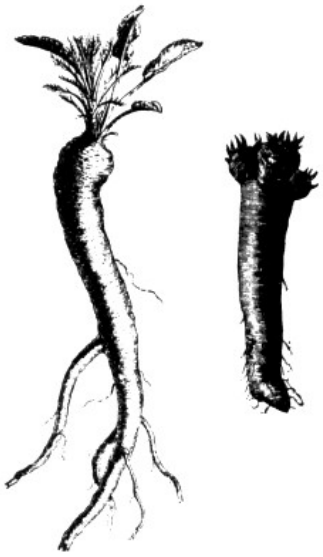


Fig. 64.
Horseradish *(Armoracia rusticana)*,
from Harter (1988).

prevent brown rot; the leaves have been used as a vermifuge in animals; and a deep yellow dye has been obtained from the foliage.

Recipe Sources

Schneider (1986) gives recipes for: Red horseradish (horseradish with beets), Chunky tomato horseradish salsa, Fish fillets baked with horseradish and sour cream, Prepared horseradish, Horseradish cream sauce, and Puréed beans with horseradish. Muenscher (1978) gives 10 horseradish recipes, including Horseradish vinegar, Horseradish jelly, and Horseradish cranberry relish. Rosengarten (1969) gives recipes for Glazed chicken with horseradish, Hot horseradish sauce, and Spicy cocktail meatballs. Launert (1981) presents recipes for Horseradish sauce and Horseradish-orange sauce. Hériteau, (1983) has recipes for Pickled horseradish, Hot horseradish sauce, and Iced horseradish. Brennan et al. (1985) have recipes for Watercress and horseradish mousse, and Frozen horseradish garnish. Phillips (1986) gives recipes for Homemade horseradish sauce, Horseradish pickle, and Horseradish and potato salad. Richardson (1991) has the following recipes: horseradish beet and sour cream sauce, Horseradish seafood sauce, Horseradish mayonnaise, Horseradish bloody Mary, Horseradish Mustard, and Horseradish sauce for vegetables.

Other recipes are: Mustard-horseradish sauce (Day and Stuckey 1964); Wild horseradish sauce (Brackett and Lash 1975); Potato salad with horseradish and dill (Garland 1979); Horseradish relish (Mallos 1979); Horseradish sauce (Stuart 1979); Braised beef with horseradish (Boxer and Back 1980); Danish open sandwiches with horseradish (Michael 1980); Horseradish applesauce (Hawkes 1984); Horseradish mayonnaise (Bonar 1985); Pickled horseradish (Bremness 1988); Smoked trout with horseradish sauce (Richardson 1990); Salmon with horseradish (De Witt and Gerlach 1991); Horseradish butter (Holt 1991).

Importance

Most horseradish is produced in the U.S. and, to a lesser extent, Europe (Simon et al. 1984). Few statistics are available on the production of horseradish. About 1100 ha were grown in the U.S. from the 1940's to the 1960's (Courter and Rhodes 1969). Most of the U.S. production occurs in the northern tier states, especially Illinois and Wisconsin. In Canada, horseradish is grown commercially in Manitoba and Ontario. The primary use of Canadian-grown horseradish at the present time is for the extraction of horseradish peroxidase. The demand for this has increased dramatically in recent years as this enzyme is used for the

diagnosis of the AIDS virus (Mazza, personal communication). There has been a slow decline of use of horseradish by consumers in recent years (Courter and Rhodes 1969). The average annual per capita consumption of horseradish in the U.S. is less than 30 g. Traditionally, horseradish was sold as a prepared condiment. Recently it has become commonly available either dehydrated or fresh.

While horseradish is a minor crop, commercial horseradish products are almost always considerably inferior to home-grown material, because the volatile pungent principles are lost or deteriorate substantially - at most surviving a few months in fresh preparation. Therefore, there is good reason to grow one's own plants.

Cultivation Notes

Soil

Horseradish will grow in most soil types but performs best in deep, moist but well-drained soil. Sandy loam or deep alluvial soils are appropriate. Heavy or shallow soils cause formation of undesirable rough, pronged roots, resulting in considerable waste during preparation at harvest time. Soils should be deeply plowed before planting to increase the development of long, straight roots. Soil pH is best between 6.0 and 7.5 (Nonnecke 1989; Khwaja, personal communication), with reported tolerance ranges of 5.8-8.3 (Duke and Hurst 1975) and 5.0-7.5 (Duke 1979). Good phosporus availability is very desirable for good root quality and size (application of phosphate fertilizer at 170 kg/ha is recommended), and added potassium (225 kg/ha) is also desirable (Khwaja, personal communication). Application of manure (22-34 t/ha) is helpful in light textured soil (Khwaja, personal communication). Annual fall application of manure is recommended. Spring application in the year that horseradish is planted will cause excessive top growth and irregular branching of the roots. Alternatively, rotation with soil-improving crops should be considered (Riekels 1972; Huxley et al. 1992).

Climate

Horseradish is a hardy perennial well-adapted to the climates of Canada and the northern U.S. It can be grown in all parts of Canada with the exception of the far north (Nonnecke 1989). The plants require supplementary moisture during summer dry periods. If plants are not kept watered, the roots may tend to become coarse (Hemphill and Hemphill 1984). Full exposure to sunlight is best, although slight shade will be tolerated. Horseradish grows most productively during late summer and early fall, as it is well adapted to cool weather. It grows best between 6 and 20°C, and optimally at 13°C.

Propagation and Cultivation

Horseradish is propagated by root cuttings. The cuttings are side roots which are trimmed from the main stem at autumn market time. They are 0.5-2.5 cm in diameter and 5-20 cm in length. Cuttings may be obtained from 1-year-old plants, but it is much better to allow the plants to reach 2 years of age in order to obtain more vigorous propagating material. To indicate which end to plant up, the top end is cut off square while the bottom end is cut obliquely. The roots taper very little and, for good growth, it is important that the upper end be planted uppermost. The cuttings are tied in bundles, packed in sand, and placed in a cool, moist location until the following spring. They are planted in furrows at least 10 cm deep and covered by soil, which is firmed around the roots to ensure good mot development. Mechanical cultivation is beneficial and hand-hoeing may be necessary late in the growing season (Riekels 1972, Nonnecke 1989).

Crown propagating material consists of a portion of the old plant that includes a piece of the root with crown buds. This portion is lifted in the autumn and replanted before freeze-up (Riekels 1972).

To obtain long, straight roots some growers will lift and strip the plant of top and side mots once or twice during the growing season. The set is raised slightly and any small roots or leaf sprouts at the top and sides are stripped, leaving only the best sprout or crown of leaves and roots at the bottom of the set. The soil is then firmed around the roots. Serious injury to the plants can occur if this process is not done carefully. Lifting and stripping should be done before the heat of summer to avoid severe checks in growth (Riekels 1972).

Double-cropping is sometimes practised by horseradish growers, to take advantage of the relatively slow initial growth. Quick-growing plants like early-cabbage, turnip, beet, lettuce, and radish may be intercropped with horseradish, these producing harvestable material before the latter requires all of the available land.

Horseradish is attacked by pests and diseases that harm other crucifer crops such as broccoli, cabbage, and rutabaga. Crop rotation is recommended to avoid the buildup of wilt and root rots that may affect horseradish production (Nonnecke 1989).

Harvest and Storage

Horseradish is grown as an annual and biennial in the U.S., and as a perennial in eastern Europe (Simon et al. 1984). It is best treated as an annual or biennial crop because if left in the field for more than one season it becomes established and increasingly difficult to control. Furthermore, plants left for 2 or more years become woody and

inferior in quality. Yields are best if the roots are not dug until October or early November. Harvesting is best delayed until after the shoots have withered. The complete root system is deeply undercut and lifted to obtain most of the main root. If any root portions are left behind they may give rise to volunteer plants the second year; these can be killed with contact herbicides in commercial plantings. The tops can either be removed after lifting or cut off near the ground a few days before harvest. Side roots are trimmed off and, in commerical farms, the large roots are packed in pallet boxes, sometimes bunched in groups of 6-8 plant lots. Commercial yields of 2-10 t/ha can be produced, depending upon the season and locality. According to Crockett and Tanner (1977), six plants will yield enough horseradish for an average family. For home winter use, roots can be harvested in late fall when they are tastiest, and kept in cool, moist sand until needed.

The home gardener who chooses to leave his plants to overwinter outdoors should be aware that the root systems must be divided at least every 2-3 years in order to prevent the plants from losing vigor. Lack of attention to this is probably the chief reason for poor performance of horseradish in the home garden, the myth having become widespread that this plant needs no attention once it has been planted. If left in the ground, the smaller roots arising from the main root can be cut off and harvested after scraping away the soil from the side of the plant.

Horseradish is stored at 0°C with a relative humidity of 90-95% in a dark location (to prevent greening of the roots). Under these conditions the roots store well for 5-6 months and, if kept disease free, they may last for nearly a year (Riekels 1972; Nonnecke 1989).

Blanched, forced leaves can be produced by placing some roots with the crowns in moist soil in a warm, light-proof place. The leaves that develop are white, tender, and sweet. They are cut when 10-15 cm long for use in salads. The first young leaves from overwintered horseradish are also eaten. The leaves quickly become inedible as they become dark green (Halpin 1978).

Example Cultivars

Big Top, Bohemian (Bohemian Giant), New Bohemian (New Bohemia, Kiester's New Bohemian), Hybrid, Maliner Kren, Newcastle Ivory, Variegata (described in Facciola 1990 and Huxley et al. 1992). Rhodes (1977) stated that the leading commercial cultivars in the U.S. are Big Top Western, Common, and Swiss.

The crinkled-leaf or common horseradish is believed to be of higher quality but more susceptible to disease than the smooth-leaved Bohemian type (Simon et al. 1984).

Fig. 65.
Horseradish *(Armoracia rusticana)*, from Vilmorin-Andrieux et C^{ie} (1883).

Additional Notes

Chemistry

The pungency of horseradish is due to volatiles consisting mostly of sulfur compounds. The principal flavor ingredients of horseradish are allyl and 2-phenethyl isothiocyanate (Mazza 1984). The volatiles are absent in intact tissues, but when the tissue is damaged reaction between the enzymes and flavor precursors occurs, resulting in the formation of several compounds, including allyl isothioisocyanate, diallyl sulfide, and phenethyl and phenylpropyl isothiocyanate (Furia and Bellanca 1975). The pungent oils are partially soluble in water but, because of the volatility, sealed containers are used to retard loss.

Medicine

Horseradish was once extensively employed in medicine, especially during the Middle Ages, when the leaves as well as the roots seem to have been used (Courter and Rhodes 1969). Horseradish was used to cure a wide variety of illnesses, including asthma, coughs, colic, toothache, ulcers, venereal disease, cancer, worms, chilblains, facial neuralgia, and rheumatism, and for expelling after-birth (Courter and Rhodes 1969; Simon et al. 1984). Horseradish juice mixed with white vinegar was once used externally to remove freckles (compare method in Curiosities). When infused in wine, horseradish root was used to stimulate the whole nervous system and promote perspiration (Grieve 1931). A poultice of the grated roots

has been used in place of a mustard plaster, and is probably preferable as it is less severe (Angier 1978). Heat is produced when horseradish is combined with liquid, exactly the same chemical reactions occurring as when mustard is combined with water (see *Sinapis* Curiosities). Additionally, there is a psychological source of heat, should the horseradish be applied directly. Lake mustard, horseradish applied directly to skin is irritating, causing the small blood vessels just beneath the skin surface to dilate, increasing blood flow and making the skin feel warm (Rinzler 1990). External use may cause skin blisters (Foster and Duke 1990).

Horseradish syrup (composed of grated horseradish root, water, and sugar) is still prescribed in England as an expectorant medicine to treat hoarseness and coughs following influenza (Rosengarten 1969). The derived chemical allyl isothiocyanate is one of the active ingredients of Rasapan, a commercial urinary antiseptic (Farrell 1985). Allyl isothiocyanate has produced chromosomal changes in hamster cells and cancer in rats, although similar effects in man have not been demonstrated (Rinzler 1990).

Vegetables and herbs of the mustard family may contain significant levels of thiocyanate and isothiocyanate. These are goitrogens, chemicals that interfere with the thyroid gland's production of hormones, resulting in an enlarged gland. Goitrogens do not pose a risk for healthy individuals consuming moderate amounts of cruciferous plants, but could be inadvisable for people with thyroid disorders (Rinzler 1990).

Livestock have died from ingesting the tops, as well as the roots of horseradish, both from plants encountered in the field and (for swine), roots deliberately fed to them (Kingsbury 1964). Raw horseradish root amounting to 1% of body weight has killed swine (Kingsbury 1964). The major problem likely to be encountered in normal use is that horseradish may irritate the digestive system (Foster and Duke 1990). Consumption of large amounts can cause bloody vomiting and diarrhea (Simon et al. 1984).

Nutrition

Duke (1977) characterized content of calcium, fiber, iron, potassium, and protein as high, and content of vitamin C as very high. Horseradish is a rich source of vitamin C (81 mg/100 g) and was once used to prevent scurvy (Lima 1986; Nonnecke 1989). The root is so rich in vitamin C that its curative properties for scurvy were regarded as miraculous (Angier 1978). Even roots that were dug from the frozen ground in winter could effect a cure (Angier 1978). Horseradish also is high in vitamin K (564 mg/100 g) and calcium (140 mg/100 g). However, when horseradish is cooked, not only does the pungent flavor disappear, but the vitamin C is denatured, and the amount of vitamin K and calcium is reduced by over half (Nonnecke 1989). Horseradish supplies appreciable amounts of starch (Hackett and Carolane 1982).

Curiosities

• *Armoracia* is thought to derive from *Armorica*, an ancient name for Britain, where horseradish grows wild (Pailler 1993).

• The German for horseradish is *meerrettich*, meaning "sea radish," an allusion to its habit of growing near the sea. The name was pronounced by the English as *mare*radish, which eventually transformed to *horse*radish (Pailler 1993).

• Horseradish is one of the "five bitter herbes" (the others are coriander, horehound, lettuce, and nettle) eaten by Jews during the 8 day Passover to symbolize the bitterness of their enslavement by the ancient Egyptians (Courter and Rhodes 1969).

• Horseradish has alleged aphrodisiac properties (Courter and Rhodes 1969).

• During the Middle Ages a doctrine became known that certain plants repelled each other. This old idea of "Antipathies" has been illustrated by a supposed ability of the horseradish to repel vines.

• Horseradish is at its most pungent in cool weather, and it has been recommended that it be harvested after the first frost of fall (Pailler 1993). Some of the most potent horseradish produced commercially comes from the region of Tuli Lakes, California, where there is frost every month of the year (Pailler 1993).

• Feiger (1975) described how she would wait for a windy day in Kansas to harvest horseradish roots, the wind helping to get rid of the tear-jerking pungency.

• The "horseradish tree" [*Moringa oleifera* Lam. (*M. pterygosperma* Gaertn.), also known as the oil of ben tree] is native to and cultivated in Arabia and India, and can be found in the West Indies and the southern U.S. This tropical tree grows as high as 8 m. The chief commercial use is as a source of ben nut oil, used for culinary and cosmetic purposes. Young leaves, flowers, immature pods, and seeds are all eaten (Morton 1976). The roots are pungent like horseradish and are

Fig. 66.
Branch of horseradish tree *(Moringa oleifera)*,
from Bailey (1900).

much used in India as a substitute for horseradish (Morton 1976). In West Africa, the tree is planted on graves in the expectation that this will repel hyenas (Morton 1991*b*).

• Powdered common horseradish root is used to adulterate wasabia horseradish (discussed in genus notes) powder in Japan (Facciola 1990).

• Medical laboratories test for blood in the stool by using the guaiac slide test; alpha-guaiaconic acid turns blue in the presence of blood. Consumption of horseradish and other food plants in the mustard family may result in peroxidase in the stool, producing a false-positive. This misdiagnosis can be avoided by not eating plants of the mustard family for 3 days prior to the test (Rinzler 1990).

• Among the many curious Hoosier (Indiana) folk remedies recorded by Tyler (1985) is the following: to remove freckles, grate horseradish into very sour milk, let stand 5 hours, and wash with this morning and night.

Problems and Potential

Horseradish is well-adapted to Canadian and northern U.S. growing conditions, and production could easily be increased. However, the market appears stable at present, limiting the potential for increased production of the raw or processed product. According to Rhodes (1977), research is needed in promotion and advertising, and into new products and packaging, in order to expand the market.

Selected References

Courter and Rhodes (1969); Riekels (1972); Rhodes (1977); Hackett and Carolane (1982); Nonnecke (1989).

Fig. 67.
Absinthe *(Artemisia absinthium)*,
from Lamarck and Poiret (1791-1823). Wormwood is
the source of oil of wormwood, which contains
the narcotic poison thujone that can
damage the nervous system and cause
mental deterioration. This was widely used in the
past to flavor the liqueur absinthe,
now illegal as originally made.

Artemisia

Family: Compositae (Asteraceae) (sunflower family)

Genus Notes

Artemisia contains about 300 annual, biennial or perennial, usually aromatic, herbs or shrubs. The genus is found across the North Temperate region, western South America, and South Africa.

This diverse group includes many species useful as natural forage for livestock. Sagebrush, popularized in Hollywood movie "westerns," are shrubby members of *Artemisia*, belonging to a group sometimes segregated as the genus *Seriphidium*. The tiny seeds of several *Artemisia* species of the Great Basin and Southwest of the U.S. were used as food by Indians (Kuhn 1987). Many species of the genus are commonly found as garden ornamentals, such as dusty miller (*A. stelleriana* Besser.), Silver Mound (*A. roxburghiana* Bessser), and white sage (*A. ludoviciana* Nutt.). Tanaka (1976) lists 44 species that have been recorded as edible. The principal species used as food are discussed below. Several others that are also occasionally used for culinary purposes are noted in Facciola (1990).

Artemisia abrotanum L. (known as southernwood, southern wormwood, old man, lad's love, and maiden's ruin), has traditionally been used as a moth repellant, hence the French name "garde robe," meaning "preserve the dress." The branches were also employed in herbal wreaths and in lovers' bouquets (Lima 1986). A deep yellow dye from the branches has been used with wool (Simon et al. 1984). The plant has been robbed on lamb before cooking, in the same manner as rosemary, and a sweet preparation was once made from the chopped fresh leaves (Clark 1939). Young shoots have been used to flavor soups, sauces, salads, meat dishes, beer, cakes, bread, confections, liqueurs, tea and other nonalcoholic beverages (Facciola 1990; Evstatieva, personal communication). The leaves are lemon-scented, and so seem to be a natural addition to herbal teas (Simon et al. 1984). Arquebuse is one French liqueur prepared in part from the species [Lamaison, personal communication; see agrimony (*Agrimonia*), where it is pointed out that the arquebus was an early hand-gun which inflicted many injuries leading to the preparation of herbal remedies]. Michael (1980) gives recipes for Southernwood cake and Southernwood tea.

Absinthe (*A. absinthium* L.), also known as wormwood and common wormwood, is a bushy, perennial, Eurasian herb. The name wormwood reflects its use in expelling parasitic worms, traceable back to the ancient Egyptians (Morton 1976). The plant gives the name absinthe to, and provides the flavor for an infamous 136-proof brew, originally made of wormwood, anise seed, fennel, star anise, coriander seed, hyssop and 190-proof alcohol (Thompson 1986; all of these herbs are discussed in this book). "L'Absinthe," a famous painting by the French artist Edgar Degas (1834-1917), shows a benumbed, glum figure, head propped on hands, sitting in a Parisian cafe, with a glass of milky liquid on the table before her. Only 14 g of the concentrated volatile oil from the plant have caused convulsions and unconsciousness. The profound mental and physical changes noted in habitual and even casual users indicate that absinthe is a very dangerous beverage. It is addictive, hallucinogenic, capable of causing insomnia, nightmares, vomiting and convulsions. Habitual users develop "absinthism," characterized by restlessness, vomiting, vertigo, tremors and convulsions. Absinthe has been banned in France, Switzerland and other countries because of its potential to cause violent psychotic behavior. Wormwood has been used in traditional medicine to treat several ailments, and has been demonstrated to have medicinal properties (Chandler 1987). It is still used to flavor alcoholic beverages such as vermouth, bitters and liqueurs, non-alcoholic beverages, frozen dairy desserts, candy, baked goods and puddings, as well as in soaps, detergents, creams, lotions, and perfumes (Chandler 1987). Thompson (1986) gives some "absinthe" beverage recipes in which instead of the original wormwood, anise-flavored liqueurs such as Pernod, anisette, Ojen and Herbsaint are used. An ointment called Absorbine was refined from absinthol, the oil of absinthe, and later, a less potent "Junior" version appeared, which is still sold for use on sore muscles (Lima 1986). Thujone in the oil is thought to be responsible for the psychotropic (mind- or mood-altering) effects. The American Food and Drug Administration has classified wormwood as an unsafe herb containing a volatile oil that is an active narcotic poison, while approving thujone-free preparations for food use (Chandler 1987). In Canada, wormwood as the herb is available in health food outlets, while teas containing only traces of thujone are permitted (Chandler 1987). In Canada, it has been recommended that wormwood must be thujone-free before use as a flavoring of alcoholic beverages; and although listed as a herb generally acceptable as food, the food use of the plant should be reevaluated (Blackburn 1993). Flowers of wormwood

may cause allergic reactions (Foster and Duke 1990). Given all of the above, wormwood can hardly be recommended for culinary purposes.

Artemisia pontica L., Roman wormwood or small absinthe, is a European perennial shrub that has become naturalized in eastern North America. It is employed as a source of essential oil for vermouth and other wines (Morton 1976). It is used to flavor toothpaste in Bulgaria (Evstatieva, personal communication).

Fig. 68.
Mugwort *(Artemisia vulgaris)*,
from Lamarck and Poiret (1791-1823).

Artemisia vulgaris L., mugwort or felon herb, is a rhizomatous perennial from Eurasia that is naturalized in eastern North America, and is especially weedy in sandy soils. The young leaves have been used as a condiment for meat dishes and vegetables, and to brew tea. In Japan the plant is consumed as a potherb (Facciola 1990). The name mugwort is commonly interpreted as reflecting use as a flavoring in a mug of beer. Stuart (1979), however, states that the name arose from the Old Saxon *muggia wort*, meaning "midge plant" after its ability to repel insects. In China, where the plant is extensively used in medicine, it is employed by Buddhist priests in initiation rites involving the burning of scars into the crown of the head (Shih-Chen et al. 1973). Sometimes scars are burned onto the faces of 3-day-old infants in the belief that this ensures their survival through infancy (Shih-Chen et al. 1973). Mugwort was one of the nine herbs used in pre-Christian times to ward off demons and venomous creatures (Stuart 1979). It was alleged that mugwort worn in the shoe put a spring in the step of the weary traveller (Zverina 1976). A cultivar, White, is available (Facciola 1990).

Artemisia princeps Pampan., Japanese mugwort, is consumed in Japan. The leaves and young seeds are eaten in soups and salads after removing the bitterness. To add color and fragrance to glutinous-rice dumplings called *mochi*, they are boiled and pounded with the latter. Mugwort mochi is widely available at natural food stores in North America (Facciola 1990). A recipe for mugwort rice cakes (mochi) is given (under *Artemisia vulgaris* rather than *A. princeps*) in Hawkes (1984).

Artemisia santonicum L. is a bushy perennial of central and eastern Europe and central Asia. Its buds contain lactone santonin, used as an antihelminthic (anti-worm) drug. Its essential oil contains thujone, whose toxic properties are discussed above. It is used in parts of Europe as a flavorant and in lotions and soaps (Peneva et al. 1988, Evstatieva, personal communication).

Artemisia annua L., sweet wormwood (annual wormwood, sweet Annie), occurs sporadically as a weed across Canada, and is becoming more common in the U.S. (Foster and Duke 1990). This species is sometimes used as a flavoring for vermouth, and has long been used in Chinese medicine. It has elicited great interest as an antimalarial drug (Simon and Craker 1989; Anon. 1992d; Klayman 1993). It is also a popular dried aromatic ornamental in wreaths, dried flower arrangements, and other herbal decorations, and is grown for these purposes (Simon and Cebert 1988).

Artemisia Dracunculus L.

Scientific (Latin) Synonyms

A. redowskii Ledeb.

English Names

Tarragon
Also: estragon, dragon sagewort, French tarragon, German tarragon, Russian tarragon

French Names

Family: Composées, famille de la marguerite
Estragon (m)
Also: dragon, dragonne, herbe (au) dragon, serpentine

Description, Taxonomy, and History

Tarragon is an aromatic, greenish- to yellow-flowered perennial herb, generally 60-120 cm high, sometimes growing to a height of as much as 2 m. It is generally considered to be native to southeastern Russia and Afghanistan. Sutton et al. (1985) give its Asian range as southern Europe and Asia, from the Caspian Sea to Siberia.

Fig. 69.
Tarragon *(Artemisia dracunculus)*,
from Hallier (1880-1888).

It is also considered native to western North America. The species grows wild in Canada in the Yukon and from British Columbia to Manitoba. In the U.S. it occurs in dry soil in prairies, in Wisconsin, Missouri, Texas, and westwards, and rarely eastward to New England. Wild tarragon grows as far south as Mexico. The wild plant may be aromatic or odorless, and usually is lacking in flavor (Foster and Duke 1990).

Cultivated and wild forms of tarragon are sometimes recognized as separate species or varieties by some authors (see Sutton et al. 1985 for a review). There is need for a modem taxonomic treatment, and at this time it seems advisable not to distinguish either wild or cultivated kinds of tarragon with scientific names. There are two forms of tarragon encountered in cultivation. Russian tarragon [sometimes separated as *A. dracunculoides* Pursh (Greenhalgh 1979)] is usually interpreted as encompassing the wild form of the species. By contrast, French tarragon (also called German tarragon and true tarragon) is generally interpreted as a cultigen, selected from a form of Russian tarragon (Tucker and Maciarello 1987). French tarragon rarely if ever produces viable seeds and is reproduced from cuttings or root divisions. Sutton et al. (1985) suggested that the sterility of the French variety is due to its repeated vegetative propagation from stocks derived from a single plant selected hundreds of years ago. Such repeated cloning is well known to be associated with the evolution of sterile lines when the initial material is normally outbreeding. Tarragon sold as seed is invariably Russian tarragon. However, Russian tarragon generally suffers from a lack of flavor, and French tarragon is universally preferred. Unless Russian tarragon is specifically mentioned, the discussion in this chapter refers to French tarragon. The following table contrasts Russian and French tarragon (mostly from information in Rousi 1969 and Sutton et al. 1985).

A comparison of French and Russian tarragon.

Characteristics	French tarragon	Russian tarragon
Flavor	attractive aniseed taste	insipid, coarse
Winter hardiness	inferior	superior
Seed production	no	yes
Height	typically ca. 80 cm	typically ca. 140 cm
Leaves	smoother, shiny, darker, small oil glands below	coarser, lighter green, commonly with stellate hairs (branched in star-like fashion)
Floral leaflets (involucral bracts)	tips rounded	tips pointed
Flower head diameter	typically about 2mm	2-4 mm
Inflorescence shape	laxly branched, conical, erect heads	thicker, broadening inflorescences, nodding heads
Pollen fertility	<10%	74-96%
Chromosome number	36	90

According to Sutton et al. (1985), tarragon "was certainly known to the Greeks in 500 B.C." However, the herb was scarcely known in Europe until the 16th century, although it may have been mentioned in 13th century writings in Spain (Rosengarten 1969; note mention of the 13th century Arabian botanist Ibn Baithar in Curiosities). It was brought to England in 1548. Tarragon is now cultivated in several temperate countries, especially in France (Hedrick 1972).

Fig. 70.
Tarragon *(Artemisia dracunculus)*,
from Vilmorin-Andrieux et C^{ie} (1883).

Uses

Tarragon is truly an exceptional culinary herb - a favorite of French cooks, and often referred to as "the Queen of Herbs" (Richardson 1991). According to Elbert and Elbert (1974), tarragon "has no peer as a culinary herb. There are few scents in the world more delicious than that which assails our olfactory prominences [noses !] when we open a jar of dried tarragon leaves. It is like the sweetest of new-mown hay on a dewy, moonlit night. How is it that no one has made a perfume of it?" [See below for perfume use.] Richardson (1991) stated "If we could take only one herb to grow on a desert island, it would be difficult to choose between basil and tarragon." The taste of tarragon is unique: pleasant, aromatic, licorice-anise-like, bittersweet, and herbaceous (Prakash 1990). The herb is particularly popular in French and Armenian dishes. Tarragon is the special ingredient in the famous Dijon mustard from France. It is also essential in the making of Béarnaise sauce, used with eggs and asparagus. Similar mixtures are excellent with cooked beets, hard-boiled eggs, boiled potatoes, chilled green beans, cauliflower, celery, onions, peas, summer squash, and zucchini. Tarragon is also one of the traditional ingredients of "fines herbes," often used in French cuisine, along with parsley, chives, and chervil. Many suggest that the herb is best used fresh. The leaves are added to tarragon chicken, eggs à la tarragon, omelettes, shellfish, and mushroom dishes, and are also an important ingredient in hollandaise, mayonnaise, and tartar sauces. Tarragon butter is an excellent seasoning on many vegetables (Stobart 1977; Farrell 1985; Lima 1986). Tarragon can be chopped and used in salads, and put in soups and quiche. It may be added late in cooking, as it takes only a few minutes to release its oil and flavor. Tarragon vinegar can be purchased commercially, or made by pushing a sprig of fresh tarragon into a bottle of cider, wine, or white vinegar. This is left to steep, in the sun if possible, for 1-4 weeks before use. Tarragon vinegar can be combined with salt and pepper, or more elaborately added half-and-half to sour cream or yoghurt and mayonnaise, and mixed with chives and garlic.

Dried leafy tips of tarragon are sometimes used in perfumes, toilet waters, and confectionary. The oil of tarragon (also known as oil of estragon) is widely used in perfumes and colognes, alcoholic and non-alcoholic beverages, confections, baked goods, vinegars, mustard and other condiments, salad dressings and sauces, soup mixes, and occasionally prepared meats (Farrell 1985).

Recipe Sources

Rosengarten (1969) gives recipes for: Sauce tarragon, Stuffed baked tarragon tomatoes, and Roast tarragon chicken. Sanecki (1974) has recipes for: Chicken tarragon and Trout tarragon. Owen (1978) gives recipes for: Frogs' legs tarragon, Creamy tarragon dressing, Béarneaise sauce, Rémoulade sauce, and Chicken tarragon with mushrooms. Garland (1979) gives recipes for: Baked eggs with tarragon, and Tarragon stuffing for chicken. Belsinger and Dille (1984) present 14 tarragon recipes, notably: Grilled lamb with mustard tarragon marinade; Lima beans with tarragon; Salmon cured with tarragon; tarragon devilled eggs in celery; Sweetbreads with tarragon and Blu castello [cheese]; Wild goose cooked in clay, with blueberry tarragon sauce; Chicken and vegetable salad in tarragon aspic; Baked potatoes with Boursault [cheese] and tarragon; Warm vegetable salad with tarragon vinaigrette; and Tarragon pickles. Lima (1986) has recipes for: Tarragon tomato juice and Tarragon vinegar. Jeanneret (1987) presents recipes for: Green beans with tarragon, Chicken with tarragon cream,

Jellied grapefruit with tarragon, Beets with tarragon, and Veal with tarragon. Holt (1989) presents recipes for: Tomato and tarragon soup, Eggs in tarragon mayonnaise, Hake with tarragon and orange, and Steamed mussels with tarragon. Richardson (1991) has 13 tarragon recipes, notably: Clear tarragon soup, Tarragon fish sauce, Tarragon blender Béarnase, Tarragon blender Hollandaise, Quick broiled sole with tarragon butter, and Tarragon scallops.

Other recipes are: Eggs à l'estragon in aspic (Fox 1933); Tarragon dressing (Day and Stuckey 1964); Tarragon tuna salad (McCormick 1979); Tarragon consommé (Boxer and Back 1980); Roast tarragon chicken (Hemphill and Hemphill 1984); Veal meatballs with tarragon (Tolley and Mead 1985); Tarragon stuffed mushrooms (Bremness 1988); Asparagus with lemon and tarragon mousseline sauce (Holt 1991).

Importance

Tarragon is grown in Russia and warmer parts of Europe, particularly France and Germany. The former Yugoslavia was also an important supplier but recent political turmoil has all but stopped production. A few producers in California are responsible for domestic production in the U.S. (Greenhalgh 1979). In 1988, the U.S. imported a total of 46 t of unprocessed tarragon valued at $578,840, and an additional 16 t of processed tarragon valued at $58,010. The majority of importation is from France (Anon. 1989a). Domestic consumption in France is estimated at 80-100 t annually. Most of this is grown domestically. No statistics seem available on its use in Canada. Tarragon is one of the more expensive herbs. It is available in supermarkets and is occasionally grown in home gardens. Russian tarragon, with its less agreeable flavor, is grown in parts of Eastern Europe, mostly for domestic consumption.

Oil of tarragon is traded mostly through France, with a production of about 2 t/yr (Duke 1985). Verlet (1993) estimated the annual world value of tarragon essential oil to be $1,600,000.00 (U.S.).

Cultivation Notes

Soil

Tarragon grows best on warm, dry, well-drained, light soils (Rosengarten 1969), and fairly poor, sandy or stony soils can be used. It does not grow well on soils that remain soaked (Lima 1986). If roots are wet during the winter, they are likely to rot (Kubat 1988). Reported pH tolerance ranges are 6.3-7.8 (Duke and Hurst 1975), 4.9-7.8 (Duke 1978), and 4.9-7.5 (De Baggio 1987). Crockett and Tanner (1977) recommend a pH range of 6.0-7.5.

Climate

Tarragon grows best between 4 and 20°C (it prefers warm, not hot conditions), in full sunlight. This perennial is winter hardy as far north as the warmer parts of Canada. A winter mulch is beneficial. Russian tarragon is more cold hardy than French tarragon, and can be grown farther north. However, taste is sacrificed by growing it. As noted above, tarragon grows best in rather dry conditions, prefering well drained, light soils, with damp soils promoting winter injury.

Tarragon was grown experimentally in greenhouses overwinter in New York State. It responded well when given long-day photoperiods (16 hours of light/day) and cold pretreatment (3-6 weeks at 4°C), with significantly increased cut shoot production for several months (Bassuk 1986). Without cold pretreatment and supplemental light, tarragon simply brought indoors from garden plantings will grow poorly, as a period of winter dormancy is needed (Kubat 1988).

Propagation and Cultivation

Propagation of the desirable French tarragon is by cuttings or root division (commercially, French tarragon is propagated substantially by micro-propagation or tissue culture). Root stock of French tarragon is listed in several North American garden catalogs. Seeds of the inferior Russian tarragon are also available. Once a plant is established, it is best divided each spring, just as the first tips of new shoots are emerging. The plant is pried out of the ground, and the spaghetti-like runners are split with a knife into 3-5 shoot divisions. Attempting to chop through the root system with a shovel instead of prying the runners apart is not recommended as the new runners are very brittle and break off easily. Tarragon roots have a reputation for becoming entangled, and if the plant is not divided regularly this may inhibit growth. The beds should be renewed every 3-4 years as older plants become less flavorful (Lima 1986). In cold areas, tarragon can be protected from frost by covering the roots with straw or leaves during the winter.

The essential oil disappears when tarragon is dried, and plants are sometimes lifted in autumn and grown under glass to provide a continuous supply of fresh leaves (Duke 1985).

Tarragon can be grown as a potted indoor plant. It requires at least 5 hours of direct sunlight a day. Crockett and Tanner (1977) note that outdoor plants should be potted for indoor use at least by midsummer, and that most potted tarragon later dies even if temperatures are warm and light conditions are excellent.

Harvest and Storage

In commercial production, generally two crops of young herbage are harvested annually in France and the U.S. The leaves are dehydrated either naturally, in subdued light, or with controlled artificial airflows and heat to maintain both color and aroma. Tarragon dries well in a microwave oven. Sutton et al. (1985) recommend 2 minutes per handful, the short drying time preserving color and flavor. The dried leaves are fragmented to the desired degree by mechanical grinding, and stored in air-tight containers to preserve flavor (Greenhalgh 1979). Gilbertie (1988) recommends handling the leaves very carefully, as they bruise easily and lose their aroma.

The home gardener is advised to use tarragon fresh, when it is best, but it can be dried or frozen. To dry, lay leaves flat or hang plants in loose bunches in a dark, airy place; when dry, crumble the leaves and store them in an airtight container.

Example Cultivars

Epicure (listed in Facciola 1990).

Additional Notes

Chemistry

The essential oil of tarragon is released by steam distillation and ranges from 1 to 2% of total leaf material. Its chief constituent is methyl chavicol [also known as methychavicol, estragole, allyl-anisole, *p*-methoxyallyl-benzene] (60-75%), with many minor chemicals including anethole (about 10%), pinene, phellandrene, ocimene, and *p*-methoxycinnamaldehyde (Duke 1985; Prakash 1990; Cotton et al. 1991). The yellowish-green liquid has an aroma reminiscent of anise (*Pimpinella anisum*, treated elsewhere in this book). A dark green, viscous liquid (an oleoresin) is prepared from French tarragon. In general, 1 kg of the oleoresin is equivalent in flavor and aroma to about 40 kg of ground, dried tarragon leaves (Farrell 1985).

Vienne et al. (1989) compared the chemistry of French tarragon and Russian tarragon. Estragole, the main component of French tarragon oil, is almost absent from Russian tarragon, wheras sabinene, methyeugenol and elemicin, principal constituents of Russian oil, are almost absent from French oil. There are also different flavonols: quercetin and patuletin glycosides were found in Russian tarragon.

Medicine

In the past, tarragon was used to treat snakebite, the bites of other venomous creatures, and the bites of mad dogs (le Strange 1977; *also see* Curiosities). It was prescribed as an antiseptic in times of pestilence (Farrell 1985). Tarragon was also employed to induce sleep and as a breath sweetener. It was regarded as "friendly to the head, heart, and liver" (Rosengarten 1969). Tarragon has been used to medicate swellings, toothache, and tumors (Duke 1985). American Indians used tarragon leaf or root to make tea for the treatment of colds, diarrhea, dysentery, headache, and difficult childbirth (Foster and Duke 1990).

Tarragon foliage contains rutin, considered to be physiologically active against inflammation, spasm, hypertension, and other conditions (Duke 1985). Estragole, the major chemical of the essential oil, has been purported to produce tumors in mice (Duke 1985). Presumably because of the content of estragole, Tateo et al. (1989) found that tarragon oil had mutagenic and carcinogenic potential.

Nutrition

Tarragon has high amounts of calcium (1139 mg/100 g) and potassium (3020 mg/100 g) (Farrell 1985). It also has vitamin A, thiamine, riboflavin, and niacin (Duke 1985).

Curiosities

• The genus name *Artemisia* has been said to be derived from Artemis, the Greek goddess of hunting, chastity, childbirth, goddess of the moon, and patroness of unmarried girls (Mercatante 1988). She is the counterpart of Diana in Roman mythology, the goddess of nature, the forests and the moon (le Strange 1977). Another interpretation is that the genus commemorates Artemisia, the wife and sister (!) of Mausolus, a 4th century B.C. king of Caria (in present-day Turkey); she built a tomb for him that was called the Mausoleum (Moerman 1982). The Tomb of Mausolus was one of the seven wonders of the ancient Greco-Roman word (the others were the Pyramids of Egypt, the Hanging Gardens of Babylon, the Temple of Diana of Ephesus, the Colossus of Rhodes, the Statue of Zeus by Phidias, and the Tower of Pharos at Alexandria).

• The second word of the name *Artemisia dracunculus* comes from the latin *draco*, dragon. The English word "tarragon" is a corruption of the French *estragon* meaning little dragon, derived from the Arabic word for dragon, *tarkhun*. The word *tarkhun* apparently was first applied to sage by Ibn Baithar, a 13th century Arabian botanist and physician, who extolled the plant's virtues (Farrell 1985). Some writers have suggested the name may have originally referred to its supposed efficacy in curing bites of venomous reptiles, while others claim that it describes the coiled serpentlike

roots, the leaves resembling a dragon's tongue, or the fiery taste (Rosengarten 1969; Mansfeld 1986; Kubat 1988).

• The ancient Greek physician and Father of Medicine, Hippocrates (460?-377 B.C.), used tarragon to draw venom from snake bites, and for alleviating the pain of insect and mad dog bites (Sutton et al. 1985).

• By the medieval Doctrine of Signatures, holding that the features of plants indicate their usefulness, the serpentine roots of tarragon were taken as a sign that the herb could cure snakebite (Castleman 1991).

• An ancient legend related that the seed of flax, put into a radish root and set in the ground, would bring forth tarragon (Grieve 1931).

• The Roman Pliny (62-113) wrote that rosemary prevents fatigue on long journeys. In the Middle Ages, pilgrims put tarragon sprigs in their shoes in the belief that it increased physical stamina (Sutton et al. 1985; Castleman 1991).

• Indigenous people of North America valued species of *Artemisia* for insect repellent, disinfectant, and deodorant properties. *Artemisia dracunculus* was used by the Okanagan, Shuswap, Kootenay and Blackfoot as a smudge to repel mosquitoes and other biting insects, and the herb was placed under pillows and mattresses to drive away bedbugs, fleas, and lice (Cheatham and Johnston 1995).

Problems and Potential

Greenhalgh (1979) suggested that there is a potential for an additional 15-20 t production of French tarragon on a worldwide basis. The major problem is acquiring root stocks of high-quality strains. Major market outlets for new production would be Western Europe and the U.S. There is little potential for economic production of tarragon in Canada and the colder parts of the U.S., given the tradition of commercial production in more temperate climates. There may be some possibility of market garden production of fresh leaves for sale at local farmers' markets. Studies in New York State showed that greenhouse production of tarragon during the winter months could be successful (Bassuk 1986).

Selected References

Greenhalgh (1979); Sutton et al. (1985); Bassuk (1986); Vienne et al. (1989).

Barbarea

Family: Cruciferae (Brassicaceae) (mustard family)

Genus Notes

Barbarea has about 20 annual or biennial species, which are native to the northern hemisphere, particularly in eastern Europe and southwestern Asia (Rollins 1993). *Barbarea verna*, occasionally grown for its edible leaves, is discussed in detail below.

Barbarea vulgaris R.Br., most frequently known as common winter cress, rocket, and yellow rocket (see Brako et al. 1995 for additional names), is native to Europe and has been widely naturalized in North America. While this biennial has been collected from the wild for use as a salad plant and pot herb, it is not employed commercially (Halpin 1978). Boivin (1992) mistakenly identified *B. vulgaris* as the upland cress encountered in commerce in Quebec. Sometimes called "poor man's cabbage," yellow rocket was probably grown in Colonial American gardens (Reay 1967). It is often a noxious weed in meadows and cultivated land (MacDonald and Cavers 1991). Cows avoid hay containing a high percentage of this weed, but it has been shown that young growth is high in protein and is useful in silage (Schreiber and Fertig 1955). A variegated cultivar, Variegatum, is sometimes grown as ornamental edible landscaping (Shimizu and Pailler 1993). Double-flowered forms are also sometimes grown as ornamentals (Huxley et al. 1992).

Barbarea Verna (Mill.) Aschers.

Scientific (Latin) Synonyms

B. praecox (Sm.) R. Br. (additional synonyms in Rich 1987)

English Names

Upland cress
Also: American cress, American wintercress, bank cress, Belle Isle cress (Belle-Isle cress, Bellisle cress), early winter cress, early-flowering winter cress, early-flowering yellow rocket, herb of St. Barbara, land cress, Normandy cress, scurvy grass (a name better reserved for *Cochlearia officinalis*, discussed in this book), spring cress, treacle mustard, treacle wormseed, winter cress, wormseed, yellow rocket (better applied to *B. vulgaris*, discussed above)

French Names

Family: Crucifères, famille de la moutarde
Cresson de terre (m)
Also: barbarée précoce, barbarée printaniére, cresson d'Amérique, cresson de(s) jardin(s) (latter ambiguous, since it is also applied to *Lepidium sativum*, garden cress), herbe de Sainte-Barbe (a name also applied to *B. vulgaris*) Wijk (1911) lists additional old-fashioned French names.]

Description, Taxonomy, and History

Upland cress is an annual or biennial (sometimes perennial) herbaceous plant, 30-90 cm tall. This species is very variable in size, depending on environmental conditions (Rich 1987). It is "perhaps native in the western Mediterranean region and Macronesia," but its native range has been obscured by cultivation (Rich 1987). Upland cress grows along roadsides and streams, and on waste and cultivated ground. The cultivated selections are indistinguishable from the wild forms. Wild plants have been introduced to much of Europe, North America, South Africa, Japan, and New Zealand (Clapham et al. 1987). In Canada, wild upland cress has become established in southwestern British Columbia. It has also been found on the French islands of St-Pierre and Miquelon (Scoggan 1978-79). In the U.S., the plant is naturalized from California to Florida, north to the north central and northwestern states (Halpin 1978; Fernald 1970). It is most common in the eastern U.S., and is occasional in the western U.S. and Canada (Rollins 1993). Little information seems available on early cultivation of upland cress. According to Rich (1987), it is an ancient salad crop, likely used as a winter substitute for watercress in the 16th or 17th century. In Sweden during the 18th century, upland cress was collected for spring and autumn salads and boiled like kale (*Brassica oleracea* var. *viridis* L.) (Organ 1960).

Uses

Young, tender leaves and shoots of upland cress are eaten fresh in salads, or employed as a seasoning or garnish. The leaves have a pleasant, peppery taste similar to watercress (*Nasturtium officinale*, also treated in this book), although somewhat more bitten The young flower buds can be added as a flavoring to salads and vegetable dishes (Halpin 1978; Owen 1978). The young seedlings are tasty sprouts. An edible oil can be obtained from the seeds.

Fig. 72.
Upland cress *(Barbarea verna)*, from Hallier (1880-1888).

Fig. 73.
Upland cress *(Barbarea verna)*,
from Syme et al. (1863-1886).

Recipe Sources

In addition to the recipes listed below, see the extensive list of recipes for watercress (*Nasturtium officinale*): Wintercress-stuffed potatoes (Brill undated); Cress soup (Organ 1960); Upland cress quiche (Halpin 1978); Watercress soup (Phillips 1986).

Importance

Upland cress is a very minor crop, sometimes grown in Europe, especially in France, and in North America (Buishand et al. 1986). Commercial seed is obtainable in Europe (Rich 1991). No information seems available on amounts or value of upland cress produced commercially.

Cultivation Notes

Soil

Upland cress requires moist, rich, well-drained soil for best performance. Halpin (1978) recommends planting in well-manured or composted soil. The pH range of tolerance is 4.5-7.5 (Duke 1979).

Climate

This cool-season biennial can withstand some autumn frost. It is sown as early as the soil can be worked. The plants need to be kept moist during dry periods (Splittstoesser 1990). Upland cress grows best at temperatures under 20°C. Full sun is recommended (Huxley et al. 1992), but semi-shade is advisable during hot weather (Halpin 1978). Leaves developed in hot weather tend to taste hotter.

Propagation and Cultivation

Upland cress is propagated by seeds, which are planted in soil in shaded moist areas, and lightly covered, According to Rich (1987), the seeds can remain dormant for many years, and may produce plants sporadically for years. The

Fig. 74.
Upland cress *(Barbarea verna)*, from
Vilmorin-Andrieux et C^{ie} (1883).

seedlings are thinned to about 10 cm apart. Upland cress can also be propagated from root divisions and cuttings made in the spring. Successive plantings will provide a regular harvest throughout the growing season (Organ 1960). As a source of flavorful leaves, this species is best grown as an annual.

Harvest and Storage

The leaves of upland cress are hand-harvested as needed. They are best consumed fresh, and the younger leaves are said to have the best flavor. Harvesting generally ends once a flower stalk forms, because subsequently the leaves become too bitter to eat.

Example Cultivars

Cultivars do not seem to be available.

Additional Notes

"Winter cress (*Barbarea* spp.)" is classed as a weed under federal Canadian legislation (Anon. 1986), so that in theory importation of seeds into Canada could be problematical.

Chemistry

No information found.

Medicine

Upland cress was once used as a healing agent for wounds (Roecklein and Leung 1987).

Nutrition

Upland cress is high in vitamins and minerals, like the other cresses (*see* watercress, *Nasturtium officinale*).

Curiosities

• The genus name *Barbarea* originates from an old name, *Herba Sanctae Barbarae*, Herb of Saint Barbara (Huxley et al. 1992). St. Barbara is the patron saint of artillerymen and miners, and is a protectress in thunderstorms (Stearn 1992*a*). It was believed that eating upland cress on the saint's special day (Dec. 4) would bring good luck (Halpin 1978).

Problems and Potential

Because of competition from similar vegetables (notably watercress, *Nasturtium officinale*), upland cress is likely to remain an obscure specialty crop, occasionally grown in home gardens.

Selected References

Halpin (1978); Rich (1987); Splittstoesser (1990).

Borago

Family: Boraginaceae (borage family)

Genus Notes

Borago has about three species of annual or perennial herbaceous plants native to the Mediterranean area. In addition to *B. officinalis*, discussed in detail below, *B. pygmaea* (DC.) Chater & Greuter (*B. laxiflora* Poir.) is sometimes grown as a rock garden ornamental.

Borago is related to the genus *Symphytum*, of which *S. officinale* (comfrey) is discussed in this book. Some parallels will be observed between comfrey and borage (*B. officinalis*, treated below); for example, the cucumber taste of both culinary herbs.

Borago Officinalis L.

English Names

Borage
Also: bee bread (beebread) [reflecting the attractiveness of the flowers to bees], borrage, bourage, burage, burrage, burridge, cool-tankard [a name reflecting usage as a beverage flavoring], langdebeef, ox-tongue, star flower [for the star-like appearance of the five-petaled flowers], tailwort, talewort
["Country borage" or "Indian borage" is an unrelated plant, *Plectranthus amboinicus*, that is sometimes used as a borage substitute. It is also treated in this book.]

French Names

Family: Boraginacées, famille du myosotis (famille de la bourrache)
Bourrache (f)
Also: borrage, borratze, bouracha, bourache, bourasse, bouroche, bourrace, bourracha, bourrache commune, bourrache bâtarde, bourrache officinale, bourrage, bourroche, courage, fausse bourrache, langue de boeuf (langue-de-boeuf), langue d'oie

Warning

Some authorities are suspicious about the potential toxicity of this herb (*see* Medicine), although it is not considered dangerous at present. Excessive or long-term consumption is therefore unwise.

Description, Taxonomy, and History

Borage is a robust, hairy annual branched herb, 15 to over 100 cm tall. The plants first produce a basal rosette of leaves, and from this a primary stem usually emerges that branches and produces flowers. The stems are prickly,

Fig. 75.
ge *(Borago officinalis)*,
from Syme et al. (1863-1886).

as those who attempt to pull them out by hand soon realize. The flowers are usually blue, but also sometimes white, violet, or reddish-purple, especially in ornamental forms. An extensive description of development of borage is provided by Simpson (1993).

Borage is commonly found throughout the Mediterranean region, including the European and North African portions and Asia Minor. Some have speculated that it was originally native to the northeast Mediterranean region, and became established as an escape from cultivation elsewhere in the Mediterranean region, as well as in other parts of Europe, and Asia. In North America it has been collected occasionally outside of cultivation, in waste places and along roadsides, in most Canadian provinces and American states.

Fig. 76.
Borage *(Borago officinalis)*, from Thomé (1903-1905).

Borage was known to the classical Greeks and Romans for its reputed medicinal powers (Awang 1990). It is believed to have been introduced to Britain by the Romans (Awang 1990).

Uses

Borage is frequently grown as a pot herb, valued for the salty, cucumber flavor of the young leaves. Fresh young leaves and flowers of borage are eaten as a condiment and as a component of salads (chopping the quite hairy leaves finely keeps the hairs from being noticed in salads). According to Medrano et al. (1992), in Spain the portion that is preferentially eaten is the basal leaf petioles of young, pre-flowering plants. The basal petioles are cooked like spinach, and the leaf blades are not consumed (Medrano, personal communication). The flowers serve to decorate salads, and can be frozen in ice cubes for use in beverages. The cucumber flavor is also popular in summer iced drinks, prepared after steeping the young leaves in water that has been brought to a boil. A sprig can also be added to lemonade, iced tea and fruit punches. Dried leaves have been used to flavor some alcoholic beverages, notably negus and claret cup (Facciola 1990). The leaves and flowers are also cooked like spinach or Swiss chard, and used in soup. Young leaves can also be pickled, and the flowers can be candied for confectionery, made into syrup, or used as garnishes. Candied borage flowers add a special touch to cakes, ice cream and the like. The flowers have also been used to brew tea, and to color vinegar blue.

At present borage has attracted great interest as a diversification crop, grown for its seed oil, used as a nutritional supplement. The seeds contain -linolenic acid (gamma-linolenic acid), hereafter referred to as GLA. This is an unusual fatty acid of medicinal and commercial value, discussed below.

Borage is extensively grown as an ornamental, especially in rock gardens. Because the flowers are pendulous, plants are often located high on a slope so that the drooping inflorescences will be visible. Some cultivars have variegated leaves. Borage is also an excellent honey plant, producing a profusion of flowers with high nectar content that provides excellent forage for honeybees. The name bee bread reflects the attractiveness of borage to bees. Borage is sometimes used as a source of dye, and as a forage plant for domestic livestock.

Recipe Sources

Gibbons (1966) gives recipes for: Borage candy, Borage jelly, Borage syrup, and Borage jam. Crowhurst (1973) has recipes for: Borage tea, Borage syrup, and Borage cider cup. Smith (1973) presents recipes for: Cider cup with borage [with leaves], Claret cup with borage [with stem and flower garnish], Borage-grape mold [with leaves], and Blender borage soup [with flowers and leaves]. Loewenfeld and Back (1974) give recipes for: Candied flowers and Borage beverage. Michael (1980) has recipes for: Borage with cottage cheese, Borage flower syrup, Borage tea, crystallised borage flowers, and Sugared borage flowers. Leggatt (1987) gives recipes for: Scrambled eggs with tarragon and borage flowers in pitta, Red and yellow pepper salad with borage flowers, White bean salad with borage flowers, Dandelion salad with leaves and petals and borage flowers, and Pimms with borage leaves and flowers. Barash (1993) gives eight borage flower recipes, including: Burgundy borage punch, and Borage and cucumbers in sour cream dressing.

Fig. 77.
Borage *(Borago officinalis)*,
from Hallier (1880-1888).

Other recipes are: Tomato salad with borage (Hériteau 1975); Borage tea (Marcin 1983); Red lettuce with borage flowers (Larkcom 1984); Borage with cream cheese (Bonar 1985); Paul Reboux's borage fritters (Holt 1989); Herbed cucumber dip with borage blossoms (Belsinger 1991).

Importance

Borage is cultivated throughout much of Europe, North America, India, China, and New Zealand. While it is widely grown as a garden ornamental, less so as a pot herb in home gardens, it is mainly as a commercial source of seed oil that borage has economic value today. As noted later, despite widespread interest in developing this ancient pot herb and herbal medicinal as a new crop grown for seed oil, this new direction for borage is still basically experimental in North America. However, in recent years over 300 ha of borage have been marketed in Saskatchewan (The Furrow 1990), with 800 ha grown in western Canada in 1991 (Belisle 1991).

Cultivation Notes

Soil

Borage is adapted to many soil types (e.g., sandy loam, organic soils), but is intolerant of heavy, poorly drained soils. For maximum productivity, borage can be grown in rich soils, but it seems to have a generally low need for nutrients compared to most crops. Borage has been collected on an unusually wide range of soil pH, with reported ranges of 4.5-8.7 (Duke 1979), 4.5-8.3 (Simon et al. 1984), and 4.3-8.4 (De Baggio 1987). Crockett and Tanner (1977) recommend a pH of 6.0-7.0. As an ornamental, borage seems adapted to dry, poor, light soils, such as might be found in a rock garden.

Climate

Borage does well in full sunlight, although it is tolerant of partial shade. The plants are frost-tolerant, and well adapted to cool growing conditions, growing between 4 and 24°C, with an optimum of 15°C. They also tolerate dry conditions well, although soil of average moisture content is best. Borage seems susceptible to a wide array of insect pests and diseases when grown under high rainfall and humidity. The plants appear to be day neutral, length of day not influencing onset of flowering.

Propagation and Cultivation

Borage is propagated by seeds, best planted 1-2 cm deep according to Kiehn and Reimer (1993), and 6-13 mm according to Wang et al. (1993). The seeds need light to germinate (Wang et al. 1993), so they should not be planted too deeply. According to Crockett and Tanner (1977), the seeds will remain viable for 8 years. Seedlings usually emerge in 5-8 days. Their soil should be kept moist while the plants are young, although once established dry soil is best. Borage is difficult to transplant, except when the seedlings are quite small, and is therefore best planted in place. The root systems are delicate and do not withstand transplanting well. Once established in a garden, plants will self-sow, but this may produce excessive concentrations of seedlings that require thinning. Although itself a weed, borage is a weak competitor with some other weeds, which need to be kept under control. [In the U.K., borage competes strongly with weeds, and is normally grown without herbicides (Fieldsend, personal communication.)] As a garden crop, borage plants should be spaced 30-50 cm apart, or somewhat farther to accommodate the branching that occurs when grown in rich soil. For indoor growth as a winter kitchen plant, seeds should be sown directly into the container in which they will develop. Whether outdoors or indoors, young leaves can be harvested regularly like spinach. Older plants get "leggy," lose the mild cucumber-like flavor, and the hairs of the leaves become sufficiently large that they are irritating either when eaten fresh or as stir-fries.

Harvest and Storage

During the growing season, a constant supply of fresh young leaves is best obtained by sowing a fresh row of seeds every few weeks. Borage wilts quickly on harvest, and should be used promptly. In Spain, borage is sometimes canned (Medrano et al. 1992). Borage does not seem to be one of the many herbs that can be dried effectively for winter use. For example, while the dried leaves can be used in tea, fresh leaves make a decidedly superior brew. As noted above, however, borage can easily be grown indoors for a fresh supply.

Seeds of borage grown for seed oil are difficult to collect because the plants shatter their seeds very readily, and ripen seeds continuously over a long period. Experiments at Morden, Manitoba in 1987 showed that 1100 kg of seed/ha could be collected if all the seeds were harvested, but when the plots were swathed and combined, only 170 kg/ha were collected (Ference 1989). Beaubaire and Simon (1987) obtained a seed yield of 754 kg/ha, and a yield of GLA of 7.2 kg/ha in Indiana.

Example Cultivars

Alba, Variegata (ornamental cultivars listed in Huxley et al. 1992).

Additional Notes

Chemistry

According to Rinzler (1990), the astringent bite of borage comes from the tannins, malic acid (which gives immature apples a sour taste), and potassium nitrate, which has a cooling, pungent taste. Borage seed contains GLA, a long-chain fatty acid of medicinal importance, as noted below. There are small amounts of allantoic acid (Prakash 1990). Pyrrolizidine alkaloids, known for their hepatotoxic and carcinogenic potential, have been found in leaves, seeds, and flowers (Awang 1990; see discussion below regarding potential for toxicity). Awang (1990) reviews other constituents that are present, including some alkaloids in minute concentrations.

Medicine

Borage has long been used in herbal medicine. Internally, it has been employed to treat kidney conditions, as a laxative, and to treat pulmonary problems, jaundice, and fever. It has also been used to stimulate lactation and as a tonic and eyewash. Topically, borage has been used in the treatment of rheumatism and skin diseases, as a poultice for inflamed swellings, and to treat dermatitis. Other conditions treated with folk remedies include cancer, corns, tumors, bladder stones, bronchitis, cough, cramps, sore throat, swellings, and urogenital ailments (Duke 1985).

González et al. (1993) compared the risk of cancer between people in the province of Zaragoza, Spain, who ate borage at least once every 2 weeks, and nonconsumers. The area was chosen because it was known that borage consumption was common, the stems and leaves usually eaten cooked (boiled in water). They found a 3-fold reduction in risk of cancer in the borage eaters.

As noted below, for the most part seed oil (rather than herb preparations) has proven to have medicinal value in modem medicine. While extracts are medicinally effective, borage has acquired a reputation for poisoning health food enthusiasts who have too enthusiastically used it as a personal remedy.

Gamma-linolenic acid is one of the so-called essential fatty acids needed by humans for maintenance of cell functions. It is a fatty acid precursor in the biosynthesis of prostaglandins, especially prostaglandin El, a hormone-like substance that has been clinically shown to regulate metabolic functions in mammals; it affects cholesterol levels, dilates blood vessels, reduces inflammation, and has additional effects (Horrobin 1990; The Furrow 1990). GLA has proven useful in the treatment of atopic eczema (e.g., Quinn et al. 1989), and some conditions in which normal GLA production is depressed in humans appear to be treatable by using GLA as a dietary supplement (Beabaire and Simon 1987). GLA has also shown some therapeutic promise in the treatment of premenstrual syndrome, diabetes, alcoholism, and inflammation, and it may have some value in preventing heart disease and stroke (Janick et al. 1989).

The beneficial effects of GLA are probably related to the role of dietary essential fatty acids, which determine the properties of membranes, as well as to such essential metabolic precursors as the prostaglandins (Galwey and Shirlin 1990). GLA is a normal conversion product of linoleic acid, a major constituent of most vegetable oils, so that it would appear that humans should not lack for an adequate supply. Nevertheless, some people, perhaps 10-20% of the population, appear not to have adequate levels, even when receiving large amount of linoleic acid (The Furrow 1990). GLA is thought to be important for development of brain tissue and other tissue growth, and nature seems to provide for human infants with high levels of GLA in human milk. Pharmaceutical and food companies are developing GLA-containing supplements and specialty foods for infants, the elderly, and people with health problems (The Furrow 1990).

Borage oil has the disadvantage of containing 1-2% of erucic acid. Although an essential fatty acid, it is believed to be harmful in large doses (Galwey and Shirlin 1990). Indeed, the development of a low-erucic acid rapeseed oil known as canola in Canada during the decades after the Second World War resulted in canola dominating the rapeseed oil market.

There are many plant sources of GLA (Ucciani 1995), including the marihuana plant (*Cannabis sativa* L.), which is considered to be a serious candidate for development as a new GLA source (Theimer and Moelleken 1995). However, the main commercial sources of GLA today are borage, currants (*Ribes* species), evening primrose (*Oenothera biennis* L.), and by fermentation of some yeasts and other fungi (Awang 1990). Companies have engaged in a boastful debate about the comparative efficacy of GLA in their preparations made from borage on the one hand, and from evening primrose on the other (Awang 1990). Jenkins et al. (1988) studied the effects of triglyceride composition of the oil from several sources, including borage and evening primrose, and while they were unable to conclude that the clinical efficacy of the oil from difference sources differed, they suggested that there should be further testing with particular diseases in humans.

Awang (1990) reviewed health concerns over borage. He noted that levels of pyrrolizidine alkaloids are notably lower than in comfrey, where the levels are dangerously

high. He recommended that physicians should be aware of a potential for eliciting undiagnosed temporal lobe epilepsy, especially in schizophrenic patients or those receiving certain drags for treatment of epilepsy. Tyler (1993) also noted low levels of pyrrolizidine alkaloids in borage, including lycopsamine, amabiline, and thesine. Tyler (1993) recommended against "chronic consumption." In Canada, crude herbal preparations of borage are "considered safe when consumed as food" (Blackburn 1993).

The hairs on the leaves and stems cause contact dermatitis in susceptible individuals who handle the plant (Mitchell and Rook 1979), and in any event the bristles may simply be irritating (Rinzler 1990). Barash (1993) stated that borage should not be eaten in great quantity because of its diuretic effect.

Nutrition

The young leaves of borage are rich in potassium and calcium (Awang 1990). Levels of iron were described by Medrano et al. (1992) as adequate by comparison with leafy vegetables. Sodium content is relatively high, and there are minor amounts of manganese, zinc and copper (Medrano et al. 1992). Protein content is about 13%, fat content 3-5% (Prakash 1990), and the fresh plant is rich in vitamin C (Awang 1990). Rinzler (1990) states the leaves are also rich in beta-carotene (pro-vitamin A). According to Rinzler (1990), the high content of calcium may indicate that those susceptible to developing calcium oxalate kidney stones should avoid borage.

Curiosities

• Borage is known as the "herb of gladness." According to the classical authors Dioscorides (50-100) and Pliny (62-113), borage was the plant Homer called nepenthe, which resulted in absolute forgetfulness when drank in wine (Awang 1990).

• In the medieval world, borage acquired a reputation for promoting courage. Borage flowers were embroidered on the scarves of warriors to aid them in battle. In tournaments it became traditional to drink borage tea before a joust.

• A variety of interpretations have been given regarding the derivation of the name borage (Awang 1990). The name has been said to arise for the Latin *cor* ("the heart") and *ago* ("I give"), in the beliefs noted above that the herb gave courage and raised drooping spirits. A similar interpretation is that the name arose from the Celtic *borrach* ("courage").

Fig. 78.
Borage *(Borago officinalis)*, from
Vilmorin-Andrieux et C^{ie} (1883).

• Dried borage contains about 3% KNO_3, believed to be responsible for popping sparks and a slight explosion when the herb is burned (Awang 1990). Potassium nitrate is used in matches, firecrackers, and gunpowder, and as an additive in cigarettes to make the tobacco bum more evenly (Rinzler 1990).

• In Lebanon, borage flowers in wine are considered aphrodisiac (Duke 1985).

Problems and Potential

As a condiment plant, borage is a rather old-fashioned herb that has lost much of its popularity, and has limited potential. The presence of toxic constituents decidedly limit its use a food plant.

By contrast, as a source of GLA borage has appreciable economic potential. It may be that lower production costs on the Canadian and northern U.S. prairies offer these regions a competitive advantage (The Furrow 1990). It needs to be stressed, however, that the economic potential is entirely dependent on the development of the market for GLA. Most GLA is presently produced in Europe and Asia.

Borage is basically a wild plant, and its habit of scattering its seeds at maturity is the chief drawback at present to the efficient collecting of the seeds in order to extract the valuable oil. Special harvesters have been developed (Galambosi 1991), and efforts are underway to develop cultivars that retain their seeds at maturity and mature uniformly in a concentrated period.

As a garden plant grown either as an ornamental or a pot herb, the weedy propensity of borage can be difficult to control. Once established, it can spread rapidly and may be difficult to keep under control. The same can be expected wherever the plant is grown.

Processors often want borage to be grown without herbicides, to maintain the crop's health image. Controlling some weeds of borage without use of herbicides can be very difficult (although as noted above, weed control in Britain is not a problem).

Evening primrose (*Oenothera biennis* L., occasionally other species of *Oenothera*) competes with borage today as a source of GLA, also obtained from seeds (Some species of *Ribes* also are commercial sources of GLA). Worldwide, more evening primrose is grown for GLA production than borage. In the Delhi region of southern Ontario, considerable amounts of evening primrose have been grown as crops used to prepare nutritional supplements. Both species are essentially wild plants that in the last two decades have attracted the interest of pharmaceutical companies, and farmers seeking new crops to plant. Borage contains a higher seed content of GLA (ca. 17-25%) than evening primrose (ca. 7-10%); indeed it has the highest content of any species used commercially to supply GLA. Depending on climate, borage seems to be more competitive than evening primrose. The crop appears to be well adapted to the cool growing conditions in parts of the Canadian prairies and adjacent American states, and possibly also to parts of eastern Canada and northeastern USA, and so has potential for development in North America (The Furrow 1990, 1992). However, in a review of attractive new oil and pharmaceutical crops for Canada, Ference (1989) concluded that ginseng and evening primrose are the best possibilities, while the harvesting problems of borage seriously compromise its potential.

Selected References

Jyurovat (1973); Awang (1990); The Furrow (1990, 1992).

Fig. 79.
Brown mustard *(Brassica juncea)*, from Köhler (1883-1898).

Brassica

Family: Cruciferae (Brassicaceae) (mustard family)

Genus Notes

The Old World genus *Brassica* is composed of perhaps 35 species of annual and perennial herbs, some of the latter somewhat shrubby in appearance. *Brassica* is an extremely complex group. Several cultivated species have evolved by hybridization. Both vernacular and scientific nomenclature of some of the domesticated plants are confusing. Several systems of formal Latin nomenclature have been developed. The work of L.H. Bailey on classification of cultivated *Brassica* (Bailey 1922, 1930, 1940), while dated, provides some of the most authoritative treatments available. This has been incorporated into a recent synoptic treatment (Mansfeld 1986). Recent DNA studies have suggested changes to the classification of groups within the genus (Song et al. 1988, 1990; Warwick and Black 1990). There is a need for much additional work. For an extensive description of *Brassica* species cultivated as vegetables, see Munro and Small (1997).

Brassica is most important economically as a source of oilseeds. Over 13% of the world's edible oil supply comes from species of *Brassica* (Downey and Röbbelen 1989). The principal oilseed species are the rapeseeds (known as canola species in Canada) *B. napus* L. and *B. rapa* L. (*B. campestris* L.). The "rape" in "rapeseed" originates from the Latin *rapum*, meaning turnip (Shahidi 1990) (turnip is a form of *B. rapa*; "Swedish turnip" (rutabaga) is a form of *B. napus*). Western Canadian rapeseed. (canola) has captured much of the edible oil market because of its low content of glucosinolates, low content of saturated fatty acids, and high proportion of nutritionally desirable fatty acids (Jolliff and Snapp 1988).

In addition to *B. juncea* discussed in detail below, two other *Brassica* species are used for mustard seed.

Brassica nigra (L.) W.D.J. Koch (*Sinapis nigra* L.), black mustard, was once the primary source of mustard seed in the world, and is still often grown. Black mustard seed oil was also used in soap and medicine (Rich 1991). This species is an annual Eurasian herb, 1-3 m tall, with small, dark-brown seeds. The young tender leaves are eaten in salads or cooked as a potherb, young flower clusters are prepared like broccoli, and seeds can be germinated and eaten as sprouts (Facciola 1990). Black mustard has become a widespread weed in the U.S., and also occurs as an escape from cultivation in Canada.

Brassica carinata A. Braun, is known as Abyssinian mustard, Abyssinian cabbage, African cabbage, and karate. The seeds are grown for mustard in India. The seeds are also used for oil. The leaves and young stems can be eaten raw in salads, while older leaves and stems are cooked, and the inflorescence is eaten as a broccoli-like vegetable (Facciola 1990).

Fig. 80.
Black mustard *(Brassica nigra)*, from Hallier (1880-1888).
In most plants of this species the fruits are more
adpressed to the stems than shown here.

Seeds of the "mustards" (both of *Brassica* and *Sinapis*) were almost certainly used, and several species were likely domesticated, millenia before classical Hellenistic and Roman times, but there is limited archeological evidence (Zohary and Hopf 1993). One rich deposit of seeds of either *Brassica* or *Sinapis* (which are difficult to distinguish in charred archeological remains) has been described from a site dated at 3,000 B.C. in Iraq (Zohary and Hopf 1993).

Brassica Juncea (L.) Czern. & Coss.

Scientific (Latin) Synonyms

Sinapis juncea L.

English Names

Brown mustard, oriental mustard
Also: Chinese mustard, Indian mustard, Russian mustard, sarepta, sarepta mustard
[Names used for vegetable forms of *B. juncea* (such as leaf mustard, mustard greens, Chinese mustard greens, and a host of oriental names) are discussed in Munro and Small (1997). "Brown" and "oriental" mustard are names commonly used to refer to differently-colored seed forms, i.e., respectively brown and yellow.]

French Names

Family: Crucifères (Brassicacées), famille de la moutarde
Moutarde de l'Inde (f)
Also: moutarde, moutarde cultivée (the weedy form, in contradistinction, is moutarde sauvage), moutarde joncée [In French, "moutarde" could refer to any of the three species that have predominantly been used to prepare mustard, *B. juncea, B. nigra*, and *Sinapis alba*.]

Description, Taxonomy, and History

Brassica juncea is an annual herbaceous plant, remarkable for the range of economic forms that have been bred. Numerous vegetable-like characteristics have been selected, mainly in Asia, to produce mimics of kales, cabbages, turnips, kohlrabi, and cauliflower, each with its own distinctive name(s). Some of these forms are useful as animal forage and as green manure (Simmonds 1976). These vegetable varieties of *B. juncea*are described in detail in Munro and Small (1997). The seeds of *B. juncea* have also been selected for yield of oil, and for use as a flavoring. Only *B. juncea* selected for mustard will be discussed here. The seeds are a major component of prepared mustard, and it is this "herb" usage with which the following discussion is mainly concerned.

Until the 1950's *B. nigra* was the chief crop grown for pungent mustard. *Brassica nigra* had to be harvested by hand, and with progress in mechanized harvesting of the larger-seeded *B. juncea*, within a decade the latter displaced the former. The related *Sinapis alba*, yellow mustard (also discussed in this book), is commonly grown for "mild" mustards.

Brassica juncea arose as a hybrid between *Brassica nigra* and *B. rapa* L. It may have originated in the central Asian Himalayas, with secondary centers of diversification in India, China and the Caucasus. There is evidence of independent hybridization of *B. nigra* with local *Brassica* in those areas. The reddish-brown-seeded forms are called brown mustard. Yellow-seeded forms arose in the Orient and are known as oriental mustard (Simmonds 1976). It is uncertain whether there are any genuine wild forms, or whether plants outside cultivation are ruderal, having escaped from cultivation. In Canada, *B. juncea* is a weed, found in all provinces and the Northwest Territories, in cultivated ground and waste places (Scoggan 1978-79). *Brassica juncea* is also widely distributed in the U.S. (Rollins 1993). Mustard was among the earliest of spices, recorded in about 3000 B.C. in Sanskrit writings of ancient India.

Uses

Mustard is available in three forms (Farrell 1985; Lewis 1984; Rosengarten 1969), as described below.

Powdered mustard, known as mustard flour or ground mustard, is made by finely grinding the seeds and then removing the hulls by multiple milling, screening, and sifting. The process of preparing powdered mustard was developed in the early 18th century, and became popular because the resulting material kept indefinitely (Norman 1990). In North America powdered mustard is often made from yellow mustard (*Sinapis alba*), and additional information is available in the discussion of yellow mustard in this book. *English mustard* is made by mixing mustard powder with water and allowing the mixture to stand for 10 minutes to develop flavor (Norman 1990).

Prepared mustard, also called "mustard paste," is a mixture of ground mustard seed, salt, vinegar, and spices. Brown mustard is utilized for its pungency. *Dijon mustard* was originally produced in France, from *B. nigra*, but can be made anywhere in the world. This is prepared with brown mustard seeds, water, white wine, salt and spices. It is light in color, sharp, salty, not sweet, and with a sharp taste of mustard. Dijon mustard is ground to a very fine paste and contains no tarragon. It is light in color because the seed coat is removed (Stobart 1977). *Bordeaux mustard*, also originating from France, is darker, slightly sweet,

milder than Dijon mustard, and is prepared with herbs such as tarragon. *Champsac mustard* is a dark brown, aromatic, smooth blend flavored with fennel seeds. *Champagne mustard* is smooth, pale, mild, and blended with champagne. *Beaujolais mustard* is a blend of coarse-ground seeds and red wine. *Red mustard* is prepared with chili. *Wholegrain mustard* is a hot, crunchy, English preparation of whole mustard seeds. *Honey mustard* is a sweet blend of mustard seeds, honey, raw sugar, vinegar, and spices. French *herb mustard* is usually smooth, mild, and lightly flavored with mixed herbs. *German mustard* is frequently flavored with herbs and spices, and is often somewhat sweet.

Whole seeds are used in pickling or are boiled with vegetable dishes such as sauerkraut or cabbage. Brown mustard seeds are seldom used as whole seeds in North America but are important in parts of Asia where they are used in curries and pickles. Indian recipes use the whole seeds in "ghee" (clarified butter or vegetable fat) that is heated until the seeds begin to sputter. Ghee is a garnish for many Indian dishes. The treatment destroys the enzyme necessary for the pungent taste and the seeds become pleasantly nutty, rather like poppy seeds (Stobart 1977).

Recipe Sources

Most of the recipes for brown and oriental mustard (*Brassica juncea*) are interchangeable with those for yellow mustard (*Sinapis alba*) given in this book. The recipes of Day and Stuckey (1964) include: Mustard gingerbread, Mustard-glazed ham, My best mustard pickle, Tongue sandwiches with hot mustard sauce, Mustard cheese sauce, Mustard hollandaise sauce, Mustard baked lima beans, and Glazed mustard parsnips. Blanchard (1975) presents recipes for Blue cheese spread (with mustard sprouts), Shrimp paste (with mustard sprouts), and Piquant sauce (with mustard sprouts). Kuo (1977) gives recipes for Shrimp in mustard sauce and Chicken in mustard sauce. Alpine (1978) has recipes for Alpine mustard, Mustard pickles, Cream of mustard soup, and Mustard sweet and sour hot sauce. Wilde (1981) has recipes for Sweet mustard and Mustard butter. Thompson (1986) presents recipes for: Shrimp in mustard sauce; Veal, crabmeat & artichoke hearts with mustard hollandaise sauce; and Mustard-fried catfish. Norman (1990) has recipes for Baked cod with mustard, and Rabbit with mustard sauce. Shulman (1991) has recipes for Cheese, pepper and mustard muffins, and Cheese and mustard bread.

Other recipes are: Mustard salmon croquettes with cheese sauce (Rosengarten 1969); Mustard flower soup (Crowhurt 1973); Tarragon mustard (Rose 1979); Mustard dressing (Stuart 1979); Mustard cream dressing (Hawkes 1984); Mustard sauce (Jeanneret 1987); Rabbit with mustard and thyme (Bremness 1988); Mustard-braised endive (Sahni 1990); Rabbit with mustard (DeWitt and Gerlach 1991); Country mustard (Solomon 1992).

Importance

Mustard condiment is one of the best known and most widely used spices. Consumption in Western countries is larger than that of every spice except pepper (*Piper nigrum* L.). Mustard use in North America is increasing, reflecting continued popularity in the home, but also in fast-food establishments, where waste is commonly promoted by the use of minipackets. World demand for mustard is estimated at about 200 000 t annually (Lewis 1984). Dijon, France manufactures about half of the world's supply of processed "hot" mustard using brown mustard seeds (Stobart 1977).

Fig. 81.
Brown mustard *(Brassica juncea)*, from Beal (1915).

North America, particularly Canada, is the major producer of mustard seed in the world. Traditionally oriental and brown mustard each occupied about 25% of the total mustard crop (yellow mustard representing 50%). However, oriental mustard is increasingly grown. Brown mustard is mostly cultivated in Britain and European countries while in Japan oriental mustard is mainly grown (Anon. 1977). Production statistics for all types of North American mustard are given in the discussion of white mustard (*Sinapis alba*).

Cultivation Notes

Soil

Mustard performs best on loamy soils that are not prone to crusting. The Brown and Dark Brown soils of the Canadian prairies are excellent for growing mustard. Sandy or dry sandy loam soils are not recommended because moisture is often limited. The crop should not be sown where flooding may occur. Mustard plants prefer well aerated soils that do not become waterlogged. The pH should be near neutral (7.0), but the plants will grow in alkaline and slightly saline soils (Forhan and Tisdale 1988). Reported ranges of pH tolerance are 7.1-8.5 (Hackett and Carolane 1982) and 4.3-8.3 (Duke 1978).

Climate

Mustard withstands cool spring temperatures fairly well. If a spring frost occurs, 4-5 days may pass before the extent of damage is known. If the growing point of the plant is not killed, the plant will recover. Moisture is required throughout the growing season and indeed is beneficial at planting time to avoid the development of a soil crust that can cause problems for emerging seedlings. Good moisture and cool temperatures help extend the flowering period. A long period of blossoming usually increases fruit set, number of seeds per fruit, and yield (Dean 1987).

Propagation and Cultivation

Propagation is by seed planted early in the spring. Early seeding reduces the risk of damage of fruits by fall frost. Seeding after the first week of June is not recommended in the Canadian prairies. A seeding rate of 5-7 kg/ha is appropriate for brown and oriental mustard. Early weed control is very important for successful mustard production as young mustard seedlings do not compete well with weeds. Once established, the plants grow rapidly and shade out weed growth. Flowering begins 5-6 weeks after seedling emergence (Dean 1987).

Brown and oriental mustard are susceptible to various disease and insect pathogens. Flea beetles are the most troublesome insect. The crop may be attacked as soon as the young seedlings emerge, the insects chewing tiny holes in the leaves. Heavy infestations can severely damage or destroy the crop. Crop rotation is very important when growing mustards, with at least 4 years apart recommended in the rotation. Mustards can follow a cereal or canaryseed crop but should not be planted after buckwheat, flax, canola, or sunflowers. Mustard should not be grown within 2 years of sugar beets because it is a host of sugar beet nematode. Canola should not be grown on the same farm because both crops can be degraded (Dean 1987).

Harvest and Storage

Brown and oriental mustard are less resistant to seed shattering than yellow mustard and are usually swathed. When swathed, the crop should be cut just below the level of the lowest pods. This enables the swath to settle into the plant stubble and reduces the danger of it being blown by wind. Green seeds are detrimental to mustard grading so the crop should be left standing as long as possible. Swathing should start when 75% of the seeds of oriental mustard have reached their mature yellow color, and when at least 60% of the seeds of brown mustard have turned reddish brown. Swathing is conducted during periods of high humidity (early morning or late evening) to reduce pod shattering. Desiccants can be used when there are immature patches of mustard plants or green weeds present in the fields. Desiccation allows the crop to be combined without swathing. Oriental mustard is less susceptible to shattering than brown mustard after use of a desiccant. The yield of brown and oriental mustard is generally 10-30% greater per hectare than that of yellow mustard. Yields of the order of 1.2 t/ha have been reported (Hackett and Carolane 1982).

Mustard seeds require storage in a tightly closed bin. The maximum moisture content allowed is 10.5%. For long-term storage the moisture level should be under 9%, accompanied by a temperature below 20°C. The maximum drying temperature is about 43°C. The seed temperature must never exceed 49°C or damage will result. Mustard with a moisture content above 15% should be dried in two stages to avoid cooking and burning of the seeds (Forhan and Tisdale 1988). An internal deflector inside the bin spreads heavier immature material, reducing the chance of seed heating (Dean 1987). The Canadian grade standards for mustard seed were described by Forhan and Tisdale (1988).

As is obvious from the above, preparation of mustard is a highly industrialized activity carded out by specialists. It is possible, however, for the interested amateur to grow and prepare his own mustard. Alpine (1978) provides the following instructions. Because the seed pods drop their seeds readily at maturity, as soon as some of the pods have begun to open a large quantity of whole seed stalks should be picked and spread on a plastic or cotton sheet. These should be dried for several days (in the sun, if convenient). The next step is to flail them with a broom or baseball bat. The mixture of seed stalks, broken pods and seeds should then be winnowed. This can be accomplished by slowly letting the mixture sift through the fingers to fall as long a distance as can be conveniently arranged into a bucket, while the breeze (or an electric fan) blows away the chaff. The process is repeated until the seeds are clean. The mustard seeds can be used directly to garnish salads and to spice pickles and relishes. Prepared mustard, however, requires the grinding of the seeds. This can be done using the finest plate in a food chopper, a mortar and pestle, or simply by placing the seeds between two sheets of paper and grinding them down with a bottle. For those who think all this is too much trouble, keep in mind that the product produced will have no additives (like sugar and dyes), will keep indefinitely, and does not require canning jars and all the other paraphernalia needed to make preserves.

Example Cultivars

Oriental mustard: Cutlass, Domo, Lethbridge 22, Stoke, AC Vulcan, Forage.

Brown mustard: Blaze, Ekla.

Bettencourt and Konopka (1990) list institutions in various countries conserving germplasm of *Brassica juncea*. Genetic diversity is discussed in Anon (1981). Warwick (see Warwick and Francis 1994) provides a series of guides to wild species that can be used to improve cultivated stocks of *Brassica*.

Additional Notes

Chemistry

Water or moisture activates the enzyme myrosinase, causing the glycoside sinigrin to yield allyl?? and 3-butenyl isothiocyanates, glucose, and potassium hydrogen sulfate. These isothiocyanates are very pungent, having an irritating odor, and a sharply acrid flavor (Lewis 1984; Farrell 1985).

The essential oil of brown mustard is obtained by steam distillation of the press cake after it has been hydrolysed to release allyl isothiocyanate. A commercial oleoresin is prepared from a blend of brown mustard with yellow mustard (*Sinapis alba*), and sometimes black mustard (*B. nigra*).

Medicine

Brassica juncea is currently used in Chinese medicine (Duke and Ayensu 1985). The leaves are boiled in soups to treat bladder inflammations, and a broth is consumed to stop hemorrhage. Seeds are employed to treat abscesses, colds, rheumatism, and stomach disorders, and seed oil is used to treat eruptions, ulcers and tumors. Mustard plasters are discussed in the chapter on yellow mustard (*Sinapis alba*). Mustard oil (allyl isothicyanate), despite its acrid, irritating properties, is considered to be a safe, effective counterirritant (Tyler 1994).

A case of acute mustard seed toxicosis in cattle was reported in Saskatchewan (Kernaleguen et al. 1989). The cows had gained access to a large quantity of mouldy mustard seeds consisting of about 84% oriental mustard.

Nutrition

Brown mustard is considered to have substantial quantities of fat and protein (Hackett and Carolane 1982).

Curiosities

• The origin of the generic name *Brassica* has been explained in several ways (Prakash and Hinata 1980; Steam 1992; Pailler 1993). The most common interpretation is that the name is related to the Celtic *bresic*, variously interpreted as meaning horse, reflecting use as forage for horses (Pailler 1993), or cabbage, a reference to the removal of leaves from the stem for cattle fodder (Prakash and Hinata 1980).

• A Buddhist parable about the reality of death is centered about mustard seed (Mercatante 1988). After the passing of her only child, a woman sought medicine from the Buddha to restore her son to life. The Buddha instructed her to obtain a handful of mustard seeds from a house where no one had lost a child, husband, parent, or friend. When she was unable to find such a house, she realized that death is common to all humankind; she buried her son, and took comfort in the teaching of the Buddha.

• Over 1000 years ago, the monks of St. Germain des Prés near Paris were famous for growing mustard (Stobart 1977).

• Mustard lovers would no doubt have liked an invitation to a feast given by the Duke of Burgundy in 1336, where guests ingested 70 gallons (15.4 L) of mustard in one sitting (Stobart 1977).

• Pope Clement VII (1478-1534) loved mustard, and ate it at every meal. To obtain his favor, many offered him attractive mustard preparations. Such people were often derisively called "the Pope's mustard maker." This led to the origin of a French expression "Il se prend pour le

moutardier du pape" ("he thinks himself the Pope's mustard maker"), which is applied to vain people (Toussaint-Samat 1992).

• A Burgundian named Bornibus discovered a method of pressing mustard into dry cakes. These cakes were manufactured in Dijon, and in 1634 the vinegar and mustard makers were granted the exclusive right to make mustard in return for wearing "clean and sober clothes."

• In Germany, a bride ensured that she would wear the pants in her family by sewing mustard seeds into her wedding gown (Swahn 1991).

• Since 1934, Dijon mustard has become an appellation controlled by French Law (Stobart 1977).

• Part of the chemical structure of a "tear gas" used in Word War I is also part of the structure of the glycoside sinigrin, found in the seeds of black mustard (*B. nigra*) (Rosengarten 1969).

• In Tanganiyaka (now part of Tanzania) dried leaves and flowers of *B. juncea* were smoked like marihuana "in order to get in touch with the spirits" (Watt and Breyer-Brandwijk 1962).

Problems and Potential

Brown and oriental mustards are important crops in North America, particularly on the Canadian prairies. Production increased throughout the last decade and this trend may continue. The present predominant importation of almost all mustard seed to the U.S. from Canada is likely to continue, as U.S. farmers are not expanding production because of relatively low prices and availability of more remunerative crop options (Buzzanell et al. 1995).

Although *B. juncea* yields a high protein oilseed, it is not popular in normal feed and vegetable oil markets because of the strong flavor (Forhan and Tisdale 1988). Research in progress (e.g., Love et al. 1990) attempting to develop a low-glucosinolate, low-erucic acid canola-like mustard has the potential of considerably increasing the importance of the species in North America.

Selected References

Rosengarten (1969); Hackett and Carolane (1982); Farrell (1985).

Calamintha

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

Calamintha has about eight species of aromatic perennial herbs, sometimes woody at the base, that are native to Eurasia and North America. The genus is allied to *Satureja* (species of savory, treated in this book), and occasionally is included in it. *Calamintha* is also sometimes put in *Clinopodium. Calamintha sylvatica* and *C. nepeta*, discussed below, have been regarded as variants of a single species, or as constituting as many as six different species; the taxonomy of this group was clarified by Ball (1972*b*).

Calamintha sylvatica Bromf., common calamint of Eurasia, has been used for culinary purposes (Facciola 1990). The leaves have been employed in the preparation of zucchini and other vegetables, and for flavoring roasts and stews, while the flowers have been used in conserves. The taste of the leaves is not as pungent nor the fragrance as strong as that of *C. nepeta*, described below.

Seeds of *Calamintha graveolens* (Bieb.) Benth. (= *Acinos rotundifolia* Pers.) have been employed as a stimulant and as an aphrodisiac (Uphof 1968).

So-called calamintha oil is steam distilled from wild European *Calamintha clinopodium* Benth. (usually placed in *Clinopodium vulgare* L.), which has limited importance in perfumery (Arctander 1960). This herb is also used medicinally, and as a source of a yellow and brown dye (Uphof 1968). Additional information on this species is in the genus notes for *Ocimum*.

Calamintha Grandiflora (L.) Moench

Scientific (Latin) Synonyms

Melissa grandiflora L., *Satureja grandiflora* (L.) Scheele

English Names

Large-flowered calamint
Also: mint savory, showy calamint, showy savory
[**Note**: The common name "calamint" can be misleading, as it may be applied to other mint-like species. For example, *Satureja arkansana* (Nutt.) Briq. is referred to simply as calamint by Foster and Duke (1990). Some species called calamint may not be safe for consumption, and reliable identification is therefore necessary.]

Fig. 82.
Large-flowered calamint *(Calamintha grandiflora)*,
from Curtis (1787-present; #208).

French Names

Family: Labiées, famille de la menthe

Calament à grande fleur (m)

Description, Taxonomy, and History

Calamintha grandiflora is native to southern and southeastern Europe, Anatolia, and northern Iran. It grows to a height of 20-60 cm, has a strong and penetrating fragrance, and produces pink flowers 25-40 mm long. This species grows naturally in damp woods and scrub, often on limestone.

Uses

The leaves are used to brew a sweet, aromatic herb tea, and as a mint-like flavorant. The species is also a useful garden ornamental that is attractive to bees.

Recipe Sources

See recipes for *C. nepeta* on following pages.

Importance

Calamintha grandiflora is essentially a wild herb that is cultivated in home gardens as an ornamental and culinary herb. It is much more familiar in Europe than in North America, but is available in Canada and the U.S.

Cultivation Notes

Soil

Calamintha grandiflora grows naturally on calcareous soils, and is best provided with well-drained soil.

Fig. 83.
Large-flowered calamint *(Calamintha grandiflora)*, from Hallier (1880-1888).

Climate

This species is frost-hardy at least to -10°C. It grows well in a sunny location or in partial shade, and is somewhat tolerant of drought once established.

Propagation and Cultivation

Calamintha grandiflora can be reproduced by dividing established clumps, or from seed.

Harvest and Storage

No information was located. The comments provided for the next species, *C. nepeta*, should also be applicable to *C. grandiflora*.

Example Cultivars

Variegata (= Forncett Form)

Additional Notes

Chemistry

Souleles and Argyriadou (1990) found that the main constituents of the essential oil of *C. grandiflora* are pulegone (ca. 35%), menthone (ca. 20%), and isomenthone (ca. 15%). Carnat et al. (1991) found pulegone (ca. 28%), isomenthone (ca. 25%), neoisomenthol (ca. 24%), and menthol (ca. 11%). Baser and Özek (1993) reported numerous constituents, isopinocamphone predominating (ca. 53%). Flavonoids were studied by Souleles et al. (1991).

Medicine

This species has been used in Greek folk medicine as a stimulant, tonic, antiseptic, and antispasmodic (Souleles et al. 1991). The presence of pulegone, a toxic chemical, suggests that large amounts should not be consumed (see discussion of pennyroyal, *Mentha pulegium*).

Nutrition

No information was found.

Curiosities

• The generic name *Calamintha* comes from the Greek *kallis*, beautiful or excellent, and *mintha*, mint. Grieve (1931) wrote that it was given this attractive name because of an ancient belief in its power to drive away serpents and the dreaded basilisk - the fabled king of the serpents, whose very glance was fatal.

Problems and Potential

Large-flowered calamint is grown occasionally in Europe as a culinary ornamental of home gardens. It is scarcely known in North America, has no potential for

competing against the well-established mint species (*Mentha*), but might be grown commercially by culinary herb suppliers of local markets as an interesting novelty.

Selected References

No reference supplying substantial information on large-flowered calamint was located.

Calamintha Nepeta (L.) Savi

Scientific (Latin) Synonyms

Calamintha officinalis Moench, *Clinopodium nepeta* (L.) O. Kuntze, *Melissa calamintha* L., *M. nepeta* L., *Satureja calamintha* (L.) Scheele, *S. nepeta* (L.) Scheele (see Garbari et al. 1991 for additional synonymy)

English Names

Calamint, lesser calamint
Also: basil thyme, calamint, calamint balm, capmint, catnep, catnip (cf. catnip, *Nepeta cataria*, also treated in this book), field balm, mill mountain, mountain balm, mountain mint (cf. *Pycnanthemum*, also treated in this book, and known as mountain mint), nepitella
[In many texts, *C. nepeta* subsp. *glandulosa* (*C. officinalis*) is referred to as calamint, whereas *C. nepeta* subsp. *nepeta* is referred to as lesser calamint. As noted below, the distinction is questionable.]

French Names

Calament (m)
Also: baume sauvage, calament de(s) montagne(s), calament officinal, calamenthe, calaminthe, fausse marjolaine, mélisse des champs, menthe de montagne, millespèce, millespèle, pouliot de montagne

Description, Taxonomy, and History

Calamintha nepeta is native to southern Europe and the Mediterranean area, where several varieties have been recognized. The species has become naturalized in the eastern United States, where it occurs in waste places and along roadsides. It has been collected as far north as southwestern Quebec. This is a strongly aromatic, rhizomatous, bushy plant with greyish foliage, 30-90 cm tall, with white or lilac flowers 5-15 mm long, produced in midsummer. It is usually a smaller plant than *C. grandiflora*. Two of the wild subspecies, *nepeta* and *glandulosa* (Req.) P.W. Ball (= *C. officinalis* Moench), are recognized in cultivation, the latter with smaller leaves and fewer flowers on the flowering stalk. However, "it is well known that there are difficulties in distinguishing between the two subspecies of *Calamintha nepeta,*" and "new

Fig. 84.
Lesser calamint *(Calamintha nepeta subsp. nepeta)*,
from Syme et al. (1863-1886).

morphoanatomical and phytochemical studies suggest... that these are seasonal morphs rather than discrete taxa and that they do not deserve recognition" (Garbari et al. 1991; also see Pagni et al. 1990).

Calamintha nepeta was used in Roman kitchens to remove the fetid odor and deteriorated taste of meat that had started to spoil (Morton 1976).

Uses

This species is a regional favorite in Tuscany, where its distinctive minty flavor is added to mushroom dishes and green vegetables (Richters 1994). The leaves are said to taste and smell like spearmint (*Mentha spicata*, also treated in this book), but warmer (Grieve 1931; Lancaster 1990). The strongly aromatic odor and pleasantly pungent flavor

go well with roasts and stews. The flower tops can be made into a conserve (Sanecki 1974). The leaves are also used to brew a sweet, aromatic herb tea.

The species is also suited to use as a rock garden ornamental, although Macleod (1968) commented "some gardeners prefer to raise the more showy *C. grandiflora*." Calamint has one of the longest flowering seasons of perennial ornamentals, beginning in midsummer and often lasting until frost. It makes an excellent edging to sunny borders and beds (Lancaster 1990). The species is quite attractive to bees and other nectar-seeking insects, and so is appropriate for wildlife gardens.

Recipe Sources

Leyel (1938) presents recipes for Syrup of calamint and Conserve of calamint.

Importance

Calamintha nepeta is essentially a wild herb that is cultivated in home gardens as an ornamental and culinary herb. It is consumed as a herbal tea and mintlike spice

Fig. 85.
Lesser calamint
(Calamintha nepeta subsp. nepeta), from Hallier
(1880-1888).

throughout Turkey (Akgül et al. 1991). It is much more familiar in Europe and Turkey than in North America, but seeds are available in Canada and the U.S.

Cultivation Notes

Soil

Calamintha nepeta grows naturally on calcareous soils. In cultivation "it is less exacting in its soil requirements, being suitable for most garden soils, especially those well drained" (Lancaster 1990). Abou Dahab et al. (1983) found that high levels of phosphorus fertilizer increased pulegone percentage in the oil (see comments regarding pulegone for large-flowered calamint).

Climate

This species tolerates dry conditions, and is frost-hardy at least to -10°C. It grows best in full sunlight, but will tolerate slight shade.

Propagation and Cultivation

Calamintha nepeta can be reproduced by dividing established clumps, by stem cuttings, or from seed.

Harvest and Storage

Fresh leaves and young shoots can be harvested in season. The foliage of the plants can be harvested and dried like catnip: the tender herbage is cut off, dried in the shade, stripped, and crumbled by hand-rubbing or screening, and stored in jars.

Example Cultivars

No information found.

Additional Notes

Chemistry

Main constituents of the essential oil of *C. nepeta* subsp. *nepeta* have been reported to be pulegone (ca. 40%), menthone (ca. 25%), and isomenthone (ca. 25%) (Souleles et al. 1987; Souleles and Argyriadou 1990). Main constituents of *C. nepeta* subsp. *glandulosa* have been reported to be the two diastereoisomers of piperitone oxide (ca. 55%) and bisabolene (ca. 9%) (Kokkalou and Stefanou 1990; Stephanou [sic] and Kokkalou 1990). Similarly Kirimer et al. (1992) reported piperitone oxide (ca. 25%), piperitenone oxide (ca. 44%), and limonene (ca. 13%). Pulegone has also been reported from subsp. *glandulosa* (Kirimer et al. 1992). Akgül et al. (1991) found pulegone (42%) and piperitenone (40.4%). Pooter et al. (1987) reported that the two subspecies produced essential oil with the same constituents. These analyses have been based

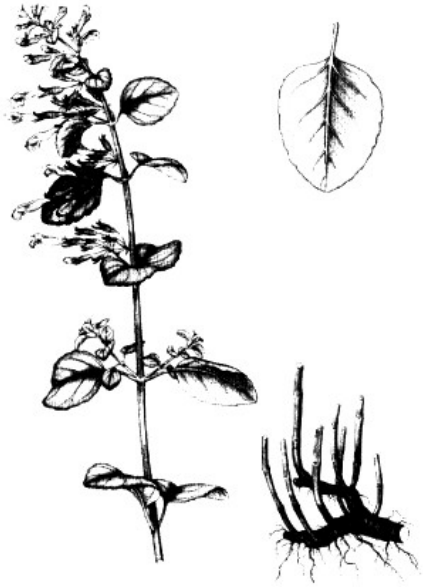


Fig. 86.
Lesser calamint *(Calamintha nepeta subsp. nepeta)*, from Bulliard (1784).

on limited samples, and additional research may reveal variability among populations and quantitative differences between the subspecies.

Medicine

In folk medicine in Europe, this species has been used as a tonic, and to treat nervous complaints, stomach problems, jaundice, worms, and leprosy (Grieve 1931). Fournier (1947-48) noted the plant has been used as a stimulant, tonic, antiseptic, and to treat spasms. Souleles and Shammas (1985) reported that the leaves and flowers are effective as an antiseptic, antispasmodic, and tonic. See comments for large-flowered calamint regarding the possibly dangerous levels of pulegone.

Nutrition

No information found.

Curiosities

• A cordial tea prepared from calamint was once widely used as a remedy for flatulence (Macleod 1968).

Problems and Potential

See comments for previously treated species.

Selected References

Grieve (1931); Lancaster (1990); Pagni et al. (1990); Garbari et al. (1991).

Fig. 87.
Lesser calamint *(Calamintha nepeta subsp. glandulosa)*, from Lamarck and Poiret (1791-1823).

Fig. 88.
Pot marigold *(Calendula officinalis)*, from Köhler (1883-1898).

Calendula

Family: Compositae (Asteraceae)

(sunflower family)

Genus Notes

Calendula has about 15 species of annual or perennial herbs, sometimes shrubs, native from the Canary Islands through south and central Europe and North Africa to Iran.

Calendula Officinalis L.

Note:

Although requiring effort to collect, the petals are generally the most palatable part of daisy-like flowers used for culinary purposes. It is not essential to separate the petals to produce palatable marigold dishes or tea, but the petals alone usually produce much tastier results.

English Names

Pot marigold
Also: bull flower, butterwort, calendula, care, cowbloom, common marigold, death-flower, drunkard, garden marigold, gold, golden flower of Mary, gouls, goulans, king-cups, holygold, marigold, marybud, poet's marigold, publican and sinner, ruddles, Scotch marigold, shining herb, solsequia, summer's bride, sun's bride, water dragon, yolk of egg
[Many of these names are old fashioned, and are taken from Jones (1962) and Marcin (1983). Grieve (1931) lists additional old-fashioned English names.]

French Names

Family: Composées, famille de la marguerite
Souci des jardins (m)
Also: (fleur de) tousles mois [literally, every month, in allusion to the long flowering period], fleur du soleil, gauche fer, grand souci, passe-velours jaune, souci, souci commun, souci cultivé, souci officinal
[Souci is applied both to species of *Tagetes* and *Calendula*. Just as in English (see below), the common name may not suffice to specify what species is being referred to, and the scientific name may be required.]

"Marigold" is part of the name of species in several genera; it is as commonly applied to species of the genus *Tagetes* (particularly French marigold, *T. patula* L. and its hybrids) as to *Calendula*, and therefore to avoid ambiguity it may be necessary to use the scientific name. In Canada and the U.S., the large variety of "marigolds" grown in abundance in gardens are usually species of *Tagetes*. Both *Calendula* and *Tagetes* are sometimes used to brew

Fig. 89.
Pot marigold *(Calendula officinalis)*,
from Thomé (1903-1905).

teas, although the former is much more widely used for culinary purposes. However in Mexico and the southwesteru U.S., *Tagetes* is much more widely used for culinary purposes than *Calendula* (Widrlechner, personal communication). (Also see the discussion of *Tagetes* in this book.)

Description, Taxonomy, and History

Calendula officinalis is a considerably branched annual [sometimes an overwintering biennial according to Hanau (1994)] growing 30-60 cm tall. The blooms are 4-10 cm across, varying through shades of yellow, orange, and orange-red. The stem may be woody at the base, and the tap root is about 20 cm long. It is uncertain whether *C. officinalis* arose in cultivation, or whether it once had

a natural distribution range. According to Hanau (1994), it originated in northwestern Africa. Heywood and Zohary (1995) stated that "its origin is still unclear but may be S.W. Europe." The species is widely cultivated in southern Europe, and plants also grow wild there, although these perhaps arose from escapes from cultivation. *Calendula officinalis* also sometimes escapes and persists in the wild in warm areas of other parts of the world (for example, in Turkey and California). Pot marigold was known to ancient Indian and Arabic cultures, followed by the classical Greeks (Stuart 1979). It seems to have been used by the classical Romans as a substitute for saffron, and for the same purpose ever since (Loewenfeld and Back 1974, Stobart 1977). The Romans also used the plant medicinally (see Medicine). Pot marigold has been known in cultivation at least since the 12th century A.D. In sixteenth century Europe, especially in Holland, grocers and spice-sellers had barrels filled with dried marigold petals, which they sold in large quantities for use in drinks, broths, and medicaments (Bianchini and Corbetta 1977). In the 18th century in Europe it was so highly regarded as a culinary herb that it was sometimes sown as commonly as spinach is today (Bryan and Castle 1974). In recent years, however, pot marigold has been grown mostly as an ornamental, not for edible use.

Flowers of the sunflower family are tiny and aggregated into flower heads. The flower heads, not the individual flowers, are commonly referred to as flowers by most people, except by botanists. As with the majority of species in the sunflower family, the outermost flowers in the flower heads each bear a prominent strap-shaped petal, while the petals of the central flowers in the head are inconspicuous (except in many cultivars whose flowers have been doubled by selection). It is the prominent, peripheral petals that are of principal interest for culinary purposes. Pot marigold "is one of the most decorative of all herbs" (Crockett and Tanner 1977), and many ornamental cultivars are available, some with doubled flowers. The single flowers are preferred over the doubled forms for culinary use, although the latter produce more of the prominent petals (Morton 1976).

Uses

Pot marigold petals, fresh or dried, give a delicate, aromatic, salty bitterness (some say sweetness) and a strong color to dishes. The petals add color and texture rather than strong flavor to drinks and foods (Bryan and Castle 1974). The flowers or their extracts are used to color and flavor puddings, soups, stews, salads, omelets, buns and cakes. Pot marigold has been called "poor man's saffron" (true saffron is *Crocus sativus*, also treated in this book).

Fig. 90.
Pot marigold *(Calendula officinalis)*,
prepared by M. Jomphe.

As a substitute for saffron, pot marigold gives a similar color, but a different taste. Marigold powder, made from dried or fresh petals, is used like saffron to season seafood, chowders, rice, soups, stews, roast meats, and chicken (Duke 1985). Instead of adding petals directly to most dishes in the home kitchen, the petals are often soaked in water or milk, and the strained liquid is used for coloring and flavoring. The petals must be well bruised or cut to give off color. For tossed salads, fresh flower petals are best chopped and sprinkled on. Both flower heads and petals can be used for making herbal tea, but the petal tea is less bitter. Pot marigold extract is used by industry for culinary purposes, for example coloring butter and cheese, and flavoring soft drinks, ice cream, candy, and baked goods (Morton 1981).

The fresh leaves have a salty, bitter taste; they used to be eaten as a salad, and are still sometimes consumed. "The leaves are advocated in salads, although they are rough, tough, and bitter to my taste" (Stobart 1977). "The leaves are edible, but have too strong and acrid a flavor to be pleasant" (Garland 1979).

Pot marigold is widely grown as a garden annual, known for blooming during much of the season. It is also grown under glass by florists for providing cut flowers. Pot marigold has been used medicinally, and used to be employed as a source of yellow dye. Rinzler (1990) provides instructions for extracting and using an orange dye for wool from the flowers. The dye can be extracted and used to color poultry products, egg yolk and milk products (Hanau 1994). The seeds are an important source of fatty acids, and have some potential for use as an industrial oil (see Chemistry). Oil from the seeds is used in soaps, cosmetics, and perfumeries (Rahman et al. 1990). According to Tyler (1993a), the carotenoid pigments have some value as coloring agents in cosmetics, and the volatile oil is useful in perfume.

Recipe Sources

Crowhurt (1973) gives recipes for Marigold buns, Marigold chowder, Marigold omelette, Marigold rice, and Marigold soup. Smith (1973) provides many recipes for marigold, including Marigold party sticks, Marigold cheese soup, Marigold cucumbers, Marigold fondue, Marigold quiche, Marigold rice, Zucchini marigold style, Marigold onions, Celery marigold, Marigold muffins, Crab-meat-marigold sandwiches, Marigold custard, and Marigold mincemeat pie. Bryan and Castle (1974) have recipes for Calendula egg spread, Calendula ramekin, and Cold cream cheese soup. Leggatt (1987) gives recipes for: Corn and marigold fritters; Chestnut and mushroom soup with marigolds; Eggs in a pot with chive and marigold flowers; Fennel salad with pansies and marigolds; Fresh crab salad with marigolds; Moroccan chicken with pistachios, apricots, roses and marigolds; and Sweet lamb casserole with pearl barley and marigolds. Bremness (1988) presents recipes for Baked ham with marigold glaze and Tagliatelle with marigold sauce aurore. Barash (1993) has nine pot marigold recipes, including Calendula rice, Calendula potatoes, and Calendula biscuits.

Fig. 91.
Pot marigold , from Sturm (1900-1907).

Other recipes are: Marigold custard (Fox 1933); Marigold buns (Grieve 1933); Marigold cordial (Grieve 1933; Leyel 1938); Marigold cheese (Leyel 1938); Marigold rice (Loewenfeld and Back 1974); Marigold arroz con pollo (rice with chicken) (Owen 1978); Greengage and marigold jelly (Garland 1979); Marigold wine (Stuart 1979); Beef stew with marigolds (Boxer and Back 1980); Marigold tea (Marcin 1983); Calendula petals in oil (Adams 1987); Four flowers vinegar (Hutson 1987); Golden corn muffins with calendula petals (Belsinger 1991); Marigold and nasturtium leaf sandwiches (Holt 1991).

Importance

The main economic value of pot marigold today is first as an ornamental, second as a drug plant, and third as a minor culinary herb. As an ornamental, pot marigold has been called "the queen of cottage gardens" (Macleod 1968). The species has recently been cultivated for extract of drugs on a limited scale in Germany, Russia, and the Netherlands. It has been experimentally cultivated as a source of oil in Europe (Beerentrup and Robbelen 1987) and in North Dakota (Berti and Schneiter 1993).

Cultivation Notes

Soil

Pot marigold grows well on a variety of soils, but a light, sandy, well-drained, moderately rich, fairly moist soil is recommended (Sievers 1948). The range of tolerance of pH is 4.5-8.3 (Duke and Hurst 1975; Duke 1978). Perry (1974) recommends a neutral soil.

Climate

This species endures light frosts and light snow in autumn, and although originating from southern Europe is hardy in temperate and cool climates. Full sun is preferred, although light shade will be tolerated. Watering should be done in response to apparent need.

Propagation and Cultivation

Pot marigold is established by seeds. The seedlings have rather large succulent leaves that wilt easily if transplanting is attempted. If left in a location, the plants will self-sow. The seeds can be planted at a depth of about 6 mm, with seedling emergence usually in 8-12 days (Wang et al. 1993). Removing side branches causes the plant to grow taller and have larger blooms, and removing dead flower-heads keeps the plant flowering throughout the summer.

Pot marigold can be grown as a house plant. Potted plants should be brought indoors several days before severe frost. Night temperatures of about 10°C and day temperatures of 15-18°C are desirable (Crockett and

Tanner 1977). Soil should be kept barely moist, definitely not soggy, which may cause roots to rot. At least 5 hours of direct sunlight or 12 hours of strong artificial light should be available.

Harvest and Storage

Pot marigold petals should be collected as the flowers are opening, and should be dried quickly. [The flowers can be washed first, and dried somewhat with paper towels; however, Weiss (personal communication) recommends against washing since this might cause too much damage.] The flowers can be spread out thinly on screens in the shade to dry. Bryan and Castle (1774) recommend drying in a dark, warm, dust-free area. Good ventilation is necessary to prevent loss of color and flavor. Crockett and Tanner (1977) recommend that while drying the petals should not be allowed to touch each other, and they should be turned frequently until they are crisp. Belsinger (1991) advocate drying the petals on paper rather than screens, as they tend to stick to the latter. When dry, the petals can be separated easily. Petals can be stored in an airtight jar, with an envelope of desiccant. Bryan and Castle (1974) suggest gathering the flowers before they receive the sun, washing them, pulling the petals off, removing moisture with paper towels, and placing them in a plastic bag in the refrigerator until ready for use.

Smith (1973) suggests the following harvest procedures. For fresh petals: pull off the petals, cut off the white (or pale greenish) "heels" which could give a bitter taste, wash thoroughly but gently, and drain well. For dry petals: wash and dry the whole flowers, remove the petals and cut off the white heels as above, spread the petals out thinly on brown paper on a cookie sheet, and place in a barely warm oven, or dry on a screen out of direct sunlight but in the path of a warm air current. Smith also suggests pulverizing some dried petals and placing them in a salt shaker.

As noted in Chemistry, the seeds have some potential as an industrial oil. Unfortunately while seed yield is good, the seeds are shed easily and are difficult to collect. Breemhaar and Bouman (1995) found that seeds were best harvested with a combine harvester after chemical desiccation.

Example Cultivars

Bon Bon Orange, Chrysantha, Hen and Chickens, Indian Prince, Kablouna Gold, Kablouna Orange, Kablouna Yellow, Lemon, Orange, Orange Prince, Prolifera, Sun Glow, Variegata (for information on most of these, see Facciola 1990 and Huxley et al. 1992). Creasy (1988) recommends the large-petalled Pacific Beauty as easy to use in the kitchen.

Additional Notes

Chemistry

Pot marigold flowers contain bitter principles, the coloring substance calendulin (a carotenoid), saponins, malic and ascorbic acids, mucilages, and small quantities of volatile oil (Loewenfeld and Back 1954; Furia and Bellanca 1975; Stuart 1979; Hanau 1994). Notable chemical constituents of pot marigold include arnidiol, carotin, calenduline, cerylalcohol, flavoxanthin, lycopene, oleanolic acid, rebixanthin, and violaxanthin (Duke and Ayensu 1985). The dried petals contain stigmasterol, sitosterol, 2-8-isofucosterol, campesterol, 2-4-methylene cholesterol, and cholesterol (Duke and Ayensu 1985). The seeds contain about 14-20% oil, including 55-61% calendic acid, which has led to the species being considered as a candidate for industrial oil production (Beerentrup and Röbbelen 1987; Breemhaar and Bouman 1995).

Medicine

The classical Romans employed the juice of fresh flowers to treat warts (Huxley et al. 1992), a use still found in folk medicine. By the Doctrine of Signatures (whereby plants intimate their usefulness by some characteristic), the yellow flowers suggested the plant was useful for jaundice. Pot marigold flowers have been used since ancient times in folk medicine to treat a variety of other conditions, for example internally to treat spasms, suppressed menstruation, fevers, smallpox, measles and various other children's ailments, and externally to treat wasp and bee bites, sprains, wounds, varicose veins, and inflamed eyes (Grieve 1931; Tyler 1993*a*). Leaves have been used in folk remedies for cancer (Duke 1985). During the American Civil War and in World War I, the plants were used as a styptic to control bleeding (Huxley et al. 1992). Fresh flowers used to be rubbed on bee and wasp stings to relieve pain and swelling (Morton 1976). Active principles responsible for the alleged anti-inflammatory and wound-healing properties remain unknown (Tyler 1993*a*, 1994). However, Hanau (1994) attributes the anti-inflam-matory effect to triterpene diols, notably faradiol. Although pot marigold has been used to treat numerous conditions in western medicine, it is considered essentially obsolete as a pharmaceutical by some (e.g. Duke 1985). The species is apparently non-toxic (Tyler 1993*a*).

In current Chinese medicine, the plant is used to medi-cate bleeding gums and piles, and tinctures of the flowers are used to treat a variety of ailments, including bruises, cholera, cramps, fevers, flu, jaundice, sprains, stomach ache, syphilis, toothache, tuberculosis, typhus, ulcers, and wounds (Duke and Ayensu 1985).

Fresh plant material contains the analgesic salicylic acid, while roots contain inulin, a natural sweetener that may be consumed by diabetics in moderate amounts without serious increase in blood glucose (Duke and Ayensu 1985). (Inulin is not digestible and can produce flatulence; Widrlechner, personal communication.)

Nutrition

Pot marigold is thought to have high vitamin A and C content (Duke and Ayensu 1985) and, according to Rahman et al. (1990), it has been used as a commercial source of provitamin A. However, Rinzler (1990) states that pot marigold is not considered a good source of vitamin A.

Fig. 92.
Pot marigold *(Calendula officinalis)*,
from Vilmorin-Andrieux et C^{ie} (1883).

Curiosities

• The generic name *Calendula* comes from the Latin *calendae*, the first day of the complicated ancient Roman month, by which days were counted backward to the ides (the 15th of March, May, July, and October, the 13th of other months). The Romans said pot marigold was in bloom on the calends of every month (Grieve 1931).

• The word "marigold" is a corruption of the Anglo-Saxon *merso-meargealla*, the marsh marigold (*Caltha palustris* L.). Because of the "mari" in marigold, it became associated with the Virgin Mary and Queen Mary (Grieve 1931). According to legend, this was the flower favored and worn by Mary (Marcin 1983).

• The French name *gauche-fer*, meaning left-hand iron, was coined because the brilliant yellow madgold flower was thought to resemble the polished shield worn by warriors on the left arm (Jones 1962).

• Yellow is the color of jealousy, tracing to a mythological origin of the marigold (Gibbon 1941). Four wood nymphs were in love with the sun-god Apollo, the most attractive of all the gods that dwelled on Mt. Olympus. Diana, sister of Apollo, became angry with the quarrels of the nymphs, and turned them into marigolds.

• Flowers of pot marigold tend to open at sunrise, and close in the afternoon (remember that blooms of the sunflower family are aggregates of tiny flowers, and large petals are often evident only on the periphery of the flower-head; doubled flowers, with large petals throughout the flower-head, don't noticeably exhibit the phenomenon). This is recorded in old English literature (Grieve 1931), for example by the English poet Chaucer (1340?-1400) in his *Winter's Tale*:

> The Marigold that goes to bed wi' th' sun,
> And with him rises weeping.

• In German folklore, rain was predicted if the flowers remained closed after 7 a.m. (Hanau 1994).

• In India, Buddhists held pot marigold sacred to the goddess Mahadevi, who carried a trident emblem adorned with the flowers, while her followers crowned themselves with marigolds at her festival (Fox 1933).

• Marigold was commonly used as an aphrodisiac, and thought to have gmat significance in love. Planting mad-gold in the footsteps of a loved one was supposed to tie him to his beloved (Hanau 1994).

• According to an old legend, dreaming of pot marigolds foretold of marriage, riches and success (Fox 1933).

• Another old legend, in Brittany, held that if a maiden touches a pot marigold with her bare foot she would be able to understand the language of birds (Fox 1933).

• In the Middle Ages in Europe it was believed that those who wore marigolds would have a vision of anyone who had robbed them (Jones 1962).

• According to Gabriel (1975) "If one picks a flower, a remarkable smell of putrefaction remains on the hand, derived from a resin."

• The pigmentation of ornamental fish in captivity can be intensified by adding *Calendula* to regular fish food (Hanau 1994).

Problems and Potential

Pot marigold is grown primarily as a garden ornamental which can serve also as a minor culinary plant. The flowers have limited commercial significance for their oil, used for culinary and other purposes. As the plant is commercially cultivated for harvest of the oil on a minor scale in Europe, the possibility exists that the same could be done in North America. The petals are sometimes marketed as a drug, but as the flowers must be collected by hand it has long been doubtful that the species can be economically grown in North America (Sievers 1948).As noted above, the seeds have some potential as an industrial oil, useful for paint and varnish additives (Breemhaar and Bouman 1995).

Selected References

Grieve (1931); Loewefeld and Back (1974); Hanau (1994).

Capsicum

Family: Solanaceae (potato family)

Warning

Hot peppers can irritate skin and eyes; in large doses chiles may cause stomach and intestinal irritation.

Precautions

When handling hot peppers, avoid touching eyes, sensitive areas, or cuts. Wear rubber gloves, especially when preparing large quantities. Wash hands well, also knife and chopping board, in chlorine and water (as explained below, soap and water will not get rid of all of the capsaicin). If gloves have not been worn, a nail brush may be necessary to remove the oil from under the fingernails (Brennan 1981). Removing veins and seeds (and especially the placenta, as discussed below) will lower the hotness of chile peppers; so will soaking them in cold water with a little vinegar. Some Mexican cooks reduce the pungency of chiles by soaking peeled, roasted fruits in salted water for several hours, then rinsing them thoroughly (Hansen 1980). Chile meals can also be made less hot by substituting sweet green pepper for half of the hot chile required in the recipe. Leonard (1971) advised that chiles should first be rinsed in cold water, not hot, as the latter may make fumes rise that could irritate one's nose and eyes. De Witt and Gerlach (1989) note that some people are extremely sensitive to chile pepper fumes, and so when preparing chiles indoors by grinding, roasting or cooking, it is advisable to provide good ventilation. These authors also advise that should eyes become irritated, they should be flushed many times with water. The following advice should not be taken as a substitute for seeking medical attention in the case of serious reactions.

What to do about a Skin Reaction

Capsaicin is the most significant chemical compound responsible for the capacity of chili to cause a burning, painful sensation, both externally and internally (for a fuller explanation of capsaicin and other capsaicinoids, see Chemistry). Because it is essentially insoluble in cold water and only slightly soluble in hot water, traces on the hands can be transferred accidentally to sensitive mucous membranes well after the initial contact (Tyler 1993). Romantic activity after handling chile could be hotter than anticipated! Following work with hot peppers it is advisable to wash one's hands before as well as after using the rest room! Cold water provides only temporary relief. As normal washing with soap will not remove capsaicin well, it has been recommended that when necessary this chemical be removed from the hands by washing with vinegar (Castleman 1991; capsaicin is soluble in vinegar) or a mild chlorine household bleach solution (one part common bleach to five parts of water according to Andrews (1984); a stronger solution does not seem to improve removal of the capsaicin). Alcohol on the skin may also be effective (Andrews 1993*a*). De Witt and Gerlach (1989) suggest that capsaicin-burned skin should be soaked in ordinary cooking oil or rubbed with vegetable shortening. Two commercial compounds, Preparation H and Mineral Ice, reduce the burning sensation on skin (Bosland, personal communication).

What to do about an Oral Reaction

Norman (1990) offers the following advice to those who have an oral reaction to chile: "soothe a sore mouth with plain rice, bread or beans. Do not drink: it will make the burning worse." Rinzler (1990) also notes that drinking iced water doesn't cool the burning sensation caused by eating a chile-flavored dish because of the insolubility of capsaicin in water. She recommends drinking alcohol (beer) or consuming milkfat (such as whole milk), which can ease the pain in the mouth. Andrews (personal communication) suggests that at least some psychological relief may be obtained by drinking cold water, since this lowers the temperature, but that this will not relieve the pain. Casein-containing foods, such as milk, cheese, butter, and yogurt, reduce the effects of capsaicin through a detergent effect (Andrews 1993*a*). Andrews (1993) states that capsaicin is soluble in alcohol, and using vodka as a mouthwash and gargle may be effective for a burning mouth. Bosland (personal communication) is of the opinion that alcohol is ineffective, although if one consumes enough one may forget about the heat! Milk seems to be a beverage of choice to reduce the heat of hot chile dishes. Richardson (1990) offers the following remedies for burning mouths: cooked rice, milk, ice cream, yogurt, and sugar or sweets.

Genus Notes

There are about 25 species of *Capsicum* (Eshbaugh 1993), which are perennial shrubs native to Mexico, Central and South America. In addition to *C. annuum, C. chinense*, and *C. frutescens* discussed below, two other species have been domesticated and are cultivated for their fruits. *Capsicum baccatum* L. var. *pendulum* (WIlld.) Eshbaugh, known as (Peruvian) pepper, uchu, pimentchien, cherry capsicum, and aji, is cultivated in South America, and is also grown to a limited extent in the U.S. Both wild and domesticated forms are known, with pungent (or very rarely sweet), and large and small fruits, often marketed as chilies. *Capsicum pubescens* R. & P., known as apple

chile, rocoto, and locoto, is cultivated at higher elevations from Bolivia to Mexico, and in southern California, but has no commercial potential in temperate climates (Heiser and Pickersgill 1969; Smith et al. 1987). This high altitude plant tolerates light frost, and some cultivars can be grown as annuals (Facciola 1990).

Capsicum annuum, C. chinense, and *C. frutescens*, treated as separate species below, are arguably separable and there has been considerable debate over whether and how they may be recognized as separate species [for a summary, see Eshbaugh (1993), who described the inter-grading complex as "a most difficult taxonomic morass"].

The name "pepper" is applied to the fruits of *Capsicum* irrespective of whether they are used as a vegetable or spice (the phrase "spice pepper" in this book refers to the pungent peppers, which are discussed in detail in this chapter). *Capsicum* pepper should not be confused with the commonly used spice also known as "pepper," obtained from *Piper nigrum* L. (the source of black and white pepper), which is grown chiefly in southern Asia. Some other species of *Piper* are also used as spices.

Several other unrelated species also have "pepper" in their name. Melegueta (or Guinea) pepper (*Aframomum melegueta* (Rosc.) K. Schum.) is a cultivated tropical plant originating from west Africa, used in the spice trade, for example for flavoring ice cream, candy and soft drinks. *Xylopia aethiopica* (Dun.) Rich., a tropical African tree, is the source of African or negro pepper, once much used in Europe. Allspice (*Pimenta dioica* (L.) Merr.), is sometimes called Jamaican pepper. The genus *Zanthoxylum* (many species of which are called prickly ash) has several species which furnish spices called pepper. *Zanthoxylum piperitum* DC., Japan pepper or Japanese pepper, is a shrub native to and cultivated in Korea, Japan, and northern China. Its bark, unripe fruits, and seeds are used as seasoning, although considered harmful if consumed habitually (Morton 1976). *Zanthoxylum simulans* Hance, Szechwan pepper or Chinese pepper, is a shrub or tree of China. Its fruits produce more pungent whole or ground spice than black pepper (Facciola 1990). *Zanthoxylum armatum* DC. (*Z. alatum* Roxb.), a native shrub or tree of southern Asia, is another "Chinese pepper" used in China and India as seasoning (Facciola 1990). *Zanthoxylum rhetsa* DC., another tree of southern Asia, is called Indian pepper, and its seeds are also used as a pepper substitute (Morton 1976). *Schinus molle* L., pepper tree or Peruvian pepper, is a native of Peru grown in California, Mexico, Guatemala, and the subtropics of the Old World. The dried, roasted berries are used as a substitute for or adulterant of pepper (Morton 1976). The fruit is sweet, but if too much is ingested the result may be intestinal inflammation and hemorrhoids (Morton 1976).

Capsicum Annuum L.

English Names

Chile, chili, chilli
Also: chillie, chili pepper, chilly, hot pepper, pepper
[See Curiosities for derivation. Most of the English-speak-ing world uses the term chilli. However, in North America, the Spanish *chile* and the anglicized *chili* are by far the most popular terms; for consistency, *chile* is used here. Andrews once (e.g., 1986) recommended *chile*, but more recently recommends *chilli* (e.g., Andrews 1993*a*). The term *chili* (short for chili con came) is also commonly applied to a variously concocted stew of meat or beans in a red pepper sauce; some pepper specialists prefer to reserve the term chili for this dish.]

French Names

Family: Solanacées, famille de la pomme de terre
Chile (m)
Also: chilli [+variants such as: cayenne pepper = piment de cayenne, cayenne (cf. *C. frutescens*); paprika = paprika (Maurais 1976)]

Description, Taxonomy, and History

Capsicum annuum is a herbaceous annual in temperate regions but may become a woody perennial in warmer climates. The wild forms that are native to tropical and subtropical regions are perennials. This is the most widely used species of *Capsicum* in the world, and includes sweet (or bell) peppers, as well as many forms of pungent peppers. A variety of fruit types and degrees of pungency have been selected. Domesticated plants have been placed in var. *annuum* (Andrews 1984). The wild *C. annuum* var. *glabriusculum* (Dunal) Heiser & Pickersgill [*C. annuum* var. *aviculare* (Dierb.) D'arcy & Eshbaugh according to D'Arcy and Eshbaugh (1973)], commonly called bird pepper, bird's-eye pepper, and chiltepín, is considered to be most like the progenitor of the domesticate (Pickgersgill 1971). This is a herb or small shrub to 2 m tall, found from the southern U.S. south to northern Peru, and widespread in the Caribbean (Andrews 1984). Facciola (1990) lists eight "cultivars" of this; some of these are simply wild collections that have been assigned a name (and therefore they are not like most cultivars, which are noticeably selected for some characteristics).

Although the archetypal hot pepper is long, thin, and bright red, peppers of other colors and shape can also be devastatingly pungent. A modem horticultural classification of *C. annuum* peppers grown in the U.S. by Smith et al. (1987) includes many forms used as spices, seasonings, and vegetables. A discussion of peppers used primarily as

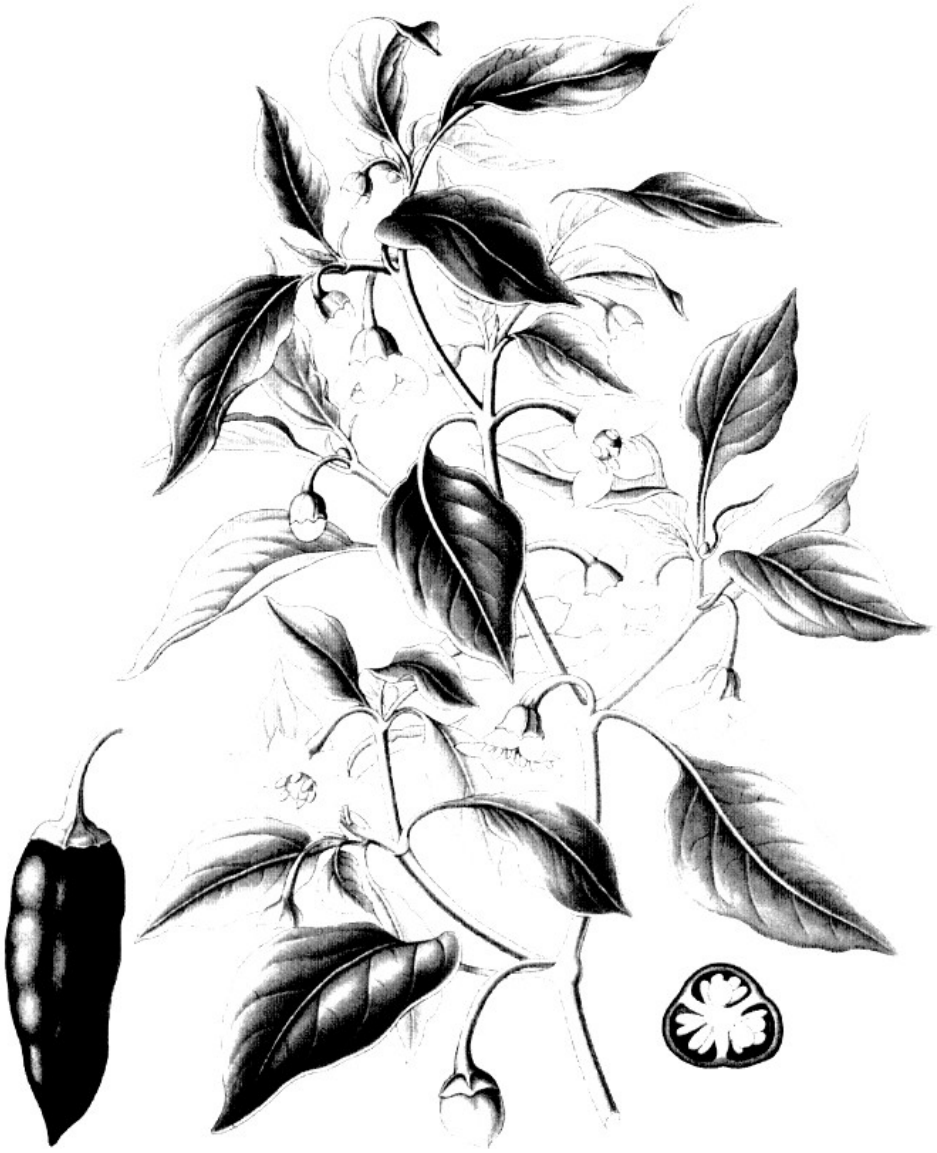


Fig. 93.
Chile pepper *(Capsicum annuum)*, from Köhler (1883-1898).

vegetables appears in Munro and Small (1997). The spice forms are selections found in the groups described below. Some new F_1 hybrids, i.e., first generation hybrids, may not fall clearly into these groups.

New Mexican (*Anaheim, Long Green*) *Chile group*: This group includes long green or red types of chile that are mildly pungent to sweet. These forms are widely used for dried chile peppers, both whole and ground, and may also be canned or added to sauces and salsas. North American paprika is mostly made from these, while imported paprika is made from quite different cultivars.

Ancho group: The members of this group have thin-walled, heart-shaped, slightly sweet to mildly pungent fruits that are utilized green for stuffing, ground, or as whole dry fruits.

Cayenne group: Selections in this group have long, slender, green to red, highly pungent fruits and include the "cayenne" peppers.

Jalapeño group: This group has elongated, dark green, highly pungent fruits and includes the jalapeño of commerce. Jalapeño's are employed fresh, or are canned or added to sauces. Smoked peppers are called chipotles, and are widely used (Andrews 1993*a*). The name of the jalapeño chile traces to the town of Jalapa, Veracruz, Mexico (Bosland 1992).

Long Yellow Wax group (*Hungarian*): These have fruits greater than 8.8 cm long, with both pungent and non-pungent selections that are used fresh or pickled and added to sauces and relishes.

Pimiento group: Pimiento (often rendered pimento) is derived from the Castilian Spanish word for pepper. This group has non-pungent fruits that are often heart-shaped. The thick, red pericarp (fleshy fruit wall), which is used in cooking, is called "pimiento" and is used fresh or processed in canning, stuffing olives, cheeses, and in salads for color and flavor. The use of the term "pimiento" should not be confused with allspice (*Pimenta dioica*) which is often referred to as pimiento in the world spice trade (Purseglove et al. 1981, Anon. 1989*a*).

Serrano group: This group has slender cylindrical fruits, sometimes somewhat constricted near the middle and tapering to an abrupt point. These are highly pungent, red when mature but harvested and marketed green and fresh.

Small Hot group: This category contains slender, thin-walled, highly pungent fruits, including some "chile" types that are used dried, whole-fruit, or ground for seasoning.

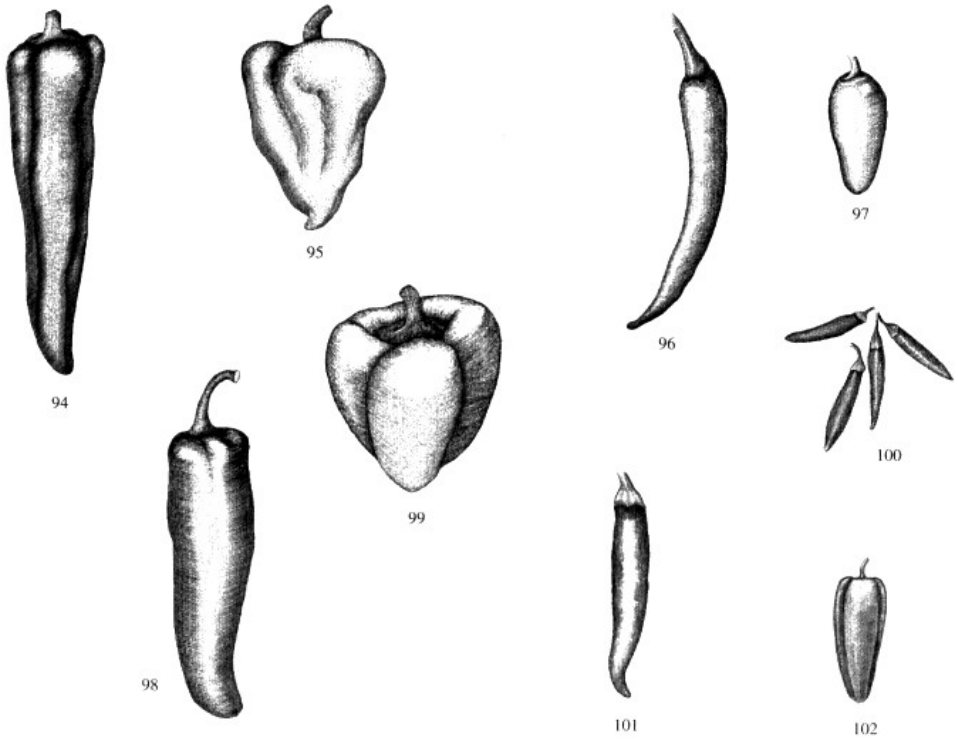
Small Yellow Wax group: This includes both pungent and non-pungent forms with small fruits that are yellow when immature. They are employed fresh or pickled, and are added to sauces and relishes.

Ornamental chiles can be recognized as comprising another group. They may have all the colors of the rainbow, and fruits of four or five colors on the same plant (Bosland 1992). Since they are often marketed during the holiday season, covered with bright red fruits, they may be called "Christmas peppers."

The fruits of peppers are highly perishable, and not surprisingly, ancient remains are few. However, there is evidence that chiles were eaten by native peoples in Mexico as early as 7 000 B.C. and started to be cultivated between 5 200 and 3 400 B.C. (Govindarajan 1985).Archaeologists have found Peruvian embroidery depicting *Capsicum* from 400 A.D., and pottery and carvings from 800 A.D. in the Americas. It has been said that during Columbus' first expedition (1492-93) he observed people using colorful red fruits called "ají" or "axí" with much of their foods. This seasoning was deemed stronger than the black pepper of Asia (*Piper nigrum*) that he had sought. Columbus took samples back to Spain and named it "red pepper." His choice of pepper as a name was obviously guided by his expectation of finding black pepper, and indeed the need to justify his expedition by such a discovery. During Columbus' second expedition, the physician Dr. Diego Alvarez Chanca observed that the natives used chile peppers as a condiment and medicine (Purseglove et al. 1981; Andrews 1986, 1993*a*). In fact, the Western Hemisphere indigenous peoples had been cultivating this pungent food additive for many centuries prior to Spanish occupation. The Peruvian Incas extensively used colorful, fiery fruits that they called "uchu." Similar fruits called "ic" were employed by the Mayans for cramps and diarrhea. There was considerable variation in colors, shapes, and sizes in different regions (Govindarajan 1985). The use of *Capsicum* quickly spread once it was introduced in Europe. Later, some of the milder forms were adopted. Andrews (1993 *a,b*) provides scholarly analyses of the historical pathways by which chile peppers reached various countries of the Old World. Chile pepper was eventually reintroduced to the northern part of the Western Hemisphere with European colonization (Nonnecke 1989).

Uses

Hot peppers are used particularly as flavoring and seasoning for various foods, and in condiments. They are also very commonly employed as a source of yellow, orange, and red color in food products (Andrews 1984). Peppers differ in aroma, and vary in taste from mild to fiery. Cayenne pepper and "red pepper" products are ground from high and medium pungency chiles. Sometimes this includes the cultivar McIlhenny Tabasco (*C. frutescens* L.). [*Tabasco* is a registered trade mark for the hot sauce. The McIlhenny Company challenged the release of the cultivar named Greenleaf Tabasco by Walter Greenleaf as a trademark infringement, but it was ruled that the name "Tabasco"



Figs. 94-102.
Common classes of chile pepper (Capsicum annuum) recognized by Smith et al. (1987, which compare for additional examples; nomenclature slightly different from that of Smith et al.). 94, New Mexican chile group (cultivar Anaheim); 95, Ancho group(cv. Ancho); 96, Cayenne group (cv. Hero); 97, Jalapeño group (cv. Jalapeño); 98, Long yellow wax group (cv.Hungarian Hot Wax); 99, Pimiento group (cv. Pimiento); 100, Serrano group (cv. Serrano); 101, Small hot group (cv.Caliente); 102, Small yellow wax group (cv. Caloro). Prepared by M. Jomphe.

could not be patented (Smith, personal communication; cf. Naj 1993).] These are used in the preparation of bottled hot sauces such as tabasco and "Louisiana hot sauces." Such sauces add color and flavor to spaghetti, pizza, gravies, and stews. Ground chile is made from macerated whole fruits, including the fruit wall, seeds, and placenta (the part of the ovary to which the seeds are attached). Chile powder is a commercial blend of several finely ground spices including chile, cumin (*Cuminum cyminum*), oregano (*Origanum* species), and garlic (*Allium sativum*), all discussed in this book. Both are used extensively in many different ethnic dishes. These include Mexican, Indian (and other Asian), and certain Italian dishes, for example as flavorings for meat and vegetable soups, pasta, pizza, curries, chili con carne, tacos, burritos, and processed meats. Paprika, a non-pungent (for the most part) bright red powder, is made from the fruit wall of certain highly colored, sweet to mildly pungent cultivars and is used mainly as a coloring agent in food preparations such as cheese, egg, and fish dishes, salads, sauces, and rice. "Hungarian paprika" can be notably hot. The fresh, fleshy fruit wall of pimiento peppers is used to stuff olives, and flavor cheese and processed meats. Several cultivars are used specifically in given ethnic dishes, for examples Ancho and New Mexican in chile rellenos, Pasilla for mole sauce, and Serrano for pico de gallo (Bosland 1992).

The oleoresins obtained from the various hot peppers are employed in the food and pharmaceutical industries. These are added to meats, sausage, catsup, sauces, ginger ale, rum, and chewing and smoking tobacco (Purseglove et al. 1981; Lewis 1984). There is increasing use of the oleoresins in the processing sectors because of uniformity of flavor and taste and because serious microbiological problems can be better controlled by comparison with pepper fruits (Govindarajan 1986*b*).

Recipe Sources

Numerous recipes for chile are given in McLaughlin (1986), Andrews (1993a), and Naj (1993), as well as in Chile Pepper magazine (for example, see Stock and Hunter 1995*a*). Kennedy (1978) has recipes for Picked serrano peppers and Fresh chile jalapeño relish. Kavena (1980) presents recipes for Venison chile and Chile rolls. Dewitt and Gerlach (1984) give recipes for Nigerian groundnut soup and Falafel. Hughes (1985) has recipes for Jalapeño pie and Jalapeño chicken enchiladas. Schneider (1986) presents recipes for Chunky poblano-tomato salsa (with hot peppers), Josefina's jalapeños stuffed with sardines, and Mexi-Magyer hot table relish. Hutson (1987) has recipes for Basil chile garlic vinegar, Oregano-chile-garlic-vinegar, and Mediterranean marinade. Creasy (1988) gives recipes for Garden chili, Black bean and chicken chili, Green chili with pork, and Baked chiles rellenos. References to selected recipes from other sources are: Pepper wine (Wolfe 1972); Yellow chile sauce (Rose 1979); Guacamole (Morash 1982); Sautéed frog legs with cayenne (Thompson 1986); Chilli sauce (Solomon 1992).

Importance

"Chile pepper is the most used spice in all the world" (Locock 1985). About one-quarter of the world's adult population regularly eats chile pepper as a flavoring in food, and for many people hot chile pepper may constitute about 1% of the total diet (Locock 1985).

Fig. 103.
Chile pepper *(Capsicum annuum)*,
from Vilmorin-Andrieux et C^{ie} (1883).

The largest cultivation areas of chile peppers are in tropical and subtropical Asia from the Indian subcontinent through Southeast Asia to Japan, and in East Africa. Central and South America, and the Caribbean produce important crops as well. A large proportion of production is consumed domestically. For example, in 1984, 650 000 t of chilies were produced worldwide, with India growing 400 000 t. However, word export trade for chilies was only a small portion of total production, about 40 000 t. Similarly, based on average 1989-94 production, India grew 776 500 t annually, but only exported 26 000 t (Nazeem 1995).

World production of paprika powder has averaged 40 000-50 000 t annually with Spain, Hungary, the former Yugoslavia, and the U.S. as major producers (Lewis 1984).

In the U.S., major cultivation areas of chile peppers include California, New Mexico, Texas, North and South Carolina and Louisiana. The U.S. produces significant quantifies of chile and paprika peppers. In 1988, California produced 8 927 t from 1 400 ha valued at $9,614,000 while New Mexico harvested 32 842 t of hot peppers including 1 905 t of paprika, 7 620 t of green jalapeños, and 3 266 t of red cayenne peppers, the total valued at $38,555,000 (Anon. 1989a).The following statistics of total imports of various *Capsicum* spices into the U.S. reflect 1988 production: New Mexican and ancho peppers, 1,164 t valued at $1,800,000; cayenne peppers, 8,060 t valued at $10,773,000; paprika (ground and unground), 4,917 t valued at $8,483,300; paprika oleoresin, 338 t valued at $11,360,200 (Anon. 1989*a*).

Few statistics are available on Canadian production or consumption of spice peppers. Quebec grew 24 ha of pimientos in 1984 (Anon. 1989*c*). It is uncertain if other spice peppers are commercially grown in Canada, although Purseglove et al. (1981) recorded that paprika was commercially produced in Canada.

With increasing interest in ethnic dishes in North America, usage of spice peppers for flavor, aroma, and color is also growing.

Cultivation Notes

Soil

Soil for peppers should be well-drained and friable, with a pH of 6.5-7.5. ApH tolerance range of 4.3-8.7 has been reported (Duke 1979). Peppers tolerate slightly acid substrates, but do better in neutral soils. Loamy soils rich in lime are considered most suitable. Abundant organic matter is recommended to provide adequate fertility and water-holding capacity. However, fresh manure can produce lush growth of plants at the expense of fruit production. Peppers respond to frequent side dressings of nitrogen fertilizer (Purseglove et al. 1981; Govindarajan 1985). To

prevent accumulation of disease organisms in the soil, crop rotation should be practised. However, peppers should not follow other crops of the potato family such as tomatoes, potatoes, egg plant or tobacco, because they are subject to many of the same diseases and pests.

Climate

Peppers are intolerant of cold weather and are killed by slight frost. In Canada and the colder regions of the U.S., they are started indoors and transplanted once the soil is warm. Peppers respond best to temperatures of 21-29.5°C, tolerating a low of 18°C and a high of 35°C. For proper germination, soil temperatures must be above 16°C. Desirable fruit color depends on soil temperature, with best color developing at 18-24°C, and very poor color formation below 13°C. Smaller-fruited types of peppers are less sensitive to cold than large-fruited peppers such as the bell peppers. High temperatures may cause abscission of flower buds. Peppers must be provided with a steady supply of water throughout the growing season, necessitating irrigation during dry periods. Many spice pepper cultivars, particularly those grown for hot pungency, require a longer warm growing season (65-80 days) than the bell peppers (60-70 days) cultivated mainly as vegetables (Purseglove et al. 1981; Govindarajan 1985). Only the hottest parts of Canada can grow high quality pungent peppers. In the U.S. hot, paprika-type peppers are grown primarily in the southwestern and western states (California, Arizona, southern New Mexico, and southwestern Texas), mostly because of the climate, but partly because of an available labor force (Kebede 1988*a*).

Propagation and Cultivation

In warm areas, hot peppers can be direct-seeded; the entire New Mexico crop is sown in this way (Bosland, personal communication). In cold areas, including Canada and the northern U.S., propagation is by seeds started indoors and then hardened off before transplanting after danger of frost. Spice pepper seeds can be very slow to germinate. To break seed dormancy several methods have been suggested. The simplest is to soak the seeds for 3-4 hours in water at room-temperature. Another method is to add 1 tablespoon of salt/L of warm water and leave the seeds in the solution for 2-3 days. The seeds are then placed on moist paper towels in a plastic bag that is left in a warm area until the seeds sprout. The seedlings are then put into peat pots or other small containers of soil. Another strategy is to simulate the hot days and cool nights of the native environment of peppers. The seeds are first soaked and then shallow-planted in starter pots. During the day the pots are kept at 30°C and at night about 16°C (Jesiolowski 1993). Seeds should be planted at a depth of 6 mm or less, the seedlings usually taking 8-12 days to emerge (Wang et al. 1993). The field should receive a thorough cultivation before planting. Light cultivation is practical and useful for weed control until the plants begin to spread (Purseglove et al. 1981). It is important not to place spice peppers outside until the air and soil temperatures are warm. Seedlings are easily killed by frost, as well as by overwatering. Warmer temperatures often seem to result in peppers with hotter flavor.

Harvest and Storage

All pimiento peppers and some jalapeño peppers are hand-harvested and consumed fresh. Harvests of 12 t/ha under ideal climatic conditions are possible (Hackett and Carolane 1992). After harvest, other spice peppers are dried in the sun (in tropical countries) or in forced air draft dryers. These are used whole or ground, or the oleoresins are extracted for commercial use. Spice peppers are affected by harvest maturity, post-harvest handling, drying conditions, grinding, and storage. Delayed harvesting and fast drying have been shown to improve the color retention of many cultivars. However, the best color retention in paprika cultivars results from harvesting fruits that are fully mature and succulent. In commercial production in the southwestern U.S., modern dehydration techniques are employed for chili and paprika cultivars. Forced air at 80°C is used to reduce the moisture content to 7-8%. Additional cutting of the fruits into 2-3 cm pieces before drying has been found to reduce drying time by 50% and improve color retention (Purseglove et al. 1981; Govindarajan 1985).

Pimiento cultivars are harvested when fully ripe and brilliantly colored. The thick skin is usually peeled by flame or lye. After washing, the fruits are put into coring machines to remove the pith and seeds. The peeled, cored pimientos are mostly canned as whole, sliced or diced fruits. A small portion is dehydrated (Purseglove et al. 1981; Govindarajan 1985).

Jesiolowski (1993) noted that because of the very long season required by some peppers, northern gardeners might consider bringing an entire pepper plant indoors and allowing the fruits to ripen fully. The plants should be lightly pruned, but the shallow surface roots not disturbed because they are the main feeder roots. The plants should be acclimated to indoors gradually; if it is cool outside, expose them to progressively warmer indoor conditions over several days. Full sunlight or artificial lighting is required and the soil should not be allowed to dry out. Some cultivars of spice peppers will survive over the winter and can be replanted outdoors the following summer.

Chiles can often be stored briefly by wrapping them in two layers of paper towelling, placing them in a plastic bag, and storing in a refrigerator (Kennedy 1989*a*). If a home vacuum-packing machine is available, fresh chiles can be stored for up to a month (see Andrews 1993*a* for instructions). Dried chilies can last for years if stored properly, preferably in a cool, dry place, or better, in plastic bags or glass jars, in a refrigerator or freezer (Kennedy 1989*a*; Andrews 1993*a*). Mildewed chiles should be discarded; Andrews (1993) notes that mildew usually starts on the inside where the seeds attach to the placenta. De Witt and Gerlach (1989) recommend against home canning, because chile peppers are a low-acid fruit.

Example Cultivars

New Mexican group: Anaheim, New Mexico 6, New Mexico 6-4, NuMex Conquistador, Sandia.

Ancho group: Ancho, Mulato, Poblano.

Cayenne group: Long Thick, Long Thin, F_1 Amando, F_1 Super Cayenne, Long Red Cayenne, Longum.

Cherry group: Large Red Cherry Hot.

Jalapeño group: Early, Jalapa, Jalapeño M, Mitla.

Long Yellow Wax group: Hungarian Yellow Wax, Sweet Banana.

Pimento group: Large Red, Perfection, Sunnybrook Red, Super Red Pimento.

Serrano group: Serrano.

Small Hot group: De Arbol, Piquin (Pequin).

Small Yellow Wax group: Cascabella, Sante Fe Grande, Color, Joloro (Yellow Hot Jalapeño).

Additional examples of cultivars are given in Huxley et al. (1992) and Andrews (1993*a*). Facciola (1990) provides extensive descriptions of hot and sweet pepper varieties available in the U.S.

Sometimes collections of pungent peppers are available through seed supply houses, such as "Hot Pepper Mix," which may represent cultivars from several of the pepper groups such as Cayenne, Jalapeño, and Small Hot.

Bettencourt and Konopka (1990) list institutions in various countries conserving *Capsicum* germplasm. *Capsicum* crop improvement, breeding, selection, and genetic resources are summarized by Govindarajan (1985).

Additional Notes

Chemistry

The chemistry of components contributing to color and pungency is extensively reviewed by Govindarajan (1986*b*). The carotenoid capsanthin is the most important pigment of *Capsicum*. The pungent principle capsaicin is present on the placenta of the fruits, and is said to retain its pungency at dilutions of one part in one million (Purseglove et al. 1981). Palevitch and Craker (1993) note that in the last 8 years over 2 000 articles have dealt with capsaicin.

There are seven closely related capsaicinoids, often collectively termed capsaicin for the most common one. Rinzler (1990) provides the following summary of the capsaicinoids, the chemicals that make hot peppers hot. Capsaicinoids act directly on the pain receptors in skin and mucous membranes. The strongest are capsaicin and dihydrocapsaicin, which deliver sting all over the mouth. A third capsacinoid, nordihydrocapsaicin, results in a warm, mellow sensation in the front of the mouth and palate. A fourth, homodihydrocapsaicin, produces a delayed reaction, stinging, numbing, and burning the back of the throat. The capsaicinoids are produced in glands on the placenta within the fruit; because seeds are very close to the placenta, they occasionally absorb capsaicin (Bosland 1992).

In 1912, a method was devised to compare the pungency of peppers in "Scoville heat units." Bell peppers are rated at 0, New Mexican at 1 000, jalapeño and cayenne between 2 000-35 000, and tabasco (*C. frutescens*) at 30 000-80 000. High-pungency flavoring extracts (oleoresins) measuring up to 1 000 000 Scoville heat units have been made from African-type chiles (Lewis 1984). The degree of pungency is enhanced by warm nights, hot days, poor soil, well-aged fruit and thin fruit skin.

Capsicum peppers do not contain volatile oil, but do have a distinctive aroma, which is particularly pleasing in the sweet varieties (Heath 1981). The compounds that contribute to aroma are discussed in Heath (1981) and Govindarajan (1986*b*).

Medicine

Chile pepper was used by the Maya of Mesoamerica to treat inflamed gums (Palevitch and Craker 1993). Chile pepper has been employed in a variety of folk remedies, to treat such conditions as asthma, lumbago, neuralgia, pneumonia, rheumatism, sores, cancers, and tumors (Duke 1985). In China and Indo-China, the leaves are used to treat toothache, while the fruit is considered useful for stomach problems, rheumatism, and for increasing circulation of the blood (Perry and Metzger 1980). In the Malay Peninsula the plant is employed to treat cholera, malaria, and scarlet fever, and the roots for treating gonorrhea (Perry and Metzger 1980). In Indonesia, leaf sap is used to stimulate childbirth (Perry and Metgzer 1980) and the root is used for gonorrhea (Duke 1985). In Vietnam, pepper is employed to treat intestinal diseases (Nguyêñ-Xuân-Duñg and Dô-Tât-Loi 1991). Aneine, made from pepper, serves to reduce nausea and vomiting in pregnant women, and for sea and car sickness (Perry and Metzger 1980).

A hot feeling and sweating commonly result after ingesting foods containing quantities of hot chile. The ingestion of chile has a significant effect on metabolic rate in humans (Henry and Emery 1985).

The most pungent types of chile (including *C. chinense*, the next species treated) are used to prepare pharmaceuticals. These include stimulant and counter-irritant balms applied externally, and formulations taken internally to treat flatulence and arouse appetite. Capsaicin ointment has proved useful for reducing pain due to shingles and stump pain following amputation (Tyler 1993). Chile extracts are found in North America in some commercial laxatives, external analgesic preparations, and liniments (Chandler 1985*a*). Capsaicin is the active ingredient in two popular rubdown liniments used for sore muscles, Heet and Sloan's Liniment (Bosland 1994*b*).

As noted above, chile is used in China to treat toothache. Moreover, a folk remedy in North America for relieving toothache involves soaking a piece of cotton in tincture of cayenne and placing it inside the tooth cavity (Stock and Hunter 1995*b*). Oil of cloves is famous for its ability to reduce the pain of toothache, because of the active ingredient eugenol (Chandler 1985*a*). Capsaicin is rather similar chemically to eugenol, which may explain why the effect of chewing a chile pepper over an aching tooth has been said to be similar to the effect of oil of cloves (Chandler 1985*a*).

Patients with duodenal ulcers are often advised to consume a bland diet, with little spice, especially chile. At least one study has contradicted this conventional advice, concluding that bland food is unlikely to be useful, and that consumption of chile does not retard the healing of duodenal ulcers (Chandler 1985*a*). Indeed, there is evidence that capsaicin in chile may have a protective effect against peptic ulcer disease (Kang et al. 1995). Nevertheless, "High doses of red pepper are an extreme irritant to the esophagus and stomach and, perhaps, kidney. Individuals with intestinal or kidney ailments are advised not to use hot red pepper" (Palevitch and Craker 1993).

Red pepper marketed as a nostrum has produced dermatitis (Duke 1985). Even the smoke from fruits can irritate mucous membranes, and the high incidence of chile intake in India has been associated with medical problems of the mucous membranes (Duke 1985). Kennedy (1989*a*) warns that one should be careful in preparing chiles not to touch the eyes, especially if wearing contact lenses, without first washing one's hands thoroughly.

Nutrition

Capsicum in a fresh state is high in vitamin C (ascorbic acid). The Hungarian Albert Szent-Györgyi was awarded the Nobel Prize for physiology and medicine in 1937 for isolating vitamin C in 1928 from paprika fruits and showing that they were one of the richest sources available for this vitamin (Purseglove et al. 1981). According to Duke (1985), paprika is higher in vitamin C than citrus. According to Andrews (1986), ripe red peppers contain at least as much vitamin A as carrots. Duke (1977) characterized fresh hot pepper's content of fiber, potassium, and vitamin A as high, and the content of vitamin C as very high. Before cooking (but not after) vitamin A (ß-carotene) and vitamin B are present in substantial quantities (Hackett and Carolane 1982). Vitamin E is also present (Purseglove et al. 1981).

Red pepper has a high content of antioxidant chemicals (because of the high content of vitamins C and E, and carotenoids). Antioxidants have been associated with prevention of cardiovascular diseases, cancer, cataracts, and perhaps aging (Palevitch and Craker 1993).

Curiosities

• The genus name *Capsicum* comes from the Greek *kapto*, to bite, in reference to the hot taste of the fruit (Huxley et al. 1992). [Pailler (1993) gives another explanation: the name comes from the Latin *capsa*, meaning "container-like," an allusion to the shape of the fruit.]

• One would expect that the name *C. annuum* would designate a plant that is naturally (not just grown as) an annual. *Capsicum annuum* is in fact a perennial, and in the tropics will grown into small to medium sized trees as tall as 4 m (Pailler 1993). The *International Code of Botanical Nomenclature* does not insist that the names of plants accurately describe them, and there are many cases of names that seem inappropriate.

• Dr. P.W. Bosland (personal communication) reports having seen *C. annuum* "trees" 10 m tall in the tropics. Dr. W.H. Eshbaugh (personal communication) has seen plants of *C. pubescens* straggling to lengths up to 18 m in Bolivia.

• The country Chile is not responsible for the name chile pepper. The country name is derived from the South American Araucanian Indian tribe's word for "the end of the earth" (Andrews 1986).

• The word "chile" comes from *chilli*, the Mexican Indian (Nahuatl) tribal name for peppers. Nahuatl, the native language of the ruling Aztecs, was the *lingua franca* of the central highlands of Mexico at the time of the arrival of the Spaniards, and is still spoken in a modified form today by 1.5 million people in Mexico (Kennedy 1989*a*). The Anglicized form is "chile" (generally in the U.S.) or "chilli." The term chilli (plural chillies) is commonly used in Britain, India, Africa,

and the countries of the Far East, but not in the U.S. (Govindarajan 1985). The Portuguese took chile peppers to India in the 16th century, where the spelling chilli has persisted (Kennedy 1989*a*). The same is true for the Philippines and other areas of the Pacific and Far East (Kennedy 1989*a*). In Australia and India, chillie and chilly are also generally used for hot peppers (Andrews 1986).

• "Cayenne" in cayenne pepper derives from a municipality in French Guiana, on the northern coast of South America (Heath 1981).

• The popular drink Dr. Pepper was named after Dr. Charles Pepper, a Virginia doctor. A pharmacist who worked with him opened up a soft drink business in Texas, and named the syrup from which the drink was made Dr. Pepper after the doctor in the vain hope that the physician would allow his daugher to marry him (Naj 1993).

• Eshbaugh (1984) notes several curious uses of hot peppers. Southern Columbian natives mixed powdered fruits with coca and snuffed the mixture, knowing that the mucous membrane irritation from the pepper accelerates the uptake of the hallucinogen. Peruvian Amerindian nursing mothers applied pepper juice to their nipples to wean their infants; similarly, some parents today use "NOTHUMB," a chile preparation applied to childrens' thumbs to keep them from sucking them.

• Fowler (1992) has several curious chile anectodes: Koreans sprinkle red pepper in flannel belly bands wrapped around their middles in cold weather as a way of keeping warm; red chile mash added to chicken feed darkens the color of the egg yolks, making the eggs more saleable; pink flamingos in captivity lose the brilliance of their plumage, but feeding chile pepper mash puts the birds back in the pink; the bite in ginger ale and the peppery flavor of old time "red hots" is often the result of added capsaicin.

• New Mexicans insist on the spelling *chile* for both the whole fruit and the red stew, and contend that both the stew and the same cultivars grown in New Mexico are vastly superior to those of Texas and California (Andrews 1986). Chile is the state dish of Texas (Bosland 1992).

• Several cultivars have interesting names. The cultivar Cascabel in Spanish means "rattle," referring to the rattle the fruits make when dried. The cultivar Guajillo is very popular in parts of Mexico where it is known as "Chile travieso" meaning "naughty chile" due to hot flavor. One American seed supplier sells a pepper with hot, small, orange fruits whose characteristic size and shape have resulted in it being called "rat turd" pepper. The Peter Pepper, also known as the Penis Pepper, is an ornamental form, with fruits decidedly phallic in appearance (pictured in Andrews 1984).

• Andrews (1984) recorded that a character named "Smoky Joe" established a world record at a jalapeño-eating contest by eating 115 jalapeñoes, and that a newspaper headline following the contest read "THE WINNER LOSES ALL!"

• There is a superstition that peppers grow better if planted by a red-headed or a hot-tempered person (Fox 1933).

• A variety of explanations of why chile pepper has become the most used spice in the world have been advanced, including: value as an appetite stimulant, ability to mask spoilage, high vitamin content, and causing salivation which may facilitate digestion of high starch diets (Locock 1985). Perhaps the most interesting explanation is that because chiles cause sweating, in tropical areas of the world this would facilitate loss of excessive heat (Locock 1985).

• Mixtures containing *Capsicum* extracts are marketed for placing in stockings to keep feet warm on cold days (Tyler 1993). On such commercial foot warmer powder is known as "Fire-Feet" (Marshall, personal communication).

• The wild forms of *C. annuum* are called bird peppers, a reference to the attractiveness of the red fruits of *Capsicum* species to birds. In the wild, pepper seeds are commonly distributed by birds, many of them passing unharmed through the bird's gut. Seeds of most wild species are slow to germinate because of germination inhibitors, which are effectively removed by passing through a bird's digestive system (Pailler 1993).

• Repeated exposure to capsaicin desensitizes people, allowing them to tolerate ever-increasing doses (Andrews 1986). For this reason, measuring the Scoville Heat Unit rating of a given chile pepper has to be performed with subjects who are not regular pepper eaters (Andrews 1986). What is considered mild to a "hot chile junky" could be intolerably fiery to those not habituated to the spice.

• In New Mexico, mature red chiles are traditionally strung together to make colorful "ristras." The ristra is hung near the entrance of a house to symbolize hospitality (Bosland 1992).

• The "tomato pepper" or "topepo" is allegedly (but doubtfully) a hybrid of *C. annuum* and the tomato (*Lycopersicon esculentum* Mill.). Facciola (1990) lists two cultivars that are available, Top Boy and Top Girl.

Problems and Potential

There is limited potential for large scale commercial production of spice peppers in Canada and the colder regions of the U.S. because of the short growing season. However, there are some spice peppers grown commercially in northern North America as indicated above in

"Importance." There is also a demand for spice pepper products for processing into various food products (Purseglove et al. 1981). By employing transplants it may be possible for a few growers in the warmest parts of Canada and the adjacent U.S. to grow acceptable spice peppers for market. With proper care, home gardeners should also have success with these culinary herbs.

Selected References

Purseglove et al. (1981); Hackett and Carolane (1982); Andrews (1984, 1986, 1988, 1993*a*, 1995); Lewis (1984); Govindarajan (1985, 1986*a, b*); Locock (1985); DeWitt (1991); Bosland (1993); DeWitt and Bosland (1993).

Capsicum Frutescens L.

Scientific (Latin) Synonyms

C. minimum Roxb., *C. fastigiatum* B1.

English Names

Tabasco pepper
Also: bird chilli, chilli pepper, hot pepper, spur pepper, tabasco-sauce pepper
[The name tabasco is a reference to the state of Tabasco, Mexico. An American soldier returning from the Mexican War of 1846-48 brought seeds from Tabasco to Louisiana (Facciola 1990).]

French Names

Piment enragé
Also: piment de cayenne (piment de Cayenne), piment frutescent, piment rouge, pilli, pili-pili, poivre de cayenne (poivre de Cayenne)
[Some of these alternative names are also given to small-fruited, hot pepper varieties of *C. annuum*.]

Description, Taxonomy, and History

Capsicum frutescens is a subshrub l-1.5 m high, with small, oblong, bright red fruit 2-3 cm long, pointed at the tip. It is native to central and eastern South America. The species is widely cultivated in tropical, subtropical, and warm temperate countries, notably in India, tropical America and the southern U.S. It has been introduced to all tropical countries and has become naturalized in many of these. Cultivars of *C. frutescens* offered in the trade are often confused with those of other species of *Capsicum* (Duke and duCellier 1993).

Uses

Fruits of *C. frutescens* have much the same uses as *C. annuum*. Cultivars include the "tabasco" peppers, which are used in commercial production of hot sauces, notably in the Gulf states of the U.S. *Capsicum frutescens* is also used as a source of cayenne pepper and chile powder (mostly made from *C. annuum*). Extracts are used to prepare ginger beer and other beverages (Duke and duCellier 1993). Tabasco sauce has long been an accompaniment to Louisiana oysters (Andrews 1984).

Recipe Sources

Also see recipe sources for *C. annuum*. The following recipes call for hot chiles. Rose (1979) gives recipes for Chile Colorado and Red chile sauce (salsa Colorado). Creasy (1988) has recipes for Shotgun Willie chili, Chili-stuffed Monterey jack cheese, Broken arrow ranch chili, and Gumbo. Solomon (1992) has a recipe for Hot chili paste.

Importance

Major producers of tabasco pepper, in decreasing order of importance, are India, Sierra Leone, Zanzibar, Japan, Mexico, and the U.S. (Duke and duCellier 1993). Accurate statistics for harvest and marketing of *C. frutescens* are not available, although "great quantities of this pepper are grown throughout the world" (Duke and duCellier 1993). In the U.S., production was once chiefly in California, Louisiana, Mississippi, New Mexico, Arizona, and South Carolina (Sievers 1948). At present, none are grown outside Louisiana, as the hand labor is too expensive (Bosland, personal communication).

Cultivation Notes

See information for *C. annuum*. Only additional notes specific to *C. frutescens* are given below.

Soil

A pH tolerance range of 4.3-8.7 has been reported, and some cultivars have been selected to tolerate acidic soils (Duke and duCellier 1993).

Climate

The very pungent fruits tend to be rather late-maturing, and so this species is usually unsuitable for northern regions. It also requires heat (an average daily temperature of 23.5°c), and is killed by the slightest frost (Duke and duCellier 1993). In warm climates *C. frutescens* can be grown as a perennial, for 2 or 3 years, while in cooler climates it has to be cultivated as an annual. The species can be grown as a house plant that produces edible hot peppers. Unfortunately seeds are difficult to obtain through seed catalogs.

Propagation and Cultivation

Capsicum frutescens is cultivated like *C. annuum*, but takes longer for the fruits to mature (often 5-6 months).

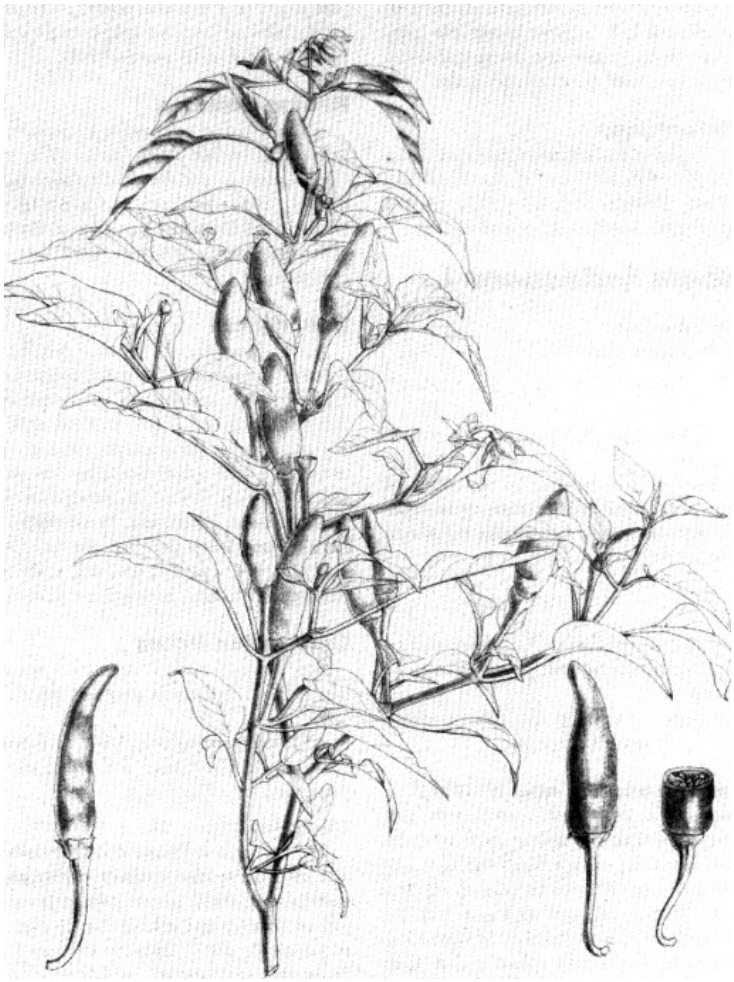


Fig. 104.
Tabasco pepper *(Capsicum frutescens)*, from Duthie (1893).

Fig. 105.
Tabasco pepper *(Capsicum frutescens)*, from Duthie (1893).

Harvest and Storage

Fruits may be hand-picked and dried. The fruits often dry up on the plant, and the whole plants may be pulled up and dried with the fruit attached (Duke and duCellier 1993). Tabasco peppers (the only cultivar grown in the U.S.) are picked when red, crushed into mash, and put into wooden barrels with salt for fermentation and storage for 3 years before processing (Marshall personal communication).

Example Cultivars

Many cultivars have been developed to suit local climates (Duke and duCellier 1993). There are several cultivars of *C. frutescens*, including ornamentals (Smith, personal communication). Facciola (1990) has several cultivars of *C. frutescens*, but Tabasco may be the only one listed that belongs to the species. Facciola (1990) lists Yatsubusa (80 days required, a Japanese cultivar that is almost extinct), and Taka-No-Tsume (68 days, another old-fashioned Japanese cultivar), but these are cultivars of *C. annuum* (Bosland, personal communication). Additional cultivars are listed in Huxley et al. (1992).

The name Malagueta, applied to a popular cultivar in Brazil, is sometimes interpreted as a cultivar of *C. frutescens*. However, in his travels in South America, Smith (personal communication) encountered the name Malegueta applied to both wild and cultivated forms of several species. In any event, Malagueta pepper should not be confused with the melegueta ("Melagueta pepper") or Guinea pepper, *Aframomum melegueta*, a relative of ginger (Bosland 1994*a*; also see Genus notes).

Additional Notes

Chemistry

Capsaicin is present in amounts ranging from 0.2 to 1%, the highest levels found in African races (Duke and duCellier 1993).

Medicine

Capsicum frutescens has been used in folk medicine to treat tumors, alcoholism, delirium tremens, and as a general disease preventative (Duke and duCellier 1993). In modern medicine the fruit may have the same values as *C. annuum*, described above, and the same potential toxicity, particularly with regard to dermatitis.

Nutrition

Duke and duCellier (1993) provide an analysis of vitamin and mineral content, which is comparable to the previously described species.

Curiosities

• Before the Spanish occupation, chiles were used as currency by some native New World peoples (Purseglove et al. 1981).

• Natives are reported to have fought the Spanish invaders by using irritating, burning chile smoke (Govindarajan 1985).

Fig. 106.
Tabasco pepper *(Capsicum frutescens)*,
from Lamarck and Poiret (1791-1823).

• "Hunan hand" was so-named after a man received serious capsaicin bums on his fingertips by chopping up red peppers for a Hunan Chinese recipe (Castleman 1991).

• Andrews (1986) recounts how recent Mexican immigrants to West Texas used pepper to assist women in giving birth. A mother-to-be is stretched out on the floor with a rope around her middle, with a corncob used as a turn-buckle. As labor progresses, the midwife tightens the rope by turning the corncob. When birth seems imminent, a final turn of the corncob is made and at the same time a handful of tobacco snuff mixed with chile powder is thrown into the face of the woman in labor, who sneezes violently, and (it is expected) expels the baby.

Problems and Potential

Tabasco pepper is a plant adapted to warmer climates than found in Canada and the northern U.S., where it has no economic potential, and can be grown merely as a tender garden or potted plant.

Selected References

Andrews (1984); Facciola (1990); Duke and duCellier (1993); Andrews (1995).

Capsicum chinense Jacq.

English Names

Habañero
Also: bonnet pepper, Scotch bonnet, squash pepper
[Habañero is the Mexican name, and means "of Havana" or "from Havana" (Facciola 1990). In Peru this is called "chinchi-uchu" (Andrews 1984). Several similar sounding words could be confused with habañero. The word habanero means a native or inhabitant of Havana, Cuba. The habanera is a slow, voluptuous Cuban dance, or a slow Cuban dance tune. Habenaria refers to any plant or flower of the orchid genus *Habenaria*.]

French Names

Habañero (m)
Also: piment antillais, piment de Chine, poivre de Chine

Description, Taxonomy, and History

Capsicum chinense and *C. frutescens* (discussed above) are very closely related, and it may be that they should be combined into one species (Andrews 1984, 1993*a*; Eshbaugh 1993). The two species differ structurally in one of the chromosomes (by one "translocation"). If merged, the correct name for the combined species is *C. frutescens* (Andrews 1984, 1993*a*). Dr. P.G. Smith, who has spent a lifetime studying *Capsicum*, provides the following comment (personal communication). "There is no question that these two species are closely related. From a strictly genetic point of view they probably should be lumped. From a horticultural point of view, they have some consistent morphological differences that are convenient. Climatically *C. chinense* forms will grow in somewhat cooler temperatures. Morphologically the peduncles of *C. frutescens* are slender and always stiffly erect at flowering stage with the flower buds borne at a slight angle to the peduncle. Peduncle number is typically two, but may be as many as five. The calyx is urn shaped without or with only a trace of 'teeth.' *Capsicum chinense* peduncles are from two to five, more commonly three or four, are thicker, shorter and always somewhat to strongly recurved in the blossom stage. Additionally, from the wild to the large cultivated types, there is a distinct annular constriction at the base of the calyx. Nevertheless, some of the material I collected in northern Colombia suggested very strongly that some introgression may have occurred naturally."

Capsicum chinense is a cultivated shrubby species. Wild plants that are probably related to it have been found in the Amazon Basin from Iquitos to southern Peru. The fruits of these wild plants are spherical whereas those of cultivated forms are quite variable in shape, some smooth, others highly convoluted. This species is widely grown in South America and is popular in many Caribbean countries, particularly Cuba and Jamaica. The fruits are usually very pungent although some non-pungent forms have been found in Argentina (Smith et al. 1987).

Uses

Capsicum chinense furnishes exceptionally, indeed dangerously hot chile peppers. The flavor of the best known cultivar of *C. chinense*, Habañero, is blisteringly hot, although it is a short-lived bum, "like a bolt of lightning." After the hot taste fades a citrus-like or "apricot" flavor has been reported.

Recipe Sources

In addition to the references given below calling specifically for *C. chinense*, see recipe sources for hot chiles, given for *C. frutescens*. Claiborne and Lee (1972) give recipes for Ground pork with hot peppers, Pork with hot peppers, Szechwan stir-fry beef with hot peppers, and Ginger beef and bean curd with hot pepper. Chang et al. (1979) have recipes for Chicken with hot pepper, Diced chicken with chilies, and Diced veal cutlet with hot peppers. Andrews (1984) has a recipe entitled Habañero pepper sauce.

Special warning: Forgetting to wear gloves when handling this chile pepper is dangerous. "Such a failure usually results in hands that burn and continue to burn every part of your body that you touch for a day or two" (Andrews 1984).

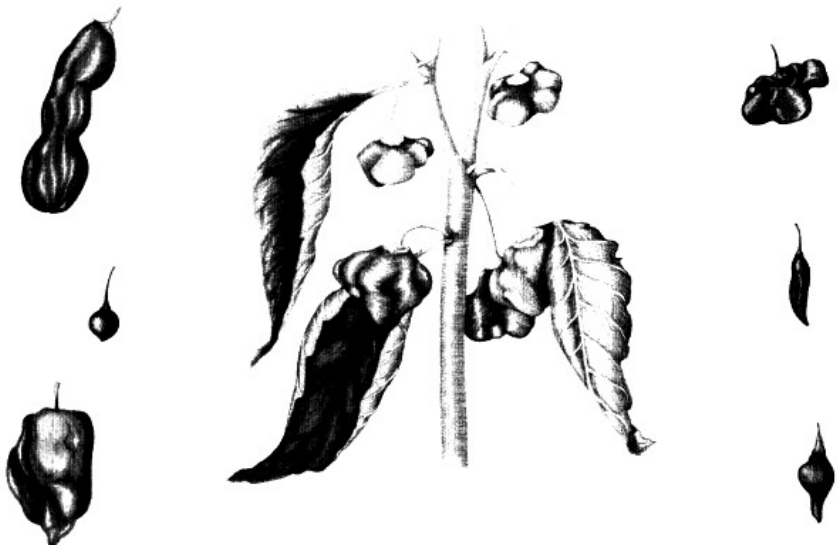


Fig. 107.
Habañero pepper *(Capsicum chinense)*, prepared by M. Jomphe. The central figure is an adaptation of an illustration by J. Andrews in Sokolov (1985), and the remaining fruits are adaptations of illustrations in Jesiolowski (1993).

Importance

Capsicum chinense is considerably less important in commercial trade than *C. annuum*. It is cultivated in the West Indies, the Amazon basin, northern South America, Peru, and Bolivia (Govindarajan 1985). Outside of the Americas, *C. chinense* is grown in Africa (Andrews 1984). The species is the most commonly grown pepper in the Amazon region, and is found primarily in the Caribbean and Mexico south to and including Bolivia and Brazil (Andrews 1984). In all of these regions, fruits are frequently sold in markets. In Mexico its cultivation is limited to the Yucatán Peninsula, while attempts to grow it in the rest of Mexico have been unsatisfactory (Andrews 1984). In more northern areas, including Mexico and the southern U.S., the cultivar Habañero is often encountered in markets, and fresh fruits are occasionally sold as far north as Canada (Andrews 1984)

Cultivation Notes

See information for *C. annuum*. Only additional notes specific to *C. chinense* are given below.

Soil

Duke and Hurst (1975) gave a desirable soil pH range of 5.3-5.8, which is lower than that for *C. annuum*. Duke (1978) reported a pH tolerance range of 5.0-7.6.

Climate

Climate requirements are similar to those of *C. annuum*, but a long, hot growing season is essential. The germination period is extremely long, and a warm moist environment is needed for the plant to satisfactorily produce fruits (Andrews 1984). In the Yucatan and Costa Rica, *C. chinense* is grown as a perennial (Bosland, personal communication).

Example Cultivars

Facciola (1990) lists the following cultivars: Datil, Githeo Miris, Piri-Piri (Peri-Peri), Rocotillo, Scotch Bonnet (70 days required, the shortest period of the cultivars listed here), Yellow Squash (95 days). Datil, which apparently originated in Florida, is described by Andrews (1990).

Additional Notes

Chemistry

In the treatment of *C. annuum* it was noted that pungency of peppers is measured in Scoville heat units. The highest ratings of *C. annuum* is around 100 000 Scoville heat units. The *C. chinense* cultivar Habañero has an impressive rating of 200 000-300 000 Scoville heat units (Jesiolowski 1993). As little as one part of the oleoresin added to 250 000 parts of water leaves a warm, glowing sensation in the mouth (Kingsmill 1993). Capsaicin is noticeable at a concentration of as little as 1:11 000 000 (Duke 1985). For this reason, the cultivar Habañero has been called the hottest pepper in the world (Facciola 1990). Jesiolowski (1993) described Habañero as the "king of sting."

Medicine

An intense stinging pain can result from handling the fruits and subsequently rubbing eyes or moist body parts.

Nutrition

See information for *C. annuum*.

Curiosities

• The French taxonomist who named *C. chinense* in 1776 got his seeds from China, hence the "*chinense*" in the name, despite the fact that it originated in the New World like all *Capsicum* species (Bosland 1994*a*).

• *Capsicum chinense* appears to have been used by the Carib Indians of the West Indies for torturing captives (Facciola 1990).

• The Carib Indians prepared a "pepper-pot," a kind of camper's stew in which various ingredients are constantly added, so that the pot is never empty (Facciola 1990).

• Habañero "is the chile-pepper that separates the men from the boys" (Andrews 1984). In a chile pepper-eating contest long carded out in Louisiana, Habañeroes were fed to contestants at the final events, in the knowledge that few could survive their fire (Andrews 1984).

• Birds apparently don't have taste buds that distinguish the hotness of capsaicin, as reflected by the consumption of chile peppers by birds. "Squirrel Away" is a commercial bird seed supplement made with chile powder from *C. chinense*. Used at wild bird feeders, it discourages squirrels from foraging on the birdseed at the feeders (Marshall, personal communication).

• A sailing enthusiast had the idea of trying the extra hot Habañero cultivar to see what effect it would have on barnacles and tubeworms growing on the underwater portion of boats (Kingsmill 1993). His insight led to the development of an epoxy-based experimental marine paint called "Barnacle Ban." This includes derivatives from the cultivar Habañero, and is so hot it will blister fingers. It is claimed that it prevent mussels (especially zebra mussels) and barnacles from attaching themselves to boats, buoys and intake pipes (The Ottawa Citizen 1993).

• There has been a lively debate as to whether or not the Habañero is or is not the hottest of the chiles. "Most of the hot South American chili-peppers will cause the Mexican Habañero to pale by comparison" (Andrews 1984). "The varieties [of *C. chinense*] grown in Africa are reportedly the most pungent of all the chili-peppers" (Andrews 1984; Eshbaugh personal communication). However Bosland (personal communication) reports that the hottest chile he has ever encountered was a Habañero.

• In West Indian markets of some large North American cities, a seasoning mixture called *sofrito* (a blend of fetid herbs and *C. chinense* chilies) is sold (Facciola 1990; cf. *Coriandrum* Curiosities).

Problems and Potential

Capsicum chinense has no economic potential in Canada and the northern U.S., as it is adapted to warmer climates than found here. It can be grown in northern North America merely as a tender garden or potted plant.

Selected References

Andrews (1984); Facciola (1990); Jesiolowski (1992); Andrews (1995).

Carum

Family: Umbelliferae (carrot family)

Genus Notes

Carum has about 30 species of mostly biennial and perennial (occasionally annual) herbaceous plants native to temperate and subtropical regions. In addition to the cultivated species mentioned below, several species have been harvested from the wild by native peoples for use as food (Uphof 1968).

In older literature, *Trachyspermum ammi* (L.) Sprague was listed as *Carum copticum* (L.) Benth. & Hook. (Facciola 1990). This native of Asia Minor and nearby Africa is grown in India, Afghanistan, Egypt, and Iran for its aromatic, pungent seeds. The seeds are used as a condiment in curries and other dishes. In India, "Ajowan oil" is extracted from the leaves and seeds for use as a flavoring and in pharmaceuticals (Morton 1976; Facciola 1990).

Bunium bulbocastanum L., known as pignut, earthnut, or tuberous-rooted caraway, was once known as *Carum bulbocastanum* Koch or *Conopodium denudatum* Koch (Facciola 1990). This plant of temperate and tropical Eurasia has tuberous starchy tubers that are used as a culinary vegetable, leaves employed like parsley, and flowers and seeds that serve as condiments (Facciola 1990).

Carum Carvi L.

English Names

Caraway
Also: common caraway, Roman cumin
["Black caraway" is a name occasionally used for the cultivar of cumin called Black; for additional information see discussion of cumin, *Cuminum cyminum*. Also note the information below regarding confusion of names among cultivated species of the carrot family.]

French Names

Family: Ombellifères, famille de la carotte
Carvi (m)
Also: aneine, anis, anis bâtard, anis canadien, anis des Vosges, anis sauvage (for the weedy form), care carvi, carvi commun, carvi des montagnes, carvi des prés, carvi noir, carvi officinal, carvi ordinaire, cumin, cumin commun, cumin de montagne, cumin des prés, faux anis (also applied to cumin; the French word cumin is best reserved for cumin and not used as in several of the previous names)
[In France, anis is the name for caraway, the result of a confusion with anise, *Pimpinella anisum* (also treated in this book), dating back to the ancient Greeks. The French name cumin des prés is another example of linguistic disorientation, deriving from confusion in translating the Indian word *jeera* (usually meaning cumin) with *shia jeera*, caraway (Norman 1990). All of these species belong to the carrot family, in which many species look so similar that it is easy to confuse them.]

Description, Taxonomy, and History

Caraway is a biennial herb (occasionally annual or perennial), native to Europe, western Asia, and northern Africa. In northern Eurasia, caraway seed is generally produced as a winter biennial, whereas in the Middle East, an annual spring caraway is grown (Toxopeus et al. 1994).The plants grow up to 150 cm in flower, although generally no more than half this height. Caraway produces aromatic, finely divided, fern-like leaves. The cultivated plant is little changed from the wild form although the former's seeds may be smaller and less flavorful (Stobart 1977). In Canada, caraway grows wild in all provinces (Scoggan 1978-79). Caraway is also naturalized in the northern U.S.

As with other members of the carrot family, the fruit (technically a schizocarp) comprises two distinct halves (mericarps), each containing a seed. These "half-fruits" are commonly called seeds, and this convention is followed here. The flowers of course need to be pollinated for the seeds to be produced. However, it is unclear whether insects, wind, or both are mainly responsible for pollination (Bouwmeester and Smid 1995).

Caraway seeds have been found in the debris of 5000 year old lake dwellings in Switzerland (Rosengarten 1969). Use of caraway as a spice and flavoring may have originated with the ancient Arabs, who called the seed "karawya" or "karauya," names the seeds still bear in parts of the Middle East. The seed oil was also employed for various medicinal purposes. Caraway was also known to the ancient Greeks and Romans. By the Middle Ages, the use of caraway seeds as a flavoring had spread across most of Europe and much of Asia. Caraway was recorded in an ancient cookery book compiled by master cooks of King Richard II about 1390. By the 16th century in England caraway was used quite freely in cooking, more so than

Fig. 108.
Caraway *(Carum carvi)*, from Köhler (1883-1898).

today (Farrell 1985). Caraway is now grown commercially in a few countries for export, with Holland leading the world (Anon 1989*a*).

Uses

Caraway seeds are used for flavoring and seasoning of various foods including rye breads, cakes, biscuits, confections, cheeses, omelets, cole slaw, cooked pasta, soups, salad dressing, applesauce, sauces, rice, seafoods, sauerkraut, cucumber dressing, stews, meat, and sausage. A small dish of caraway seeds is traditionally served along with muenster cheese. The seeds are often added to the following vegetables: beets, carrots, cabbage, cauliflower, cucumber, onions, turnip, green beans, potatoes, and zucchini. Caraway seeds may often be substituted for poppy seeds, for example in poppy seed cake. Germans use large amounts of caraway seeds in baked goods, pie crusts, sauces, and sauerbraten. Austrians add it to stews, and Italians boil hot chestnuts with caraway seed before roasting the nuts. "Caraway-seed cake is as traditional in England as apple pie or gingerbread" (Hemphill and Hemphill 1984). Macleod (1968) sugggests that those who dislike the smell of cooking cabbage should put a teaspoonful of caraway into a muslin bag and boil it with the vegetable. In general, caraway lightens the flavor of heavy foods like spareribs, roast goose, pork, mutton, and other hearty foods (Lewis 1984, Farrell 1985).

In northern Europe, especially Norway, the roots are eaten as a vegetable like carrots or parsnips, and considered by some to be superior to parsnip. A Norwegian soup, "Karvekàl suppe," is made by gathering the taproot (about 6-8 cm long) and the young leaves of 1-year-old plants in the spring, scraping and washing the roots, and placing the finely chopped roots and young leaves into a hot broth for 5 minutes. The soup is thickened with meats or fried bread and ladled over a poached egg in a bowl. The young, mild-flavored leaves have been added to cheeses, salads, stews and soups. The older leaves have been cooked like spinach but develop a stronger flavor reminiscent of the seeds.

The essential oil is used with pickles, flavored meats, canned goods, confectionery, non-alcoholic beverages, condiments, candy, ice cream, marinades, and alcoholic preparations such as the Scandinavian brandy schnapps, the Scandinavian liqueur Aquavit, and the German liqueur Kümmel. Rye bread is often flavored with carvone-rich caraway oil or carvone (Arctander 1960). Carvone can be produced synthetically, and this has decreased the demand for caraway oil (Duke and Reed 1978). Caraway oil is used in the pharmaceutical industry in mouthwashes, gargles, and medicines. The oil is also employed in soaps and perfumes (Farrell 1985).

Recipe Sources

Fox (1933) has recipes for Caraway and rose cookies and Fresh curd cheese with caraway seed. Leyel (1938) gives recipes for Caraway brandy and Caraway comfits. Day and Stuckey (1964) present recipes for Caraway seed

Fig. 109.
Caraway *(Carum carvi)*, from Syme et al. (1863-1886).

snaps, Blue cheese caraway seed spread, Caraway cheese pot, Pancakes with caraway cheese filling, Caraway seed macaroni rarebit [rabbit], Caraway seed noodles, Caraway seed noodle ring, Caraway French dressing, Caraway seed-cottage cheese salad dressing, Carrots with caraway seed, and Caraway sauerkraut with pot roast. Rosengarten (1969) gives recipes for Caraway blue cheese wafers, Caraway pork loin with sauerkraut, and Caraway potato dumplings. Muenscher (1978) has recipes for Caraway crinkles and Caraway tea. Gilbertie (1988) has recipes entitled Caraway pound cake, Caraway rye breadsticks, and Sweet potato salad with caraway.

Other recipes are: Caraway apple muffins (Simmons 1969); Caraway casserole (Sanecki 1974); Vinegar with caraway (Hériteau 1975, 1983); Red cabbage and caraway salad (Garland 1979); Cheese dip caraway (McCormick 1979); Caraway soup (Launert 1981); Caraway tea (Marcin 1983); Beetroot in caraway port jelly (Hemphill and Hemphill 1984); Karkevàl (caraway) soup (Lima 1986); Turkey liver pâté with caraway leaves (Holt 1989); Rabbit in sour cream with caraway (Norman 1990).

Importance

Caraway is grown commercially for its seeds and essential oi1. It is cultivated in several temperate countries including Bulgaria, Canada, Germany, Holland, Poland, Russia, parts of Scandinavia, the U.K., and the U.S. (Farrell 1985). It is also cultivated in the hotter climates of Morocco, India, and Syria (Farrell 1985). Holland is usually the major exporting country for caraway seed, producing 15 000-20 000 t annually (Lewis 1984). In 1988, the U.S. imported a total of 2 838 t valued at $2,440,980 including 1 679 t worth $1,466,680 from Holland (Anon. 1989*a*). Values of U.S. imports averaged $3.7 million over the period 1990-1994 (Buzzanell et al. 1994; this includes imports of caraway oil, discussed separately below). Canada has cultivated up to 800 ha of caraway in Manitoba, where there are occasional setbacks from drought and early snows (Anon. 1992*a*). Caraway has also been grown in Saskatchewan and Alberta (Mazza, personal communication). In 1988, Canada exported 142 t of caraway seeds valued at $130,000 to the U.S. (Anon. 1989*b*). Canada's production ranges from 500 to 1 400 ha annually (Mazza 1991*b*).

Caraway oil is also a commercial commodity. The U.S. imported 6 672 kg of caraway oil worth $216,200 in 1991; 6 557 kg worth $210,800 in 1992; and 10 878 kg worth $411,800 in 1993 (Dull 1994*a*). World production of caraway seed oil is estimated at about 10 t, down from about 40 t in the 1950's (Mazza 1991*b*). Verlet (1993) estimated the annual word value of caraway essential oil to be $300,000 (U.S.). Holland, Poland, and Egypt are the leading producers of the seed oil (Mazza 1991*b*).

Cultivation Notes

Soil

Caraway grows best in well-tilled, moderately-light clay soils, rich in humus (Rosengarten 1969). Mazza (1991*b*) recommended heavier, water-retaining clay to sandy clay and loam soils, while according to Huxley et al. (1992), heavy soils are tolerated. The soil should be well-drained, deep, and fertile (Huxley et al. 1992).A pH tolerance range of 4.8-7.8 has been reported (De Baggio 1987). Crockett and Tanner (1977) recommend a pH of 6.0-7.0.

Climate

Caraway is adapted to full sunlight. Bouwmeester, Smid et al. (1995) found that light availability strongly influenced seed yield. Caraway requires additional moisture during dry periods. The seeds can be planted early in the spring as soon as the ground can be worked. Grown as a biennial, this hardy plant can successfully overwinter in many parts of Canada (including the southern prairies) but may be killed by early snows during the first season. The range of temperature between which growth occurs is 4-22°C. Hirvi et al. (1987) studied the effect of latitude on the growth and oil content of caraway. Vegetative growth in northern plants (69°N lat.) was slow and the fruits did not ripen until a third season. However, compared to southern plants (48°N lat.) there were no significant differences in the amount and composition of the volatile oils of the seeds. Caraway is day neutral, so that daylength does not affect onset of flowering. Rain or wind may ruin a harvest (Duke and Reed 1978).

Propagation and Cultivation

Propagation is by seeds sown in the early spring. Caraway does not transplant well. The seeds are slow to germinate like many other members of the carrot family (e.g., carrot, parsnip, parsley), and are viable for only a short time [according to Crockett and Tanner (1977), seeds will germinate fairly rapidly immediately after they are harvested]. Placing the seeds in a freezer for a few days before sowing may improve germination. Putievsky (1980) found that, for commercial purposes, caraway seed is efficiently germinated by providing a daily cycle of 15°C for 8 hours and 10°C for 16 hours. The seeds should be planted about 6 mm deep, with seedling emergence usually in 8-12 days (Wang et al. 1993). Caraway is often grown in rows about

30 cm apart. Weed control is important until the plants grow to their mature height. A cover crop that matures in 1 year, such as mustard, poppy, beans, or flax, is often grown simultaneously, thus providing a cash crop during the first season, although a cover crop will depress yield in the second year (Bouwmeester, personal communication). Coriander may also be useful for this purpose (Rosengarten 1969).

Caraway is typically grown as a biennial in Europe, although an annual form has been cultivated in the Middle East and Poland (Fleischer and Fleisher 1988*b*). In the U.S. the annual form of the plant is usually grown (Simon et al. 1984), and an annual form is now also grown in the Netherlands (Bouwmeester, personal communication).

Harvest and Storage

During the second year caraway flowers and sets fruits, which are harvested when the oldest seeds turn brown. A few non-shattering varieties are now available (see Cultivars). With shattering varieties, harvesting is conducted with care to prevent shattering of the seed clusters and consequent seed loss. The seeds are best harvested early in the morning while humidity is high, thus reducing the chance of shattering. After harvest, the fruiting branches are allowed to dry before threshing of the seeds (Rosengarten 1969). In Holland, a chief producing country, good yields are about 2 200 kg/ha (Lewis 1984), although average yields are about 1 600 kg/ha (Bouwmeester, personal communication). Hirvi et al. (1987) reported experimental yields in Helsinki, Finland of 3 200 kg/ha. In the U.S. commercial yields of 780-1 300 kg/ha of seeds for the biennial, and 780 kg/ha for the annual are typical (Duke and Reed 1978). In Alberta, yields averaged about 1 100 kg/ha/ year (Embong et al. 1977*a*), with a Canadian yield range of 0-2 500 kg/ha (Mazza 1991*b*).

The home gardener usually requires only a few plants for a good supply of seeds. The harvested fruiting branches (umbels) are usually hung upside down in a warm dry place to ripen. These should be suspended over a newspaper or dish, or enclosed in a paper bag to catch falling ripe seeds. The seeds must be thoroughly dry before storage in jars. Weedy caraway may result from ripe seeds that escape from the home garden. However, a few fruiting plants can be left to perpetuate the crop naturally (Lima 1986).

Crockett and Tanner (1977) recommend scalding seeds to be eaten to kill any insects that may be in the seeds. The freshly-picked seeds can be scalded in boiling water, dried (in the sun if possible) for several days (but brought indoors at night), and stored dry in an airtight jar. As the embryos will be killed, such seeds are unsuitable for planting.

Example Cultivars

Some cultivars have been selected in Europe. Hirvi et al. (1987) cited the cultivars Hungarian (from Hungary), Kami LD (from Denmark), and Caraway I and Caraway II (from Sweden). Toxopeus et al. (1994) mention 10 cultivars. Silvia (Danish) and Bleija (Dutch) are non-shattering varieties, Karzo (Dutch) is an annual variety, and Mansholt and Volhouden are other Dutch varieties (Bouwmeester, personal communication). However, named cultivars of caraway are usually not sold in North America, and Facciola (1990), while listing cultivars for most American crops,

Fig. 110.
Caraway *(Carum carvi)*,
from Harter (1988).

does not list any for caraway. Duke and Reed (1978) refer to a cultivar called Mogador, and the German cultivars Koningsberger and Niederdeutsch. According to Duke and Reed, the seeds of English caraways are the best (although this would seem to simply reflect a personal preference).

Additional Notes

Chemistry

The volatile oil, responsible for the characteristic aroma and taste of caraway, contains two major constituents, carvone and limonene (Mazza 1991*b*). Limonene is probably the direct biogenetic precursor of carvone (Embong et al. 1977*a*). Minor constituents include myrcene, beta-caryophyllene, thujone, anethole and pinene (Mazza 1991*b*). Good quality caraway oil should contain 50-60% carvone. Carvone is mainly responsible for the characteristic odor of caraway oil; it has a warm, herbaceous, bread-like, spicy, slightly floral odor and a warm, sweet,

spicy-herbaceous taste (Embong et al. 1977*a*). Limonene has a fresh, sweet, citrus-like odor, and typically comprises about 45% of the oil (Lawrence 1985*a*). The oils are obtained by crushing and steam-distilling the seeds for up to 8 hours. Experiments on oil content distilled from crushed vs. whole seeds demonstrated that crushed seeds are a preferred method of oil recovery. The remaining seed material is rich in protein and may be fed to cattle (Lewis 1984). In addition to the volatile oil, caraway seeds contain about 15% of fixed oil, mainly triglycerides, proteins, cellulose, pentosans, and minerals (Mazza 1991*b*).

Caraway oil develops differently in quantity, quality, or composition depending on the location where it is grown (Simon et al. 1984; Bouwmeester, Davies et al. 1995). Seeds grown in northern latitudes generally yield higher quantities of volatile oil than those grown in warmer climates. Dry, sunny weather during seed maturation reduces oil content while increasing the content of carvone. Cool damp weather gives a higher yield of oil but increases the content of limonene at the expense of carvone (Embong et al. 1977*a*). In Alberta, oil from caraway seeds contained about 7% less *d*-carvone than oil from the U.S. (Embong et al. 1977*a*), because the local climate did not allow the seeds to fully mature. Conversely, limonene was higher in the Alberta material than in samples from the U.S. The Alberta-grown oil was considered lower in quality than seeds from some other parts of the world. However, in 1987 Manitoba and Alberta crops, Mazza (1991*b*) recorded quite different results: carvone contents of 74-79% and limonene levels of 20-26%. In studies in Israel (Fleisher and Fleisher 1988*b*) it was noted that the carvone content in the oil was nearly 80% just after harvest but diminished to 60% after 6 months of storage. [Bouweester, personal communication, cautions that some of the above observations Of relatively high carvone content could be due to incomplete extraction of limonene; cf. Bouwmeester, Davies et al. (1995).]

A commercial oleoresin of caraway is a greenish-yellow liquid, one part of which is the equivalent of 20 parts of freshly ground seeds in flavor and odor (Farrell 1985). The oleoresin is primarily used in the baking industry.

Medicine

In the 1st century A.D. the Greek physician Dioscorides suggested that caraway was a tonic for pale-skinned girls (Farrell 1985). In India, caraway seeds are used to flavor soups in the belief that the seeds have antibacterial properties (which is true). Caraway seeds have been used to relieve gas and flatulence, and were recommended for indigestion, hysteria, and incontinence (Duke and Reed 1978). During this century they were still occasionally given to infants for flatulent colic (Grieve 1931). Caraway has been used to combat nausea (Simon et al. 1984). It continues to be employed as a medicinal plant in China (Perry and Metzger 1980; Duke and Ayensu 1985).

Carvone and limonene in the essential oil can cause contact dermatitis (Simon et al. 1984).

Nutrition

Nutritional analysis of caraway seed is given in Duke and Ayensu (1985) and Rinzler (1990). Caraway does not seem remarkable for content of nutrients, although there is good protein content. Because of the limited amounts normally consumed, caraway does not contribute significant nutrients to diet.

Curiosities

• The generic name *Carum* has been interpreted as an allusion to Caria, a former province in Asia Minor (Fox 1933).

• Julius Caesar was fond of a form of bread called "chara," made from ingredients including milk and caraway seeds (Farrell 1985).

• Shakespeare wrote in the play Henry IV, Part 2 "you shall see my orchard where, in an arbour, we will eat a last year's pippin [apple variety] of mine own grafting, with a dish of caraways..." (Rosengarten 1969). The custom of serving roast apples with a little saucerful of caraway was maintained up to the Second World War at Trinity College, Cambridge since Shakespeare's time (Macleod 1968).

• It was customary for farmers in England to give caraway seed cakes to their laborers at the end of the wheat sowing (Fox 1933).

• Caraway used to be considered an essential ingredient in love potions, useful to keep lovers from straying; even pet pigeons were sometimes given caraway seeds baked in dough in the belief that it would prevent them from wandering away (Hemphill and Hemphill 1984). Some pigeon fanciers still put caraway dough in their lofts in the belief that this will prevent the loss of the birds (Macleod 1968).

• A number of German folk beliefs held that caraway seeds were useful against evil forces (Mathias 1994). Bread made with caraway was employed to drive away demons, and seeds were sprinkled in coffins as a protection against hexes and sorcerors.

• According to another folk-belief, caraway was supposed to prevent the theft of articles in which it was placed, even holding captive the would-be thief until the rightful owner arrived (Macleod 1968).

• According to Undset (1945) "The queen of pot herbs to all Norwegians is 'Karvekal,' - caraway... Almost, but not quite as good as caraway are the young shoots of the common stinging nettle."

• Caraway is used by some to mask alcoholic breath (Farrell 1985).

Problems and Potential

Caraway seed production in Canada and the northern U.S. is a crop of limited production, of interest to a small number of growers. When grown as a biennial, with the harvest during the second year, it is susceptible to poor growing conditions such as drought or early snow. Studies have shown that while essential oil content in prairie regions of Canada may be of high quality (Mazza 1991*b*), it may also be of lower quality than seed oil produced in some other countries (Embong et al. 1977*a*). However, cultivar selection for shorter season, and higher oil content, may provide increased potential for caraway production in Canada and the northern U.S. Selection for annual caraway in the Netherlands (Toxopeus et al. 1995) may provide useful cultivars for North America. The market for caraway seed may increase as a result of the use of carvone from caraway essentail oil as a sprout-inhibiting agent for potatoes in storage (Toxopeus et al. 1995).

Selected References

Rosengarten (1969); Embong et al. (1977*a*); Duke and Reed (1978); Farrell (1985); Mazza (1991*b*); Toxopeus et al. (1995).

Fig. 111.
Roman chamomile *(Chamaemelum nobile)*, from Köhler 1883-1898).

Chamaemelum

Family: Compositae (Asteraceae) (sunflower family)

Genus Notes

There are four species of *Chamaemelum*, which are annual or perennial herbs indigenous to western Europe and the Mediterranean region.

Chamaemelum Nobile (L.) All.

Scientific (Latin) Synonyms

Anthemis nobilis L.

English Names

Roman chamomile
Also: chamomile, common chamomile, English chamomile, false chamomile (the same name used for German chamomile), garden chamomile, lawn chamomile, manzanilla (Spanish), May-then, noble chamomile, Russian chamomile, Scotch chamomile, sweet chamomile, true chamomile (the same name used for German chamomile), Whig plant, white chamomile
[Camomile is a variant spelling of chamomile. "Chamomile" is generally pronounced with a long i.]

French Names

Family: Composées, famille de la marguerite
Camomille romaine (f)
Also: anthémis noble (anthemis noble), anthémis odorant (anthemis odorant), camomele, camomèle, camomille anglaise, camomille (noble), camomille d'Anjou, camomille odorante, margaridié

Warning

Chamomile is a member of the same plant family as ragweed, and people allergic to ragweed or other members of the sunflower family need to be particularly cautious (See Medicine).

Description, Taxonomy, and History

Chamaemelum nobile is an aromatic, low-growing, creeping or trailing, considerably branched perennial (at least the root system is perennial), growing 10-30 cm tall. It has finely divided, parsley-like leaves. Roman chamomile is a native of western Europe, the Azores, and North Africa, and is found occasionally as an escape from cultivation in North America. The species was used medicinally by the ancient Egyptians (Grieve 1931). It was first recorded as a cultivated plant in England in 1265 (le Strange 1977).

Roman chamomile is a member of the sunflower family, sharing with other members of the family the characteristic of having tiny flowers grouped together to form the daisy-like head that most people mistakenly call the flower (actually an aggregate of flowers). By the 16th century in Europe, double-flowered forms had been selected (i.e., flowers with extra or more prominent petals).

This species is often confused with *Matricaria recutita* L., German chamomile. See the treatment of the latter in this book for a table comparing the two species.

Uses

Fresh or dried flower heads of Roman chamomile are used in herbal teas. Both flowers and leaves are sometimes employed for making herb beers, and in Spain the flowers are used to flavor Manzanilla, the driest of all

Fig. 112.
Roman chamomile *(Chamaemelum nobile)*,
from Harter (1988).

sherries (Zverina 1976). Hemphill and Hemphill (1984) suggest strewing a few chamomile flowers over a tossed green salad.

The flower heads of Roman chamomile are also employed pharmacologically. Aside from its use by qualified doctors, chamomile tea is often brewed by herbal enthusiasts, more for the purported medicinal properties than for its bitter flavor.

Flower extracts are used in alcoholic beverages, confections, desserts, perfumes, cosmetics, soaps, and deter-gents. Extracts are used to flavor liqueurs such as benedictine and vermouth, bitters, nonalcoholic beverages, baked goods, candy, frozen dairy deserts, gelatins, and puddings; and for such non-edible products as bath preparations, cosmetics, hair dye, mouthwashes, shampoo, and sunscreens (Duke 1985). Tobacco is also scented with Roman chamomile (Morton 1976).

The leaves are generally not used for culinary purposes, but Bryan and Castle (1974) suggest that small sprigs can serve as a seasoning for cream sauces, butter, honey and sour cream. Medium-aged sprigs should be used, the small ones lacking flavor, the large ones too strong in taste.

Roman chamomile is cultivated occasionally as an ornamental and as a ground cover. Indeed, Roman chamomile's soft, lush appearance has made it a popular grass substitute for lawns in Europe (Crockett and Tanner 1977). It can be mowed and is drought resistant.

Recipe Sources

Bryan and Castle (1974) have recipes using chamomile entitled Turkey rice casserole and Scallop ramekins.

Other recipes are: Chamomile beer (Grieve 1933); Chamomile tea (Grieve 1933; Michael 1980; Marcin 1983; Hemphill and Hemphill 1984).

Importance

Roman chamomile is cultivated in Europe for the pharmaceutical trade, particularly in England, Belgium, France and Germany. Considerably more German than Roman chamomile is produced (Mann and Staba 1986). Chamomomile (both Roman and German collectively) has been ranked as one of the top selling five herbs in the U.S. (Duke 1985).

Verlet (1993) estimated the annual world value of Roman chamomile essential oil to be U.S. $3 million.

Cultivation Notes

Soil

Roman chamomile will grow in most soils having good drainage. Single-flowered, wild-type plants do well in rather dry, sandy soils, like those of the natural habitats. Double-flowered forms should be given a richer soil, in moist, black loam. Roman chamomile has been collected in soils ranging in pH from 6.5 to 8.0 (Simon et al. 1984). A pH tolerance range of 5.5-8.0 has been reported by De Baggio (1987). Foster (1992/1993) recommends a slightly acid-to-neutral garden soil with good drainage, and warns that while a rich soil will produce lush leaf growth, few flowers may be produced.

Climate

A sunny, open situation should be provided, although slight shade can be tolerated. This perennial species has been rated as capable of growing in regions with minimum temperatures as low as -15°C (Huxley et al. 1992). According to Foster (1992/1993), Roman chamomile does not tolerate hot, dry weather.

Propagation and Cultivation

Roman chamomile can be divided easily by separating the runners and replanting them. The species is also easily established from seeds, except for the vegetatively propagated lawn cultivar Treneague. Older plants tend to die out, and may need to be replaced in an ornamental setting.

Harvest and Storage

Commercially, the flower heads may be harvested by hand during the peak blooming period, up to five times during the season, and dried in air or in a drier. For personal culinary purposes, Bryan and Castle (1974) suggest the following procedure: snip the flowers off with scissors, using only those in full bloom (flowers that have started to darken lose their flavor); wash and pat dry thoroughly, then place on a rack or mesh screen to dry in a warm place.

Example Cultivars

Flor Pleno is a double-flowered ornamental cultivar. Treneague is a non-flowering, vegetatively reproduced cultivar used for lawns (Huxley et al. 1992). Seeds of Treneague are available through North American seed catalogs.

Additional Notes

Chemistry

Drug preparations of Roman chamomile contain essential oil, flavonoid glycosides, bitter principles, and other substances. The essential oil consists mainly of chamazulene, angelic acid, tiglic acid, and several sesquiterpene lactones (Simon et al. 1984, Prakash 1990, Lawrence 1993). Angelic and tiglic acid esters comprise about 85% of the oil, one of the highest content of esters of any known essential oil (Staba and Mann 1986). Other

Fig. 113.
Roman chamomile *(Chamaemelum nobile)*, from Millspaugh (1884-1887).

constituents include anthemic acid, athesterol, anthemene, resin and tannin (Simon et al. 1994). Double-headed flowers (i.e., with extra "petals") usually yield somewhat above 0.7% essential oil on a fresh weight basis, while regular flowers are higher in yield - about 1.75% (Mann and Staba 1986).

Medicine

Roman chamomile was used as a sedative, tonic, and to relieve a range of ailments (Grieve 1931; Duke 1985). Internally it was employed to treat nervous problems, fever, colic, heartburn, loss of appetite, gout, headache, and other complaints. Externally it was used as poultices to treat facial swelling, inflammation, and neuralgia, and as lotions for toothache, earache, and other problems. Folk medicinal uses in Middle America are reviewed by Morton (1981).

In modern medicine, Roman chamomile serves as a pharmaceutical flavoring agent, and in antiseptic lotions for cracked nipples, inflammations, sore gums, and wounds (Duke 1985). Extracts have shown antitumor activity (Simon et al. 1984). Other uses are much the same as for German chamomile.

A case of anaphylactic shock after a few sips of "chamomile tea" has been recorded (Snider 1991; whether Roman or German chamomile tea was involved is uncertain). Chamomiles, even chamomile ointments, can also cause contact dermatitis (Simon et al. 1984; Duke 1985). Growers cultivating chamomile have developed dermatitis (Duke 1985). Individuals allergic to ragweeds may show hypersensitivity reactions (dermatitis, anaphylaxis, or other symptoms). On the whole, toxic reactions to the chamomiles seem to be quite limited. A survey of the world's medical literature for the 95 years from 1887 to 1982 revealed only 50 negative reactions, 45 from Roman chamomile and just five from German chamomile (Castleman 1991). Additional information pertaining to Roman chamomile is presented in the discussion of German chamomile.

"Roman and German chamomile are generally recognized as safe for human consumption as natural seasonings/flavorings and as plant extracts/essential oils from the flowers" (Simon et al. 1984). According to Tyler (1993), because of its infrequency "chamomile hypersensitivity should certainly not deter normal persons from consuming it if they so desire."

Nutrition

The chamomiles are used in such limited amounts that they do not supply significant nutrition.

Curiosities

• The name chamomile was coined by the classical Greeks, from *kamai*, on the ground, and *melon*, apple, literally ground-apple, reflecting the apple-like odor and low-growing character of the plant (le Strange 1977). The Spanish name manzanilla (note the Spanish beverage with this name) signifies "little apple" (Grieve 1931).

• The word "Roman" in Roman chamomile, serves to distinguish this species from German chamomile. Ironically, the name Roman chamomile has persisted since the 16th century when a German botanist discovered it growing wild in the environs of Rome (Sanecki 1974).

• Roman chamomile was one of the aromatic strewing herbs used in the Middle Ages, purposely planted in walks so that when it was stepped on it released its pleasant odor (Grieve 1931).

• Roman chamomile is used as a ground cover or lawn because it tolerates traffic on it well. This is likely the chamomile referred to by Falstaff in *Shakespeare's Henry IV, Part I*: "the camomile, the more it is trodden on, the faster it grows."

• Sir Francis Drake is believed to have been playing bowls on a green of Roman chamomile when told that the Spanish Armada was approaching the English Channel (le Strange 1977).

• Chamomile used to be called the "Plant's Physician," a reference to the belief that when it was planted in gardens it cured nearby plants that were sickly (Grieve 1931).

• In *The Tale of Peter Rabbit*, after gorging himself in Mr. McGregor's garden Peter is chased away by the angry man. Upon returning home, Peter's mother served him chamomile tea (Castleman 1991).

• In the early days of America, chamomile was used to quiet fetal kicking (Castleman 1991).

• A chamomile enema may cause asthma (Duke 1985; compare German chamomile Curiosity regarding chamomile suppositories).

• Rinzler (1990) notes that chamomile flowerheads are sometimes full of seed-loving insects. For those not desiring the extra protein, she recommends the following procedure to get rid of these: spread the flowers on a cookie sheet, dry in an oven at 120°C for half an hour, sift the flowers in a strainer or colander, and discard the debris.

Problems and Potential

See comments for German chamomile (*Matricaria recutita*).

Selected References

Grieve (1931); Simon et al. (1984); Mann and Staba (1986); Hamon (1989); Foster (1992/1993).

Fig. 114.
Roman chamomile *(Chamaemelum nobile)*, from Syme et al. (1863-1886).

Chenopodium

Family: Chenopodiaceae (goosefoot family)

Genus Notes

Estimates of the number of species of *Chenopodium* vary from about 100 (H. Wilson, personal communication) to about 250 (Bailey and Bailey 1976). The species are annuals and perennials of wide distribution. From a culinary point of view the genus is best known for *C. bonus-henricus* L., good king Henry, a potherb that is discussed in detail as a vegetable in a companion book to this volume (Munro and Small 1997). Several other species are grown as ornamentals, for their nutritious seeds, and as potherbs. In additional to the four species highlighted below, ten additional species of *Chenopodium* that are eaten are discussed by Facciola (1990). Several recipes that may be used with different species of *Chenopodium* are give by Michael (1980).

Chenopodium album L., lamb's quarters, is an annual which originated in Eurasia and is now a weed worldwide. It is sometimes collected from the wild as a potherb, and a cultivar called Magenta has been developed in California for the San Francisco restaurant trade (Facciola 1990).

Chenopodium capitatum (L.) Asch., strawberry blight, is another often weedy annual. This native of North America also occurs in Eurasia, and is sometimes collected from the wild for use as a potherb.

Chenopodium quinoa Willd., quinoa, is native to the Andes, and the seeds are a staple grain in parts of South America. Quinoa is grown as a crop in Canada and the U.S., and substantial amounts are sold in health-food stores.

Chenopodium Ambrosioides L.

English Names

Mexican tea, Epazote
Also: American goosefoot, American wormseed, Baltimore wormseed, bitter weed, Californian spearmint (in New Zealand), demi-god's food, epasote, herb sancti Mariae, Indian wormweed, Jesuit's tea, Mexican goosefoot, mouse food, pazote, Spanish tea, West Indian goosefoot, worm bush, worm grass, wormseed, wormseed goosefoot, worm-seed oil plant, wormweed
[Other English names noted by Morton (1981) include hedge mustard (a name well established for the common weed *Sisymbrium officinale* (L.) Scop.) and stinkweed

Fig. 115.
Mexican tea *(Chenopodium ambrosioides var. ambrosioides)*, from Hallier (1880-1888).

(used for other species, for example *Thlaspi arvense* L., and *Pluchea camphorata* (L.) DC.).]

French Names

Family: Chénopodiacées, famille du chou gras (famille du chénopode)
Thé du Mexique (m)
Also: abroisine, ambroisie (des jardins), ambroisie du Mexique, ambroisin, ansérine ambroisie, ansérine américaine, anserine fausse ambroisie, ansérine anthelmique, ansérine du Mexique, ansérine odorante, ansérine vermifuge, blite ambroisie, chénopode ambrosioïde, chénopode fausse ambroisie, herbe de Sainte-Marie, pied d'oie, thé de Silésia, thé des Jésuites, thé d'Espagne

The name Mexican tea is highlighted to emphasize the culinary use of the plant. Used as a tea, Mexican tea is popular in Mexico, southern France, Germany, and the West Indies (Morton 1976). For pharmaceutical purposes the plant is more commonly known as wormseed. In the southern U.S. and Mexico it is usually known as epazote. Morton (1976) highlighted the name ambrosia for this species, a usage I have not encountered elsewhere. Following others, the name ambrosia is used for *C. botrys*, the next species described (which is commonly called "*Ambrosia mexicana*" in the horticultural literature). Morton (1981) listed as common names for *C. ambrosioides* Jerusalem bush, Jerusalem oak, and Jerusalem parsley, since Jerusalem oak is widely used for *C. botrys*, it is not advisable to use these names for *C. ambrosioides*, which in any event may simply represent confusion of the two species. Brako et al. (1995) also list Jerusalem tea as a common name for *C. ambrosioides*, and this usage too is similarly unwarranted.

Ephedra, with about 40 species, is the only genus of the Ephedraceae, a rather unique group of desert or semi-desert shrubs of Asia, northern Africa, and North America. Some of the species are sometimes called Mexican tea, and are consumed as tea, and so could be confused with *C. ambrosioides*. *Ephedra nevadensis* Wats., a native of the southwestern U.S. and Mexico, is called Mormon tea as well as Mexican tea. It was once a very popular folk remedy for syphilis and gonorrhea (hence the name whore-house tea), and is still consumed both for its alleged medicinal properties and for its taste (Tyler 1993). Several Asian species (but not North American plants) contain alkaloids, notably ephedrine, a useful nasal decongestant (Tyler 1993). The medicinal use of *Ephedra* species dates back 5,000 years in China, where the drug is known as *ma huang*; the herb has been described as the world's oldest medicine (Castleman 1991), and has been used to treat upper-respiratory problems. Concern that ephedrine from *Ephedra* could serve as a precursor for the illegal synthesis of methamphetamine or "speed" has led to legislation in some states restricting the availability of herbal preparations (Tyler 1993). Overdoses of ephedrine can cause irregular heartbeat, heart attack, stroke, seizures, psychosis and even death (Burros and Jay 1996). Unfortunately in the U.S. pills made partly or wholly of *Ephedra* are now marketed in natural food stores, under such names as Herbal Ecstacy, Cloud 9, and Ultimate Euphoria, as a way to get a "legal high" (Burros and Jay 1996). Advertised as a way of obtaining "a pleasant buzz without side effects, heightened sexual feeling and tingly sensations," adverse reactions and deaths have resulted (Burros and Jay 1996).

Warning

Chenopodium ambrosioides contains pharmacologically active principles and cases of poisoning have been recorded. Although widely used as a culinary herb in Mexico, its consumption could be hazardous. If eaten despite this warning, it should only be consumed in very limited quantities, and rarely.

Description, Taxonomy, and History

Chenopodium ambrosioides, a native of tropical and subtropical America, is an annual or a perennial depending on its situation. It has become naturalized in warm regions throughout the world. In North America it grows along roadsides and in waste and cultivated grounds as far north as southern Canada. In the southwestern U.S. it thrives along stream beds (Hutson 1987). The species is quite variable, and the different variations are difficult to classify. The plants grow from 0.5 to 1.5 m tall; weedy forms in North America are usually about 0.8 m in height. Large clusters of small, yellowish-green flowers are produced in midsummer to early fall and, later, small brownish-black seeds. Plants that are cultivated to make tea and soup are sometimes put in var. *ambrosioides*, while those cultivated for use as a vermifuge and source of wormseed oil are sometimes placed in var. *anthelminticum* (L.) A. Gray (Mansfeld 1986). The species is strongly aromatic. Worm-seed oil, the chief product of interest of the plant, is produced mostly in the leaves and the seeds, the seeds normally producing more than half of the plant's yield. The leaves are conspicuously dotted beneath with oil glands. *Chenopodium ambrosioides* was used for centuries as a vermifuge in the Americas, and was also used for the same purpose in post-Columbean times in Europe and Asia.

The availability of Mexican tea as a wild plant has made it a "poor man's herb" for centuries in Mexico, enhancing otherwise common peasant fare (Hutson 1987). Kennedy (1989*a*) described the plant as "the most Mexican of the culinary herbs."

Uses

The turpentine-like odor of Mexican tea is rather objectionable, although Hutson (1987) states "don't let this discourage you! Its pungence and refreshing camphor and minty overtones can lend a pleasing contrast to many foods." According to Kennedy (1989*b*), the plant grown in the north does not have as strong a flavor as that grown in Mexico. The foliage is used to flavor corn, black beans, mushrooms, fish, soups, stews, chile sauces, shellfish, and

Fig. 116.
Mexican tea *(Chenopodium ambrosioides var. anthelminticum)*, from Millspaugh (1884-1887).

freshwater snails (Facciola 1990). The foliage is also used to brew a tea, and the tender leaves are sometimes used as a potherb.

Hutson (1987), who provides a most extensive and enthusiastic culinary account, wrote: "Remember to add the dried leaves the last 15 minutes of cooking so that the food will not become bitter, and remember to use the fresh herb sparingly, as its flavor must be acquired by most. In very large doses, toxicity may occur."

Mexican tea is cultivated mostly for its essential oil which has medicinal properties (see Medicine). *Chenopodium* oil or American wormseed oil is obtained by steam distillation of the above-ground flowering or fruiting plant. The oil is used as a fragrance in soaps, detergents, creams, lotions, perfumes, and other cosmetic products (Duke 1985).

Mexican tea is sometimes used to repel pests. It has been employed to deter insects from eating stored grains (Su 1991). Indochinese farmers mix the fruiting stalks with fertilizer to discourage insect larvae in their crops (Duke 1985). In Brazil, the plant is used as a household insect repellent and insecticide (Morton 1981).

Recipe Sources

Hutson (1987) has recipes entitled Crab cushions with epazote, Tomatillo sauce, Frijoles negros en olla, Refritos (refried beans), Caffé Annie's black bean terrine with goat cheese, Corn relish, Golden corn soup with roasted pepper strips and epazote, Pollo con epazote, and Quesitos.

Other recipes with Mexican tea are: Corn cooked with epazote (Kennedy 1978); A joy of a black bean soup (Rose 1979); Quesadillas with epazote (von Welanetz and von Welanetz 1982).

Importance

Mexican tea is a popular herb tea in Mexico, Germany, and the West Indies (Morton 1981). Culinary use of Mexican tea is generally limited in northern North America, but not in Mexico. "Because of its tenacious character and ability to withstand less than optimum growing conditions, epazote remains unmatched in traditional Mexican cuisines" (Hutson 1987). It does not withstand the arid climate of northern Mexico well, but is used throughout southern and central Mexico. It is employed to a limited extent in the U.S., mostly by those of Latino heritage. However, according to Hutson (1987) "this herb is rapidly gaining popularity, and seeds are now available from special mail-order catalogs."

Mexican tea is economically important as a source of drugs and as a garden plant. For extraction of drugs, the species has been cultivated in the U.S. [Illinois, South Dakota; "formerly cultivated in Maryland and Ohio" (Morton 1981)]; it has also been grown in Transcaucasia, and Moldavia.

Essential oil produced from Mexican tea is of minor value. Verlet (1993) estimated the annual world value of "*Chenopodium*" essential oil to be U.S. $40,000.00. The essential oil was used until recently against roundworms, hookworms, dwarf (not large) tapeworms, and intestinal amoebae, but has largely been replaced by synthetics (Foster and Duke 1990).

Cultivation Notes

Soil

Mexican tea grows well in almost any soil, but a good sandy loam is best (Sievers 1948). Carroll Country, Maryland has been the chief site of production of wormseed oil in North America, and its soils have been the model for successful growth. The soils have generally been well-drained, gravelly loams, normally high in potash (which is rich in potassium). The best yields of ascaridole (the active principle of wormseed oil) have been obtained when the nitrogen: phosporus ratio is about 1: 4. Tolerance ranges of pH reported are 7.3 to 8.3 (Duke and Hurst 1975) and 5.0 to 8.7 (Duke 1979).

As a wild plant in the southwestern U.S., Mexican tea is sometimes seen in disturbed, poor soil (Hutson 1987).

Climate

Mexican tea originates from subtropical areas, but has proven itself capable of being grown as a commercial pharmacological crop as far north as Maryland. Length of growing season is a constraint in how far north the species can be grown (for harvest of oil), as at least 5 months of suitable temperatures are necessary. Mexican tea is a short-day plant, flowering promoted by shorter days of late summer. In the southwestern U.S., which has high light levels, wild-growing Mexican tea is often found in habitats with afternoon shade, and can be grown in partial shade (Hutson 1987). However, it also grows well in full sun.

Propagation and Cultivation

Seeds take several weeks to germinate, and stem cuttings root slowly in water (Hutson 1987). Mature plants needs to be kept pinched back or they will go to seed. In warm climates of the southern U.S., garden plants can become weedy through dispersal of the seeds. In California, gardeners often find Mexican tea as an unwelcome weed in their gardens. Northern gardeners wishing to experiment with the culinary value of Mexican tea needn't grow more than a single plant, or two for insurance. Potted plants may look straggly if allowed to grow tall, and should be trained to bush form by pinching back the lead shoot (Hutson 1987).

Commercial wormseed production in the U.S. has been carried out much as for tobacco production (Weiland et al. 1935).

Harvest and Storage

Very little Mexican tea is needed in recipes, and fresh sprigs can be picked from a garden or potted plant and used as needed.

To dry Mexican tea, branches or plants can be hung upside down in a dark, well-ventilated room until completely dry, and the leaves stored in tightly covered jars in the dark to prevent their turning yellow (Hutson 1987).

In experimental growth in Peru, leaf yields of 12,700 kg/ha fresh, and 900 kg/ha dry, have been obtained (Ugás, personal communication).

When harvested for oil, plants are allowed to mature until 50% of the seeds are black. Entire plants are harvested. Overly mature plants drop their seeds.

Example Cultivars

No information found.

Additional Notes

Chemistry

The average oil content of commercially harvested plants is about 2% on a dry weight basis. Ascaridole is the active principle in the oil, and predominates in var. *anthelminticum*, whereas in plants not of this variety other components, such as pinocarvone and trans-pinocarveol, are the major constituents (Sagrero-Nieves and Bartley 1995). Ascaridole content seems to rise relative to other components up to the time mature seeds are produced (Weiland et al. 1935). Geraniol, a saponin, *l*-limonene, *p*-cymene, *d*-camphor, methyl salicylate and numerous other compounds have also been identified in the essential oil (Morton 1977; Perry and Metzger 1980; Sagrero-Nieves and Bartley 1995).

Fig. 117.
Mexican tea *(Chenopodium ambrosioides)*, from Nicholson (1885-1889).

Medicine

The Creek Indians used *C. ambrosioides* as a spring tonic (Wilson 1963). In folk medicine Mexican tea was also used to treat asthma, malaria, and various nervous diseases, but its main use has been as a vermifuge (Grieve 1931). According to Morton (1981), the seed oil paralyses, but does not kill intestinal worms, which must be expelled by a purgative. The oil of Mexican tea is particularly effective in getting rid of hookworms, but is a dangerous remedy in the hands of laypeople, overdoses causing poisoning (Grieve 1931). Nevertheless it is widely used in the world as a vermifuge. Warnings have been recorded suggesting that Mexican tea has the potential for causing abortion (Morton 1981). Morton (1981) notes that mild reactions to the oil are headache, dizziness and nausea, while more severe symptoms include vomiting (sometimes bloody), deafness, tingling of the extremities, and depression. Acute poisoning may be fatal. In western medicine the oil is now seldom used in pharmaceutical preparations because it has been replaced by synthetic anthelmintics (Su 1991). The plant continues to be employed medicinally in Asia for a variety of ailments (Perry and Medsger 1980). Morton (1981) provides an extensive list of home medicinal uses in Middle America. Duke (1985) lists numerous folk uses in various cultures around the world.

Touching Mexican tea may cause dermatitis and allergic reactions, and a case of vertigo from contact with essential oil released during harvest has been described (Foster and Duke 1990). Fernald et al. (1958) recommended that Mexican tea not be consumed as a potherb. Chickens have died from eating the seeds, and while grazing animals usually avoid Mexican tea, it has caused fatalities in cows (Morton 1981).

Nutrition

Morton (1981) describes Mexican tea as a good source of calcium, iron, carotene, riboflavin, and ascorbic acid. Duke (1985) provides analyses of food and vitamin value of the foliage. Because of the high toxicity, significant amounts cannot be consumed to supply nutrients to the human diet.

Curiosities

• Epazote, the popular Mexican name for Mexican tea, is derived from the Nahuatl words *epatl* and *tzotl*, meaning an animal with a rank odor, a reference to the turpentine-like smell (Hutson 1987).

• Cooking the leaves of Mexican tea with beans is said to reduce the flatulence caused by the latter (Facciola 1990). In Mexico where the herb is well known, Mexican tea is commonly added to bean dishes to avoid socially embarrassing consequences (Hutson 1987).

• The name Baltimore wormseed arose from the fact that the Baltimore Maryland area was the center of production of wormseed in North America for over a century (Weiland et al. 1935).

• Brazilians feed Mexican tea to pigs to rid them of parasites (Duke 1985).

• In New Mexico, suppositories of dried pulverized leaves of Mexican tea, ground spearmint and salt have been inserted into the rectum as a remedy for appendicitis (Morton 1981).

• One of the many health problems treated with a Mexican tea folk remedy is athlete's foot. It has been found that Mexican tea indeed inhibits fungi such as cause this disease, confirming the wisdom of this herbal remedy (Duke 1985).

• The popular use of Mexican tea in New York city by Latinos has led to it becoming somewhat weedy there, growing in cracks of sidewalks and in Central Park (Hutson 1987).

Problems and Potential

The culinary use of Mexican tea is limited by its toxicity and restricted taste and aroma appeal. Mexican tea's potential as a medicinal plant in North America is presently limited in view of its restricted use in modern western medicine. In North America medicinal use is exceeded by use in cosmetic preparations, and perhaps there is some potential for increasing the market for this purpose.

Selected References

Weiland et al. (1935); Hutson (1987).

Chenopodium Botrys L.

Scientific (Latin) Synonyms

Ambrosia mexicana hort.

English Names

Ambrosia
Also: sticky goosefoot, feather geranium, Jerusalem oak (hyphens between words of the latter two names optional), Jerusalem oak goosefoot, turnpike goosefoot

[The common name ambrosia should not be confused with the scientific name *Ambrosia*, which refers to quite different species. *Ambrosia artemisiifolia* L. is the common ragweed, the most abundant of the ragweeds that cause hay fever.]

French Names

Chénopode botrys (m)
Also: ansérine à épi, botri, herbe à printemps, millegraine, piment aromatique, piment botrys

Fig. 118.
Ambrosia *(Chenopodium botrys)*, from Hallier (1880-1888).

Warning

This plant contains pharmacologically active principles. It is suggested that its consumption be avoided, or at least highly limited.

Description, Taxonomy, and History

Chenopodium botrys L., ambrosia, is native to southern Europe, the Orient, and central Asia, and has become locally naturalized in central Europe, North and South Africa, Australia, and North and South America. In North America it grows along roadsides and in waste and cultivated grounds as far North as southern Canada, from sea to sea. Ambrosia is an unpleasant smelling, annual herb, 10-80 cm high, covered with sticky, glandular hairs. It produces small, but numerous flowers in late summer and fall. Ambrosia was cultivated in Germany in the nineteenth century, for use in controlling moths and for medicinal purposes. A cultivar called Green Magic was developed in The Netherlands, and is said to have a delicious, nutty flavor (Facciola 1990).

Uses

The leaves of ambrosia are sometimes used as a potherb, and are employed as a tea substitute. The South African Bantu have consumed it like spinach (Watt and Breyer-Brandwijk 1962). However, Fernald et al. (1958) recommend that ambrosia not be consumed as a potherb.

The oil of this species is occasionally used for medicinal purposes. Ambrosia is sometimes cultivated as a garden plant, particularly for its intensely fragrant foliage, and for its arching stems and flowers, valued in dried flower arrangments.

Recipe sources

None found.

Importance

Ambrosia is cultivated as a medicinal plant in the warmer parts of Europe. It has been grown recently in Kazakhstan as a medicinal plant.

Cultivation Notes

Soil

In its indigenous range in Europe and parts of Asia, ambrosia is typically found in sandy soils (le Strange 1977). According to Crockett and Tanner (1977), ambrosia will flourish in any kind of well-drained soil.

Climate

As reflected by its weedy distribution in North America, ambrosia can be cultivated as far north as much of southern Canada. It does best in full sun (Crockett and Tanner 1977).

Propagation and Cultivation

The plant is propagated by the tiny seeds, best scattered on the soil surface where they are to grow, and the seedlings thinned to about 35 cm apart (Crockett and Tanner 1977).

Harvest and Storage

For harvesting material for culinary purposes, see information for Mexican tea, discussed above. For dried flower arrangements, harvest the plants before they go to seed, and place the cut stems in vases without water, allowing the stems to dry away from the sun (Crockett and Tanner 1977). The graceful dried sprays should retain their delicate green hue. Unharvested plants left to go to seed may produce a weed problem in the garden.

Example Cultivars

Green Magic

Additional Notes

Chemistry

The chemical composition of ambrosia essential oil was examined by El-Sayed et al. (1989). According to Watt and Breyer-Brandwijk (1962), the oil does not contain ascaridol, the vermifuge agent of wormseed.

Medicine

In the Mediterranean area, ambrosia has been used as a stimulant, and to relieve spasms, asthma, inflammations of the mucous membranes of the nose and air passages, and migraine (Watt and Breyer-Brandwijk 1962). In China, it has been employed to treat poisonous insect and spider bites (Revolutionary Health Committee 1977). Ambrosia oil has also been used to promote discharge of mucus from the respiratory tract (Grieve 1931). The Cherokee used an infusion of ambrosia, both internally and externally, for colds and headache; a root infusion for fever; and a herbal mixture including various parts of the plant for worms (Moerman 1986). In the Dutch East Indies ambrosia has been used against worms, although as noted above it lacks ascaridol (Watt and Breyer-Brandwijk 1962).

Nutrition

Ambrosia is not known to supply nutrients to the human diet.

Fig. 119.
Ambrosia *(Chenopodium botrys)*, from Beal (1915).

Curiosities

• The alternative name "Jerusalem oak" reflects the oak-like appearance of the leaves of ambrosia. Jerusalem oak is neither an oak nor a native of Jerusalem (similarly, Jerusalem artichoke, *Helianthus tuberosus* L., is neither an artichoke nor a native of Jerusalem).

• In North America *C. botrys* became established along railroad embankments during the age of steam locomotion. The plant thrives in potash-rich soils which come from the ashes of wood and coal. With the advent of diesel power and the leaching of potash from the embankments, the plant occurs less commonly (Crompton, personal communication).

• In Tanganyika (now part of Tanzania) plants in seed are said to be powdered and used in food by assassins to poison people (Watt and Breyer-Brandwijk 1962).

Problems and Potential

The toxic potential of ambrosia limits its potential as a crop. It is used to a very limited extent as medicine and food, but seems to have essentially no potential for either in North America.

Selected References

No article providing appreciable information on ambrosia was located.

Cichorium

Family: Compositae (Asteraceae) (sunflower family)

Genus Notes

The genus *Cichorium* is composed of nine species native to the Mediterranean region, one of these reaching northern Europe and another Ethiopia. Two of the species, *C. endivia* L, endive, and *C. intybus* L, chicory, have been domesticated, and are dealt with extensively as vegetables in Munro and Small (1997). The following treatment of *C. intybus* concentrates on its use as a coffee substitute.

Cichorium Intybus L.

English Names

Chicory
Also: bachelor's button, blowball, blue daisies, blue daisy, blue dandelion, blue sailors, bunk, coffee-weed, common chicory, Italian dandelion, monk's beard (after the French *barbe de capucin*), ragged sailors, succory, wild bachelor button, wild chicory, wild endive, wild succory

French Names

Family: Composées, famille de la marguerite

Chicorée sauvage (f)
Also: barbe-de-capucin (barbe de capucin), cheveux de paysan, chicorée, chicorée bleue, chicorée à café, chicorée amère, chicorée commune, chicorée cultivée, chicorée frisée, chicorée intybe, chicorée ordinaire, écoubelle bleue, écoubette, écoubette bleue, endive sauvage
[Chicorée sauvage is applied either to roots or foliage of wild plants. Barbe-de-capucin is an international French term, applied to edible roots. Chicorée, also an international word, refers to any part of the plant.]

Description, Taxonomy, and History

Chicory is a perennial herbaceous plant native to parts of Eurasia and northern Africa. The wild plant, var. *intybus* of some authors (Mansfeld 1986), has been introduced in the Americas, South Africa, Australia, and New Zealand. Wild chicory grows, often abundantly, in waste places, pastures, fields, and along roadsides. In North America it occurs from southern British Columbia to Nova Scotia, and south throughout the U.S., but especially in the eastern and central states. As weeds, chicory plants may be less than 20 cm tall in poor circumstances, but can reach a meter in height in good soils, while cultivated plants at the flowering stage can be 1-2 m tall. Chicory has bright blue (rarely white or pink) flowers. A dandelion-like rosette of leaves is produced. A class of thick-rooted cultivars sometimes called "Italian Dandelion" (Halpin 1978) is discussed below.

Wild chicory was known to the classical Romans, who used it medicinally and as a salad plant (Grieve 1931). However, chicory was not domesticated until 1845 at the Botanical Gardens in Brussels. That form became known as "witloof," Flemish for "white leaf." Cultivation was so successful that by 1875 roots were exported to France for consumption. By 1899, leaf chicory production was a new enterprise in the United States.

One distinctive group of vegetable cultivars [var. *foliosum* Hegi of some authors (Mansfeld 1986)] produces a tightly closed rosette of leaves. These forms are dug in the fall, given a cold treatment, and forced in the dark to produce the *chicons* (tightly closed rosettes of leaves). · These vegetables are variously called witloof chicory or French, Belgian, or Brussels endive.

The remaining (nonforcing) vegetable cultivars are sometimes placed in var. *sativum* Lam. & DC. of some authors (Mansfeld 1986). Green-leaved forms (Italian selections called radichetta) are grown for their deeply notched foliage and petioles that are used in salads. "Asparagus chicory" (also sometimes called Italian dandelion, like the thick-rooted forms of chicory) is grown for its thick petioles, served like asparagus and allegedly tasting like it (Halpin 1978). Broad-leaved forms (Italian selections called radicchio, chioggia, or Italian chicory) are also grown for their dark red or variegated red and green leaves, which are used in salads.

Also placed in var. *sativum* are nonforcing forms selected specifically for their distinctive, deep, fleshy tap roots, some growing more than 30 cm in length, that are used as a coffee substitute. The roots of these are thickened, externally yellow and internally white. In Italy this group of cultivars is sometimes called Cicoria Siciliana or Madgeburg (a name also given to a single cultivar). The roots are dried, chopped, roasted, and ground, and then added to coffee to impart a strong, bitter flavor. The roots of the vegetable cultivars are also sometimes dried and used like coffee. Thick-rooted varieties of chicory seem to have first become popular as coffee substitutes during the 18th century (Halpin 1978). Since then, chicory roots

Fig. 120.
Chicory *(Cichorium intybus)*, from Clark and Fletcher (1906).

Fig. 121.
Chicory *(Cichorium intybus)*,
from Oeder et al. (1761-1883).

have been used extensively in Europe as a substitute for, or additive to coffee, especially during times when coffee was scarce or expensive.

Uses

The forcing vegetable forms of chicory are generally grown for the blanched shoots (chicons), which are cooked by steaming, boiling, or baking and used in vegetable dishes. During the summer the dandelion-like leaves can be cooked or used in salads, and the roots may be cooked and eaten like carrots.

The nonforcing vegetable forms (including radichetta) are sown in late June through late July for autumn harvest. The leaves are used fresh in salads.

Forms selected for edible roots are pulled, washed, and cut into short segments. These pieces are dried and roasted in a slow oven at 120°C until they are brown and brittle. They are then ground and stored in a closed container in a cool place (Turner and Szczawinski 1978). The pieces may be ground and mixed with a similar grind of coffee to make a pleasant drink. Chicory is added to some coffee brands marketed in North America and is also available separately as a coffee substitute. The addition of chicory gives coffee a deeper color and longer-lasting flavor and aroma. Many prefer the flavor of coffee blended with chicory over the taste of coffee by itself. Chicory root does not contain caffeine.

The chicory found as a common weed in fields and along roadsides can also be used as a coffee substitute. Wild chicory roots can be dug up during the summer months, and processed as described above for cultivated roots.

In order to generate tasty shoots, the wild plants can be dug up in late fall and stored in moist sand in a cool location, with occasional watering. Young crisp sprouts will appear a few weeks later. Because these are wild plants they are unlikely to be as acceptable as cultivars. The leaves of forms with roots selected as a coffee substitute can be picked and used in salads but also may not be nearly as palatable as cultivars selected for edible leaves.

The attractive blue flowers can be used in salads, either fresh or pickled (Facciola 1990). Young, tender roots can be boiled and eaten as a vegetable. Chicory extracts are used in beverages, both alcoholic and nonalcoholic (Simon et al. 1984). Extracts are also used commercially to flavor ice cream, candy, and baked goods (Morton 1981). Chicory is sometimes grown for forage (Rocklein and Leung 1987).

Chicory is a source of inulin, a Iow-calory agent. The inulin can be hydrolysed to produce a high fructose syrup that is used as a sweetener in the food and beverage industry. However, production has generally not been economically feasible, because artichoke is a better source (Rubatzky, personal communication).

Recipe Sources

Crowhurt (1973) has recipes entitled Crystallized chicory flowers and Pickled chicory flowers. Barash (1993) has several chicory flower recipes, entitled Chicory ricotta; Crab spread; and Red, white and blue salad.

Other recipes are: Chicory coffee (Szczawinski and Turner 1978; Turner and Szczawinski 1978); Chicory flower and cottage cheese salad (Phillips 1986).

Importance

Chicory is primarily of value as a vegetable, and is far more important in Europe than in North America. The use of chicory roots as a coffee substitute is limited. Root

chicory has produced yields of inulin of 9.8-16.1 t/ha in the Netherlands, and the sugar industries of the Netherlands and Belgium were expected to grow about 5 000 ha of root chicory in each country to produce inulin in 1992 (van Soest 1993). It may be noted that references to cultivation of "chicory" frequently refer to the vegetable varieties rather than the thick-rooted forms, and therefore establishing the importance of the latter in North America is difficult.

Cultivation Notes

Soil

Chicory will grow on a wide range of soil types from mineral to muck soils. Wild chicory has been collected on soils ranging in pH from 4.5 to 8.3 (Simon et al. 1984), although in cultivation 6.0-7.5 is acceptable, and calcareous soils are best. In the garden, soil should be friable to a depth of at least 35 cm to accommodate the long taproot. Crockett and Tanner (1977) recommend that generous

Fig. 122.
"Magdeburg chicory" *(Cichorium intybus)*,
from Vilmorin-Andrieux et C^{ie} (1883).

amounts of manure or compost should be dug into the soil. However, Rubatzky (personal communication) advises that excess nitrogen can result in excessive vegetative growth.

Climate

Cultivated chicory is a hardy perennial that may be grown in most parts of North America. It does best in somewhat cool weather. Commercial cultivars are usually direct-seeded (rarely transplanted) after soils remain above 7°C. Sustained periods below this temperature cause bolting, which uses up the energy stored in roots, making them poor for use as a coffee substitute. Irrigation is advisable during dry periods.

Propagation and Cultivation

Propagation is by seeds. Plants should not be allowed to flower as this will rob the root of its energy reserves. Root chicory will tolerate freezing, but where winters are very cold the plants may be dug up, de-topped (except for

Fig. 123.
"Brunswick chicory" *(Cichorium intybus)*,
from Vilmorin-Andrieux et C^{ie} (1883).

the top 5 cm, with the growing point), and stored just above freezing in a horizontal position in sand or peat moss, for replanting in the spring.

Harvest and Storage

Roots can be harvested in late fall, dried, and ground for use as a beverage.

Example Cultivars (for use as a Coffee Substitute)

Magdeburgh (= Magdeburg = Cicoria Siciliana), Brunswick, Palinghop

Additional Notes

Chicory is classed as a weed under Canadian federal legislation.

Chemistry

The natural taste modifier maltol, known to intensify the flavor of sugar, is extracted from chicory (Simon et al. 1984). Fructose for the flavor industry can also be obtained. Young leaves contain tannin and a glycoside (Morton 1981). Fresh roots contain 77% water, 7.5% gummy matter, 1.1% glucose, 4.0% bitter compounds, 0.6% fat, 9.0% cellulose, inulin and fiber, 0.8% ash, and minor amounts of choline, stearin, mannite, tartaric acid, tannin, a fatty oil and a volatile oil, and other compounds (Simon et al. 1984; Duke and Ayensu 1985; Tyler 1993). Palmitic and linoleic acids are major components of the air-dried root (Sannai et al. 1982). The bitter principles are lactucin and lactucopicrin (Tyler 1993). Oven roasting of the inulin converts it to oxymethylfurfurol, a compound with a coffee-like aroma (Tyler 1993).

Medicine

Chicory has been used medicinally since the period of the classical Romans (le Strange 1977). A decoction of the roots was purported in the Middle Ages to be effective in treating jaundice, liver enlargements, gout, and rheumatic complaints (Grieve 1931). Chicory has also been used as a digestive aid, to stimulate urination, as a laxative, tonic, mild sedative, and to treat warts, tumors and cancer (Simon et al. 1984). The leaves have been employed as a source of vitamin C to prevent and cure scurvy (Angier 1978). The Iroquois used a decoction or poultice of roots for fever sores (Moerman 1986). Cherokee Indians used the roots in nerve tonics and as a poultice for skin infections (Duke 1992*a*). In Egypt chicory root serves as a folk remedy for tachycardia (rapid heart-beat) (Tyler 1993). Root extracts have been shown to decrease activity of toad heart tissue (Simon et al. 1984). Tyler (1993) comments that this subject requires additional study. Duke (1992*a*) provides an extensive list of pharmacological effects of chicory. Chicory plants are presently used in medicine in China (Duke and Ayensu 1985), and in folk medicine in Middle America (Morton 1981).

Grieve (1931) noted that excess use of chicory could produce loss of retinal vision and sluggish digestion, and Duke (1992*a*) pointed out Grieve's warning. Research does not seem to have been conducted to clarify these symptoms. Duke (1992*a*) recorded that chicory in coffee has caused dermatitis in workers handling the mixture. Tyler (1993) concluded that except for the occasional allergic reaction, chicory consumption is quite safe.

Nutrition

Fresh chicory roots contain large amounts of vitamins A and C (Simon et al. 1984). The roots also contain 11-15% (up to 58% in cultivated plants) inulin (a low-calory sweetener), and 10-22% fructose (Tyler 1993).

Curiosities

• A statute was passed in 1832 in England forbidding the use of chicory to adulterate coffee. However, the taste had become so popular that the law was repealed in 1840 (Halpin 1978).

• The beautiful blue of chicory flowers is alluded to in the name "blue-sailors," and in Emerson's poetry (Medsger 1939):

> Grass with green flag half-mast high,
> succory to match the sky.

• The flowers (i.e., flower heads) of chicory close at night, and usually in bright afternoon sunlight (Turner and Szczawinski 1978). The famous botanist Linnaeus (1707-1778; note how many names in this book were coined by him) used chicory as one of the flowers in his "floral clock" in his garden at Uppsala Sweden, because the flowers regularly opened there at 5 a.m. and closed at 10 a.m. (Grieve 1931).

• Like the ephemeral flowers of day lilies, the flower heads of chicory usually last just one day, rarely longer (Belzer, personal communication).

• A German legend relates how a girl waited daily for the return of her betrothed, finally dying of a broken heart by the roadside. Chicory arose on the spot, explaining the German name "watcher of the road" (Sanecki 1974).

Problems and Potential

Chicory is grown mostly as a vegetable crop, and in this regard there are reasonable prospects for increasing production. The use of chicory as a coffee substitute is mostly limited at present to a gourmet market. Given the volatile price of coffee, it is possible that market conditions could arise that would justify the increased development of chicory as a beverage crop.

Selected References

Halpin (1978); Turner and Szczawinski (1978); Hackett and Carolane (1982); Simon et al. (1984); Mitich (1993); Munro and Small (1997).

Fig. 124.
Chicory *(Cichorium intybus)*, from Harter (1988).

Cochlearia

Family: Cruciferae (Brassicaceae) (mustard family)

Genus Notes

Cochlearia has about 25 species of annual and perennial herbaceous plants native to the Northern Hemisphere. In addition to *C. officinalis* described below, some of the other wild species are also eaten, and *C. danica* L., Danish scurvy grass, is cultivated and considered by some to be superior to *C. officinalis* (Facciola 1990).

Cochlearia officinalis L.

English Names

Scurvy grass
Also: bad man's oatmeal, common scurvy grass, round-leaved scurvy grass, scorbute grass, scruby grass, scurvy cress, scurvy grass, scurvy-grass, spoonwort, scurvy weed
[The name "scurvy grass" is most likely to designate *C. officinalis*, but is also often used for other members of the genus. Additionally, Some species of other genera may bear this name, for example *Sedum rosea* (L.) Scop., a wild plant of Canada and the northeastern U.S. sometimes used as a potherb (Fernald et al. 1958). None of these species is a "grass," i.e. a member of the Gramineae (Poaceae) family.]

French Names

Family: Crucifères (Brassicacées), famille de la moutarde
Cuillerée (f)
Also: coch1éaire, coch1éaria (officinal), cranson (officinal), herbe à la cuiller, herbe aux cuillers, herbe aux cuillères, herbe au scorbut, herbe aux scorbutiques

Description, Taxonomy, and History

Cochlearia officinalis (in its wide sense) is a circumpolar, salt-tolerant sea-beach plant that thrives near sea-bird nesting sites producing high concentrations of nitrogen from their droppings. In Europe it occurs along the shores and some rivers of Scotland, in stony muddy and sandy soils in England and Ireland, along the seacoasts of northern and western Europe, in many salt marshes in northern and western Europe, and at elevations up to 2200 m in the great European mountain chains such as the Alps (Huxley et al. 1992). A few records of *C. officinalis* have been noted in lowland inland sitations in Britain, usually on roadsides, generally in situations where salt has been used for the clearance of ice (Wyse Jackson, personal communication). In North America scurvy grass is found in various habitats, including sandy seashores and sea-cliffs, open fields, wet hillsides, stream banks, rock crevices, mud flats, mountainous, stony, loose, granular soil resulting from the disintegration of rocks, in moist coastal sands, on silt and gravel mounds, and in marshes and muddy areas. It occurs along the Arctic coast, from Greenland to Quebec to Alaska, down the West and Atlantic coasts of Canada. In the U.S. it may be established in Washington (Scoggan 1978-79), and an isolated population occurs off Del Norte County, California (Rollins 1993). As might be expected with such a widespread plant, it is very variable, has races with different chromosome numbers, and requires taxonomic study (Scoggan 1978-79; Rich 1991). Often different kinds of *C. officinalis* are called species by some authors, but subspecies or varieties by others. The populations in the Alps and Pyrenees have usually been regarded as separate species (e.g. *C. pyrenaica* DC. and *C. alpina* (Bab.) H.C. Watson are both regarded as part of *C. officinalis* subsp. *pyrenaica*, mentioned below). Rollins (1993) refers native North American *C. officinalis* to van *arctica* (Schlecht. ex DC.) Gelert (= *C. arctica* Schlecht. ex DC.). He describes this as differing from typical *C. officinalis* of northern Europe in being much smaller and less coarse, and having lower leaf blades that aren't heart- or kidney-shaped. Nordal and Stabbetorp (1990) recognized three ecologically distinctive subspecies in Scandinavia, including subsp. *officinalis* (which includes beach and bird cliff populations); subsp. *integrifolia* (Hartm.) Nordal & Stabbetorp (which includes inland populations of cold, base-rich springs); and subsp. *norvegica* Nordal & Stabbetorp (which includes populations of poor, often inundated habitats near river outlets of the ends of fjords). Wyse Jackson and Akeroyd (1993) recognized three subspecies in Europe: subsp. *officinalis*, mainly on the coasts of northwestern Europe; subsp. *pyrenaica* (DC.) Rouy & Fouc. in the mountains of central and western Europe; and subsp. *scotica* (Druce) P.S. Wyse Jackson in Great Britain.

Scurvy grass is a biennial, rarely a perennial, although normally cultivated as an annual. In its first year it forms a low rosette (basal cluster) of leaves. In the spring of the second year, it produces a flowering stalk about 30 cm in height with small white flowers. The plant continues to flower into summer. Dwarfed plants may have stems that are only 5 cm long, while the stems of robust plants may be as long as 35 cm (Rollins 1993). The plant has an unpleasant odor like that of horseradish.

Fig. 125.
Scurvy grass *(Cochlearia officinalis)*, from Köhler (1883-1898).

Fig. 126.
Scurvy grass *(Cochlearia officinalis)*,
from Oeder et al. (1761-1883).

Historically, scurvy grass was used by mariners, explorers, prospectors, and traders to combat scurvy resulting from vitamin C deficiency. The leaves steeped in ale were highly valued by sailors, perhaps as much for the alcohol as for preventing scurvy. In Scandinavia, scurvy grass sometimes persists around dwellings where in historical times it was planted as a source of vitamin C or for other medicinal purposes (Nordal, personal communication). Today, it is occasionally cultivated as a culinary herb, and collected also as a wild edible plant.

Uses

Scurvy grass is sometimes grown as a salad plant and pot herb with a warm flavor reminiscent of cress, although opinions differ on its palatability. Grieve (1931) characterized the taste as bitter, acrid, tarry and unappetizing, and Gabriel (1975) stated that it tastes too much like tar to be liked by many people. By contrast, Fernald et al. (1958) described scurvy grass as one of the most agreeable of salads, and Szczawinski and Turner (1980) found it delicious. Michael (1980) wrote that "It is excellent in salads, and makes the best sandwiches of any wild plant I know, a cross between cucumber and mustard and cress, very cool and juicy. Scurvy grass does not make good tea, it is insipid and slightly salty when drunk as an infusion." The opinions expressed above may not simply reflect different personal tastes, but the different tastes of different races of scurvy grass. Nordal (personal communication) observes that in Norway subsp. *norvegica* is milder and tastes better than subsp. *officinalis*. The succulent, slightly salty leaves can be eaten fresh or cooked; the taste of fresh leaves is very pungent. They can be used in tossed green salads like watercress, in sandwiches along with other ingredients, and in soups, sauces, and stuffed vegetables. Michael (1980) recommended that before serving scurvy grass in a salad, it should be soaked in fresh water for at least half an hour, and salt omitted from the salad dressing as the scurvy grass has enough of its own. The flower-heads are also sometimes eaten like the leaves (Facciola 1990). Scurvy grass is occasionally cultivated in gardens as edible landscaping.

Recipe Sources

Michael (1980) has a recipe for Scurvy grass sandwiches. Szczawinski and Turner (1980) have recipes for Scurvy grass salad and Scurvy grass salad with rice.

Importance

Scurvy grass was important historically as a conveniently obtainable green that would prevent or reduce the effects of scurvy. To a minor extent, northern people in North America and Europe still make use of it today for the same purpose (Szczawinski and Turner 1980). The species has no commercial importance, although it is occasionally sold through seed catalogues.

Cultivation Notes

Soil

Scurvy grass grows naturally in light, well-drained soils, often with high levels of nitrogen, and often in saline soils. It is best cultivated in well-drained, gritty or sandy soils. Eriksen and Nordal (1989) found that a population of plants

growing on cliffs where the soil was fertilized with bird droppings was adapted to using higher levels of nitrogen than populations from other habitats in Norway.

Climate

Scurvy grass thrives in a cool location. Indeed, in some parts of its range it survives colder temperatures during the winter than any other perennial species in this book. Scurvy grass grows well in sun or light shade, but in warmer situations it prefers partial shade. As it grows naturally in the Arctic, it is often cultivated by northern gardeners.

Propagation and Cultivation

This species is propagated by seeds. For a continuous crop of leaves, successive sowings can be made.

Harvest and Storage

The leaves of scurvy grass are ready to be harvested 2-3 months after planting. Leaves should be gathered when young, preferably from plants in their first year.

Example Cultivars

None located.

Additional Notes

Chemistry

The leaves contain a glycoside, butyl mustard oil, a bitter principle, and tannins (Gabriel 1975). The pungent oil contains a sulphide (Grieve 1931). A type of alkyl-glucosinolate (2-butyl glucosinolate, also called glucocochlearin) was found in some northern Scandinavian populations (Nordal et al. 1986).

Medicine

Scurvy, a disease marked by spongy gums, loosening of the teeth, and bleeding into the skin and mucous membranes, is caused by a lack of ascorbic acid (vitamin C). Scurvy grass was used a great deal in former times on sea voyages to prevent scurvy. It was considered to be stimulating, a tonic and appetizer, and an agent promoting urine flow, and was also used to treat paralysis and rheumatism (Grieve 1931).

In France, the medicinal use of scurvy grass became quite popular in 1987, following favorable press reports, and the value increased from $4.00 American/kg to $20.00/kg (Verlet 1990).

Nutrition

Scurvy grass leaves are quite rich in ascorbic acid, hence the historical use as an antiscorbutic. According to Jacobsen (1994), it has appreciable vitamin E, and is also rich in minerals, especially manganese.

Curiosities

• The generic name *Cochlearia* comes from the Greek *cochlear*, a spoon, in reference to the spoon-shaped basal leaves, which also are responsible for the common name of spoonwort. [However, in Europe the basal rosette leaves of *C. officinalis* (as opposed to the leaves on the the stem) are typically heart-shaped, not spoon-shaped as in the closely related C. *anglica* L. (Wyse Jackson, personal communication).]

• In the 1700's, before the British navy issued lime juice (with limited benefit) to combat scurvy, mariners commonly used scurvy grass to prevent this disease. Unfortunately they usually did not appreciate that the benefit was mainly in the fresh herb, and they collected and stowed large bales of dried herb (Angier 1978).

Problems and Potential

Scurvy grass is a minor ornamental and culinary herb of very limited appeal, and therefore has no commercial potential.

Selected References

Grieve (1931); Szczawinski and Turner (1980).

Fig. 127.
Scurvy grass *(Cochlearia officinalis)*,
from Vilmorin-Andrieux et C^{ie} (1883).

Coriandrum

Family: Umbelliferae (carrot family)

Genus Notes

Coriandrum has two herbaceous annual species native to the western Mediterranean. One species, discussed below, is used for its seeds and distinctly flavored fresh leaves.

Coriandrum Sativum L.

English Names

Coriander
Also: cilantro, culantrillo
[Vietnamese coriander is *Polygonum odoratum*, discussed in this book. As noted below, the word coriander is often applied in a narrow sense to a form of this plant used for its seeds. A form of the species used for its leaves (and sometimes for its roots) is called cilantro, Chinese parsley, Chinese chervil, or (less commonly) Mexican parsley and Arab parsley.]

French Names

Family: Ombellifères, famille de la carotte
Coriandre (f)
Also: coriandre cultivée, mari de la punaise, persil arabe (Algérie), persil chinois, punaise mâle

Description, Taxonomy, and History

Coriandrum sativum is native to southern Europe and the Mediterranean. It is a strongly aromatic, erect, annual growing 20-90 cm (in flower), with fernlike foliage and white, pink or purple flowers. The cultivated plants closely resemble the wild forms.

The fruit is rounded and is made up of two united "half-fruits," each containing a seed. The half-fruits are commonly called seeds, and this convention is followed here. Large-fruited types (var. *vulgare* Alef., with fruit diameter of 3-5 mm) are widely grown in tropical and subtropical countries. These contain limited volatile oil (0.1-0.35%) and are used for grinding and blending spice preparations. By contrast, smaller-fruited types (so-called var. *microcarpum* DC., with fruit diameter 1.5-3 mm) are grown in Russia and some other countries of Eastern and Central Europe, and have between 0.8 and 1.8% volatile oil (Purseglove et al. 1981). The large- and small-seeded variants are not usually recognized as separate varieties, although commonly referred to in reviews of coriander, such as those of Purseglove et al. (1981) and Lewis (1984).

According to early Sanskrit writings, coriander was known as far back as 5000 B.C. (Farrell 1985). It is said to have added fragrance to the Hanging Gardens of Babylon (Sansregret 1974). Coriander seeds have been used since the times of ancient Egypt and Rome. Seeds were found in a tomb from the 21st dynasty of ancient Egypt (Hedrick 1972). An ancient papyrus dated from 1550 B.C. mentions the use of coriander seeds at Egyptian burials. The Chinese have cultivated coriander since at least the 4th century A.D. The plant was used in medicine and cookery in Britain before the Norman conquest (1066A.D.). In 17th century Paris, coriander was an ingredient of "eau de Carmes," a liqueur invented by Carmelite monks that was consumed internally and also recommended for external use as a fragrant toilet water (Purseglove et al. 1981). Coriander was one of the first herbs introduced to America, by early colonists to Massachusetts before 1670. It is now grown in many temperate and semi-tropical countries (Hedrick 1972; Farrell 1985; Schneider 1986).

The odor of the foliage of coriander seems to have kept the leaf form, cilantro, from becoming popular in North America north of Mexico until fairly recently (Tucker and Maciarello 1987). However, the superior taste of this herb has made it fashionable among ethnic food connoisseurs, although it remains much more familiar outside of the U.S. and Canada. It is extremely popular in Mexico, prompting Hutson (1987) to comment "cilantro is to Mexicans what parsley is to Americans." According to Muenscher (1978) "the use of coriander may be an acquired taste, but once it is acquired it may come close to being an addiction."

Uses

Ripe seeds have a sweet, spicy aroma with a peppery, balsamitic note, and a mild, sweet, slightly burning taste with a hint of orange peel (Norman 1990). In North America coriander seeds are commonly used in mixed pickling spices and in baking. The seeds are also sometimes sugar-coated and eaten as comfits (Morton 1976). Ground coriander is a flavoring for baked goods such as buns and cookies, and meat preparations like sausages and hot dogs (Lewis 1984). In the Middle East coriander is popular in minced meat dishes and stews. In India the seeds are lightly toasted before grinding to bring out a more curry-like flavor, and are added to various dishes such as roast pork and lamb (Stobart 1977). Coriander is considered an essential ingredient in curry powder. Classical French vegetable dishes served à la grecque incorporate

Fig. 128.
Coriander *(Coriandrum sativum)*, from Thomé (1903-1905).

coriander. Mességué and Peter (1982) recommend filling a peppermill with the seeds and grinding a little over stewed fruit such as apples and prunes, as well as spinach, cooked salad greens, and cucumber.

The oil and oleoresin have many food uses (Furia and Bellanca 1975), including the flavoring of canned soups and foods, sauces, candy, confectionery, ice cream, baked goods, chewing gum, cheese, pickles, sausages and other meats, beverages, liqueurs, vermouth, gin and tobacco. The flavor is also used to mask the disagreeable odors of some medicines. The oil is incorporated in soaps and cosmetics (Simon et al. 1984), and has been used as a lubricant (Lewis 1984). Coriander oil is an important ingredient of colognes and some perfumes like jasmine (Lewis 1984), and is also used in incense.

The herb cilantro has long been an important ingredient in Indian, Oriental, Middle Eastern, Caribbean, Mexican, and other Latin American cooking. It provides much of the characteristic flavor of Mexican salsa, Chinese smoked duck with plum sauce, and Chinese-style barbecued beef. The combination of ground cumin and cilantro is responsible for the characteristic smell of much of the food of India (Norman 1990). The flavor of cilantro has been described as "unique, musty, curry-like" (Larkcom 1984). The taste is rather different from that of the seeds. Cilantro is one of only a few herbs (like basil and parsley) that are occasionally used in large enough quantities to be called a vegetable. It is added generously to condiments, sauces, chutneys, guacamole and green salads. When added to tomato and chile peppers, it makes a memorably pungent sauce. Simmered with thickening agents, such as nuts and bread, it becomes an unusual delicacy. Cilantro is useful as a garnish for fish and soups, and makes an interesting addition to lamb stew, other meat dishes, and stir-fries.

Cilantro, like parsley, should not be washed until ready for use as its aroma is quite volatile (Schneider 1986). The leaves should be consumed when young and tender since they develop a stronger flavor with age. They are best chopped into smaller pieces and should not be added until the last few minutes of cooking, in order to retain the full flavor

The plants are often sold with the roots attached. The roots are used in Thai cooking and are apparently delicious after boiling (Prakash 1990).

Recipe Sources

Seed Recipes

Rosengarten (1969) presents recipes for Coriander butter wafers, and Kemroune (Moroccan shrimp with coriander). Garland (1979) has recipes for Green olives with coriander, Butterscotch flavored with coriander, and Bean sprouts with coriander (with leaves and seeds). Belsinger and Dille (1984) give the following recipes: Coriander coconut dressing, Coriander and lemon broth (with leaves and seeds), Chicken moe with coriander (with leaves and seeds).

Other recipes are: Coriander curry powder (Macleod 1968); Carrot and turnip soup with coriander [leaves and seeds] (Boxer and Back 1980); Lentil and coriander soup [leaves and seeds] (Bremness 1988); Indian apple chut-ney with cilantro and coriander (with both seeds and leaves) (Richardson 1991).

Leaf (Cilantro) Recipes

Jaffrey (1975) has recipes for Carrots and peas with ginger and Chinese parsley, and Cauliflower with ginger and Chinese parsley. Belsinger and Dille (1984) present recipes for: Mushroom soup with coriander; Enchilada sauce with cilantro; Salmon in champagne with coriander; Orange, olive, and avocado salad with cilantro; Snapper and shellfish salad with coriander; and Fruit salad with cilantro. Hutson (1987) gives recipes for Sweet potato relish with fresh cilantro and toasted peanuts, and Spicy cilantro butter. Gilbertie (1988) has recipes entitled Spicy Thai shrimp soup with fresh cilantro, California seviche with fresh cilantro, and Grilled tuna with pecan cilantro butter. Richardson (1991) has nine cilantro recipes, notably Zucchini and cilantro stir-fry, Cilantro pepper cream cheese, and Shrimp with Tequila and cilantro. Shulman (1991) has recipes for Soupe au coriandre, Sweet and spicy coriander sauce, Mint and coriander dip, and Peas with ginger, spices, and fresh coriander

Other recipes are: Tripe with coriander (Claiborne and Lee 1972); Coriandered shrimp in egg-white batter (Kuo 1977); Braised fresh pork sides with quince and coriander (Garland 1979); Tomato and coriander salad (Mallos 1979); Coriander chutney (Shepard 1979); Soft yogurt cheese with Chinese parsley and scallions Gujarati style (Jaffrey 1981); Baked gilt-head bream with coriander (Mességué and Peter 1982); Spaghetti with cilantro, corn, and tomatoes (Schneider 1986); Cilantro pesto with peanuts (Creasy 1988); Zucchini with fresh coriander (Holt 1989); Crab and broccoli gratin with coriander leaves (Holt 1991); Onion and coriander leaf salad (Solomon 1992).

Flower Recipes

Barash (1993) has recipes entitled Coriander bean dip, Coriander chicken in a clay pot, Cucumber coriander salad, and Southwestern chicken.

Fig. 129.
Coriander *(Coriandrum sativum)*,
from Köhler (1883-1898).

Importance

Coriander is one of the world's most important spices, and is of great significance in international trade. India, Morocco, Pakistan, Romania, and Russia are the major producers. Other important producers include Iran, Turkey, Egypt, Lebanon, and Israel in the Middle East; China, Burma, and Thailand in Asia; the Netherlands, the U.K.; France, Italy, Hungary, the former Czechoslovakia, Poland, Bulgaria, and the former Yugoslavia in Europe; and the U.S.A., Argentina, Mexico, and Guatemala in the Americas. World coriander seed production has been estimated to be above 300,000 t annually, with India alone producing 79,000 t yearly, of which 10% is exported (Lewis 1984). In 1988, the U.S imported nearly 6,000 to of coriander seed valued at $3,322,340, the majority from Mexico (3,566 t). U.S. imports averaged U.S.$1.4 million annually during 1990-95, mostly from Canada and Morocco (Buzzanell et al. 1995).

Coriander seeds are produced on the Canadian prairies, and in Ontario (Ference 1989). Results vary from year to year, and deviate considerably in degree of success. Mazza (1991*b*) estimated Canadian acreage at between 500 and 1,000 ha annually. Apparently at one point about 600 ha were grown in Ontario, succeeded by only about 8 ha (Ference 1989). In 1991, some two dozen farmers in Manitoba grew 480 ha of coriander (Anon. 1992*a*). Limited amounts are also produced in Manitoba and Saskatchwan (Mazza, personal communication). Canada exported 254 t of coriander seeds valued at $163,370 to the U.S in 1988 (Anon. 1989*a*).

Steam-distilled coriander oil is produced mainly in Eastern Europe. Russia is the world's leading producer of the oil. It has been estimated that about 100,000 t of coriander seeds are annually distilled to yield 1000 t of oil (Lewis 1984). Lawrence (1993*a*) estimated that the annual word production of coriander oil has a value of about $U.S.50 million, making coriander oil the world's second most important essential oil (after the oil produced from the common orange). However, Verlet (1993) estimated the annual value to be only about $9 million (U.S.), and placed it at 19th in world importance as an essential oil.

Cilantro (leaves) are less important than coriander (seeds). Cilantro is much less popular in North America (at least north of Mexico) and Europe than in Asia, the Middle East, and Central and South America, where substantial amounts are grown for domestic use. Consumption of the roots of cilantro as a vegetable is limited to certain countries, particularly China. In northern North America, cilantro is increasingly found in supermarkets and specialty markets. Forms of cilantro marketed as Chinese parsley for the U.S. and Canadian Oriental vegetable markets are grown in California, Florida, Hawaii, New Jersey, British Columbia, and other locations (Yamaguchi 1973; Mazza, personal communication).

Cultivation Notes

Soil

Coriander thrives best on a weedless, fertile, deep, medium to heavy soil (Lewis 1984). Weiss (personal communication) recommends a light, sandy, calcareous soil. The soil should be well-drained and not too rich in nitrogen (Huxley et al. 1992). Excess nitrogen (more than 60 kg N/ha) delays ripening of fruits and may cause fungal diseases (Weiss, personal communication). Reported tolerance ranges of pH are 6.3 to 8.3 (Duke and Hurst 1975),-4.8 to 8.3 (Duke 1978), and 4.9 to 8.2 (De Baggio 1987).

Climate

Coriander tolerates cold and heat (Simon et al. 1984), but requires full sunlight. Irrigation is beneficial during dry periods. The species survives light frosts very well. In the home garden, Crockett and Tanner (1977) recommend growth in a location protected from the wind, which may blow down plants that have become top-heavy with seeds. If cilantro (leaf) production is desired, the plants should be started very early in the spring or in late summer because hot weather induces flowering, limiting leaf production (Halpin 1978).

Propagation and Cultivation

Propagation is by seeds sown in early spring. Putievsky (1980) found that, for commercial purposes, coriander seed is efficiently germinated by providing a daily cycle of 27°C for 8 hours and 22§C for 16 hours. Seeds should be planted at a depth of 6-13 mm, with seedling emergence usually in 10-20 days (Wang et al. 1993). For the home gardener, the plants often establish themselves from the dropped seeds of the previous season's crop, providing an early harvest (Lima 1986). Unlike many members of the carrot family, coriander germinates readily. The plants grow quickly and the leaves can soon be harvested as cilantro. Because coriander seeds itself, it can become a persistent weed. The plants rapidly flower and set seed. If a continuous supply of cilantro is desired, successive plantings every 3 weeks are recommended (Lima 1986).

Harvest and Storage

For coriander seed, harvesting is carried out when about half the seeds are fully mature. Timing of harvest is critical because gathering at a late stage risks excessive losses from seed shattering. Early harvest should be avoided because immature fruits contain a lower volatile oil content than ripe fruits, and the aroma is considered disagreeable in Western countries (Purseglove et al. 1981). The crop is best harvested when there is dew to reduce shattering.

In warmer climates than found in northern North America, the plants may be stacked, and the remaining fruits will mature. The stalks are then dried and threshed. The fruits should be reduced to a moisture content of less than 9%. In traditional practice the plants were allowed to wither in the field after swathing, followed by further drying under shelter. Artificial drying without loss of quality is sometimes carried out under controlled conditions. The desired temperature for drying is 80-90°C, and fruits should be left to dry naturally down to 18% water content before commencement of artificial drying. Drying is essential to develop the full aroma, prevent growth of moulds, and retain desirable color and essential oil content. Fumigation with methyl bromide is sometimes carried out to eliminate insect infestation during long term storage. Usual yields of dried seeds is 1200-2400 kg/ha (Lewis 1984). Under favorable conditions a yield of 2.5-4 t/ha of dried coriander seeds can be obtained (Rosengarten 1969, Beerentrup and Röbbelen 1987).

In Canada, consistent high yields and quality of coriander have not yet been achieved (Mazza 1991*b*).

Commercially, cilantro is preferably harvested with the root attached to prevent wilting of the leaves. Plants should be very leafy with short stems. Because of the relatively short shelf-life of cilantro, it requires refrigeration, and therefore is routinely iced after harvest (Mazza 1991*b*). Cilantro will store for 3 to 4 weeks at 5°C.

The home gardener can harvest seeds as soon as the fruit is light brown. Crockett and Tanner (1977) recommend the following procedure. Cut the plants at their base, collect them into a paper bag, and dry in a warm, dark place. Shake the dried fruits in the bag to remove them from the stems, and rub the dried fruits to split the pods and remove the seeds. The dry seeds should be stored in a well-closed container.

The home gardener can cut off leaves as early as 4-6 weeks after planting. Successive cuts can be taken from one sowing, although once the plants start producing seeds the flavor of the leaves deteriorates.

For home storage, the cilantro plant is set in a bottle of water, with the leaves tightly enclosed and covered with a puffed-out plastic bag. If refrigerated, cilantro will keep for up to 2 weeks. If the roots are cut off from the rest of the plant for culinary use, the cilantro is best wrapped in a damp towel, enclosed in plastic, and kept in a refrigerator. The roots can be washed and frozen for long-term storage. However, frozen or dried leaves are considered less flavorful (Schneider 1986).

Example Cultivars

Some cultivars selected in Russia and India for both yield and oil content are noted in Purseglove et al. (1981). Named cultivars of coriander are generally difficult to obtain in North America. The following cultivars are described by Facciola (1990).

Seeds: Indian, Moroccan

Leaves (cilantro): Kasturi Sweet Scented, Large leaved,

Santo

Seeds and leaves: Bengal Giant

Additional Notes

Chemistry

Coriander seeds contain 0.3-1.7% essential oil. The most abundant constituent is *d*-linalool (composing 45-70% of the volatile oil) which imparts the distinctive flavor. Russian and East European corianders tend to be rich in linalool (Lewis 1984). Also present are camphor, *d*- -pinene, camphene, -pinene, sabinene, myrcene, -terpinene, -terpinene, limonene, and other compounds (Simon et al. 1984). The oil is extracted by steam distillation. Coriander oil has the advantages of being more stable and retaining its agreeable odor longer than other oils of its class (Lewis 1984). The unique aroma of young seeds, due to aliphatic aldehydes, disappears on ripening. Because the aroma is often perceived as fetid and is disliked in Western markets, only ripe fruits are employed for distillation of the spice oil. The seed meal that remains contains 20% or more fixed oil, which has been used as a lubricant in Russia, and for soapmaking. An oleoresin is extracted that has been used for food flavoring (Lewis 1984).

Coriander contains 9-22% fatty acids, of which 39-79% is petroselinic acid (Weiss, personal communication). It is grown in Europe as a medicinal and industrial crop for its content of petroselinic acid (Weiss, personal communication).

The aroma of cilantro leaves is due to an extractable essential oil, as with the seeds, but the composition is distinctly different from that of the seed oil (Mazza 1991*b*). The composition of cilantro leaves was studied by Potter and Fagerson (1990). Many volatile compounds were found, including alkanols and 2-alkenals, other aliphatic aldehydes and alcohols, and nonane. Some of these have anti-fungal properties.

Medicine

Greek physicians about 400 B.C. recommended coriander for its medicinal properties. In India it was regarded as beneficial as a tonic, cough medicine, and stomach curative. Its main medicinal use today in Western countries is as a flavoring to mask the taste of certain medicines (Grieve 1931; Rosengarten 1969). In Vietnam, coriander is used to treat intestinal diseases (Nguyêñ-Xuân-Duñg and Dô0-Tât-Loi 1991). Commonly in Asia, the seeds are used as a general tonic to treat stomach problems and nausea, and the oil and other parts of the plant to treat a variety of ailments, including fever, measles, colds, hernia, and spasms (Perry and Metzger 1980; Simon et al. 1984). Handling leaves of the plant or the essential oil can cause contact dermatitis in susceptible individuals (Rinzler 1990). An unusual case of anaphylactic reaction to coriander was reported by Bock (1993).

Nutrition

Cilantro is rich in pro-vitamin A (carotene) and has about 250 mg/100 g of vitamin C (Lewis 1984; Prakash 1990). The vitamin C content diminishes rapidly on storage (Purseglove et al. 1981). Boiling for 5 minutes causes a 50% loss of vitamin C, and drying makes the content negligible (Toghrol and Pourebrahimi 1976). Duke (1977) characterized content of calcium, fiber, iron, phosphorus, potassium, and vitamin A as high, and content of vitamin C as very high. For those interested in dieting, "cilantro is just about without calories (5 per cup)" (Schneider 1986).

Curiosities

• The name coriander comes from the Greek *koros*, a bug, because of the supposed likeness of the unpleasant smell of the leaves to that of bed bugs (Grieve 1931; Stobart 1977). Purseglove et al. (1981) state that the smell responsible for the analogy with the bug was noticed in the young fruits. In any case, the aliphatic aldehydes responsible for the peculiar, unique aroma are present in both the vegetative parts of the plant and in the unripe fruits (Purseglove et al. 1981).

Fig. 130.
Culantro *(Eryngium foetidum)*, prepared by B. Brookes.
(Based on H. Smith 1475 at Agriculture and
Agri-Food Canada herbarium, Ottawa.)

• Another herb in the carrot family with an even stronger bedbug odor is called "culantro," Java coriander, false coriander, spiny cilantro, or stinkweed (*Eryngium foetidum* L.). The name culantro is the Spanish word for coriander, and the plant was named for its similarity to the cilantro form of coriander. Culantro is native to the West Indies and tropical America, and is widely consumed in its indigenous area of Columbia, Peru, Panama, and Cuba; and in China, Indonesia, and elsewhere in Southeast Asia. Young leaves are eaten with rice, used as a garnish, and added as flavoring to soups and curries (Morton 1976). Roots are used as a condiment in soups and meat dishes. In West Indian markets of some large North American cities, a seasoning mixture called *sofrito* (a combination of culantro, cilantro, and chiles) is sold (Facciola 1990; cf. *Capsicum chinense* Curiosities). Plants have been cultivated in the province of Ontario by immigrants of Asian origin (R. Cerkauskas, personal communication).

• Coriander is mentioned in the Bible in Exodus 16:31, "And the house of Israel called the name thereof Manna: and it was like coriander seed, white; and the taste of it was like wafers made with honey." Coriander is eaten during the Passover as one of the bitter herbs ordained to commemorate the Hebrew flight from Egypt (Farrell 1985).

• The ancient Chinese believed that those who ate the seeds of coriander during a spiritual trance would achieve immortality (Farrell 1985).

• Coriander, considered an aphrodisiac, has been fed to animals during the mating season (Farrell 1985). Its use as an aphrodisiac was mentioned by the mythic Arabian princess Scheherazade in "The thousand and one Arabian nights" (Purseglove et al. 1981).

• Queen Elizabeth I (1533-1603) loved hard candies made with coriander seeds (Castleman 1991).

• Cilantro "zoomed to the top of the charts when highlighted in Mick Jagger's recipe for shrimp curry published in *Rock 'n' Roll Cuisine*" (Dowling 1995).

Problems and Potential

There are only a small number of commercial coriander growers in Canada and the adjacent U.S. (Anon. 1992*a*). The possibility of increasing the North American seed crop is uncertain due to well established production outside of North America.

The leaf form of the species, cilantro, is of minor importance at present. As North Americans become more acquainted with diverse forms of cooking, there is a potential for increasing demand for cilantro. It has been noted that the market for cilantro in Toronto is growing (Anon. 1989*c*), and the same is true for Vancouver (Mazza, personal communication). The major disadvantage for increasing the market for cilantro is that it is consumed fresh, and is grown in the cool weather of spring and fall (Tucker and Maciarello 1989). However, this provides opportunities for local and niche marketers. The market may be extended to the winter months by greenhouse culture.

Selected References

Purseglove et al. (1981); Lewis (1984); Farrell (1985); Prakash (1990); Mazza (1991*b*).

Fig. 131.
Saffron *(Crocus sativus)*, from Köhler (1883-1898).

Crocus

Family: Iridaceae (iris family)

Genus Notes

Crocus is made up of about 80 species of herbs, chiefly in the Mediterranean region, but found from Spain and North Africa to Western China. The majority of the species occur in the Balkans and Turkey (Mathew 1982). Many are grown as ornamentals, and it has been said that "few genera of this size include so many exquisitely beautiful species" (Huxley et al. 1992).

Crocus Sativus L.

English Names

Saffron
Also: common saffron, dye-saffron, saffron crocus, true saffron

French Names

Family: Iridacées, famille de l'iris
Safran (m)
Also: safran cultivé, safran d'automne, safran d'Orient, safran du Gâtinais, safran médicinal, safran officinal, safran oriental, vrai safran

Warnings

(1) Do not confuse the species described below with other plants called "crocus" (some, such as autumn crocus or meadow saffron, *Colchicum autumnale* L., are extremely poisonous). (2) Saffron corms are toxic to young animals (including children!). (3) Do not exceed specified amounts of saffron in recipes, as toxicity is possible.

Description, Taxonomy and History

Crocus sativus grows 15-30 cm tall from corms that are produced annually; the latter are underground, somewhat depressed, globular, onion-shaped, white, and fleshy. The plant is "stemless" (actually the corm is a condensed stem), with each corm producing 6-9 narrow leaves. In the fall, saffron produces one (sometimes two or even three) lily-shaped flowers that are lavender, violet, red-purple, bluish, or white. Each corm develops and flowers only once (in the year following its development), giving rise to new corms before withering and dying. The species is known only in cultivation, or occasionally persisting in an area after cultivation. It is usually thought to be a clonal selection of an unidentified wild plant or a hybrid between two wild species (Mathew 1977). Mathew (1982) classifies it as the cultivated phase of *C. cartwrightianus* Herb., a very similar wild species of Greece that is sometimes cultivated. The wild plant was gathered in antiquity, and is still harvested as a wild source of saffron (Negbi 1990). *Crocus sativus* is reported to be triploid (i.e., it has three sets of chromosomes, rather than the normal two) and sterile (it cannot produce fertile seed).

The female reproductive part of flowering plants, known as the pistil, comprises the ovary, style, and stigma. Stigmas are the receptive platforms for pollen, and are sticky in many plants. In fertile plants (but not in *C. sativus*) pollen germinates on the stigmas, and grows through the style to reach and fertilize the ovules in the ovary. The styles are extremely long, commencing at about ground level. The ovaries are subterranean, although in fertile species seed pods develop so that they are above soil level, allowing seed distribution. The stigmas of saffron are divided into three long lobes, atop the style (see illustrations). The brilliantly colored stigmatic lobes of saffron flowers are the economically important part. The tops of the styles are often collected too, but their presence in high-quality saffron is limited (for example, to 10% in "unadulterated saffron" in the U.S.) (Rosengarten 1969).

Throughout its recorded history saffron has been a commodity of great commercial value. Today, it is the world's most expensive spice, at $2000.00 (U.S.)/kg (Visvanath et al. 1990), with values up to $5000.00/kg recorded (Homes et al. 1987). Symbolic of the value of saffron, a small amount colors a large dish a brilliant gold.

Saffron has been used as a condiment, medicine, dyestuff and perfume since antiquity, and was known by the classical Egyptians, Greeks, Jews, Romans, Hindus, and Muslims. It, or a very closely related species, was recorded in Crete of 1600 B.C. (Mathew 1977). Saffron is mentioned in classical Greek and Roman literature, and in subsequent writings including that of Shakespeare. It has been said to be mentioned in the Old Testament, but this may be a misinterpretation (Negbe, personal communication). It was introduced to Spain by the Arabs in the tenth century. Saffron reached France and Germany in the 1lth century, and England in the 14th century. It became very popular for flavoring and coloring food, and even for use as a perfume. There were harsh penalties, including death, during the Middle Ages to discourage adulteration of saffron. In 1444 in Nürnberg, 1456 people went to the stake for adulterating saffron (Fox 1933). Today, adulteration continues to be a problem, even urine being added to increase color (Rosengarten 1969). Saffron is often mixed with raw materials of similar color, such as the flowers

of marigold (species of *Tagetes*, discussed in this book), safflower (*Carthamus tinctorius* L., also known as false saffron, fake saffron, and American saffron), pot marigold (*Calendula officinalis*, also discussed in this book), and other plants. Petals and styles of the saffron flower are also used to adulterate saffron. The high cost of saffron has encouraged the alternative use of turmeric (*Curcuma domestica* Val., also known as Indian saffron) and the synthetic colorant tartrazine (Simon et al. 1984). [Turmeric

Fig. 132.
Saffron *(Crocus sativus)*, plant, flower and stigma, prepared by M. Jomphe.

is indeed an inexpensive and effective saffron substitute; very little should be used, since its acrid flavor can easily overwhelm a dish (Rinzler 1990)].

Uses

Commercial saffron is a compressed, very aromatic, matted mass of slim, dark orange to reddish-brown, occasionally yellow strands 2-3 cm long. The deeper the color the better the quality (Norman 1990). Ground saffron is also available, but as it may be adulterated the thread form is a more reliable product. Whole material can be used, or individual strands can be added intact or crushed. It is suggested that because the odor is so sharp and penetrating, and in view of the possibility of toxicity, no more than called for in recipes should be used. Saffron threads should not be added directly to foods; they should be placed in a little warm water until it takes up the strong yellow color and aroma, and the liquid then poured into the dish being prepared. The odor of saffron is tenaciously and characteristically pungent, sweet, spicy and flowery; the taste is pleasantly spicy and bitten However, as noted by Stobart (1977), "opinions are sharply divided on the question of saffron: people who are not used to it may find it unpleasant or too strong, masking the other flavors of the dish."

Saffron's major use is in coloring and flavoring foods, including cheese, butter, cream, sauce, meat, soups, preserves, puddings, confectionery, pastry, liquor, and nonalcoholic beverages. Some liqueurs, such as chartreuse, may contain saffron. Saffron seems to go especially well with rice. It is considered an essential ingredient of several well known dishes, including French bouillabaisse (shellfish and fish, a famous soup of Marseille); several Spanish dishes: Arroz con Pollo (chicken and rice), Bacalao a la Vizcaina (codfish), zarzuela (fish and rice), and the Spanish national dish paella (meat, fish, rice, vegetables); the Italian risotto Milan style (rice cooked in meat stock); and the more expensive curries in the East, such as chicken biriana. Spain, the of saffron production, flavors many of its dishes with this condiment. The Arabs, said to be saffron's greatest consumers (Ward 1988), use it to flavor lamb, chicken, and rice dishes. Saffron cakes and loaves are very popular in parts of the U.K.

Saffron extracts have reportedly been used commercially in non-alcoholic beverages, ice cream, candy, baked goods, and condiments (Furia and Bellanca 1975).

A warning is given about the excessive culinary use of saffron at the beginning of the treatment of this herb and in the section Medicine. In fairness, it should also be noted that "saffron is generally recognized as safe as a natural seasoning or flavoring and plant extract" (Simon et al. 1984).

Before the advent of coal-tar dyes, *Crocus sativus* was used to produce a popular yellowish-orange dyestuff. Indeed, the word saffron is derived from the Arabic *za'faran*, meaning yellow (Brouk 1975). The reddish-yellow pigment of saffron, crocin, is so effective that one part can color up to 150000 parts of water unmistakably yellow.

Saffron oil is rarely available because of its cost. Very small amounts of tincture of saffron are used to prepare Oriental-type perfumes (Rosengarten 1969). The plant has been used in cosmetics for eyebrows and nail polishes, as incense, and as an ink applied to foreheads on religious and ceremonial occasions (Duke 1985).

Saffron is prized as a garden decoration in North America, blooming in the fall, when few flowers are in peak condition.

Recipe Sources

Rosengarten (1969) presents recipes entitled Holiday saffron cake, Arroz con pollo, and Seafood pilaf. Crowhurt (1973) gives recipes for Saffron bread and Saffron rice. Garland (1979) has recipes for Saffron lamb stew, Scented rice with saffron, Saffron rice with nuts, Saffron cake, and Saffron apple fritters. Batmanglij (1986) presents recipes for Saffron pudding, Saffron cake, and Saffron cream. Schneider (1986) gives recipes for Swiss chard stuffed with saffron rice, raisins, and walnuts; and Stew of quinces and lamb with saffron and split peas. Norman (1990) has recipes for Monkfish parcels with saffron and Saffron bread.

Other recipes are: Saffron-lemon tea bread (Day and Stuckey 1964); Mussels with saffron (Leggatt 1987); Mussel soup with saffron (Norman 1990); Roasted peppers with saffron (Ornish 1990); Rich saffron soup (Shulman 1991); Bouillabaisse (Swahn 1991).

Importance

Spain generally furnishes the majority of the world's supply, in the recent past annually producing about 100 000 kg (Starý and Jirásek 1973), representing about 70% of the world market (Ward 1988). The best saffron is said to come from La Mancha in Spain (Norman 1990). Kashmir is the world's second-largest producer (Ward 1988). Negbi (personal communication) has compiled the following information on annual production of the major producing countries: Iran: 30 000 kg in 1989; Spain: 29 153 kg (1985-1988); Greece: 3700 kg in 1990. Saffron is also (or has been) commercially cultivated in France, Italy, Hungary, Germany, Switzerland, Algeria, Morocco, Turkey, China, in the Caucasus, Azerbaijan, Mexico, and Australia. Saudi Arabia, Kuwait, and the U.S., respectively, are the leading consumers of saffron (Ward 1988). Saffron is less widely used today than in the past, when it was

Fig. 133.
Saffron *(Crocus sativus)*, from
Vilmorin-Andrieux et C^{ie} (1883).

added to soups, sauces, and dishes for Lent. In the U.S. more than 2 t of saffron were consumed annually in the 1980's, with retail prices varying from $700.00 to $8,000.00/kg (Negbi 1990). U.S. imports totaled $3.2 million (U.S.) in 1995, and averaged $3.5 million over the period 1989-93 (Buzzanell et al. 1995). The volume imported was 7800 kg in 1994, up from the average of 3720 kg for the previous 5 years (Buzzanell et al. 1995). After Spain, the balance of imports to the U.S. came from Costa Rica, Italy, and India.

Cultivation Notes

Soil

A sandy or loamy soil, free from clay, with excellent drainage is best. The soil should be well cultivated. Fertile soils rich in nutrients tend to increase vegetative growth at the expense of flower production, and soils of medium fertility are recommended. The pH range of tolerance of saffron has been reported to be 5.5-7.8 (Simon et al. 1984) and 4.3-7.5 (Duke 1979).

Climate

Saffron is grown in diverse regions varying in altitude, temperature, and humidity. It grows best in warm subtropical climates that are able to provide a growing season of at least 6 months. However, it also grows very well in moderate, cool climates, provided the growing season is long. Limited rainfall, about 38-46 cm of rainfall annually, is considered desirable. Heavy rains or frosts during flowering may be disastrous. Photoperiod is important for saffron, a short-day plant requiring 11 hours of light/day for flowering. Home gardeners should select a sheltered spot. In northern regions the corms require protection during the winter. Saffron has been grown in Toronto, and may even flower the first year if planted close to a house wall where it receives warmth (Cole, personal communication).

Propagation and Cultivation

Saffron is reproduced vegetatively using the young cormlets formed each year at the top of the mother corm. Plants will live 12-15 years, but commercial plants are rarely maintained more than 5 years. Sometimes the plant is grown commercially as an annual. In areas with summer rain it is preferable to dig the new corms up every summer and plant them during September (Negbi, personal communication).

The home gardener can grow saffron for culinary purposes. Since seeds are not produced, it is necessary to purchase corms. The small, shiny, brown corms should be planted about 15 cm deep. They can be left in the ground for 3 years, or dug up and separated each year. It should be kept in mind that the stigmas of about six plants are needed for the average recipe (Richters 1994).

Harvest and Storage

Harvesting starts with blooming, and continues for the entire flowering period, which may last only 15 days. The flowers are picked from the field, and the stigmas separated by hand, generally by home labor. The stigmas are dried in the sun or by artificial heat, losing about 80% of their weight. Only a small amount of the style should be attached to the stigmas when they are harvested, although for lower-quality saffron the styles are also collected. If the stigmas are not dried soon after picking, they are attacked by moulds (Basker 1993). The finest quality saffron, produced in southeastern Spain, is "toasted" or dried in sieves over low heat. Dried saffron is best stored in airtight, light-proof containers, because it easily loses its aroma, color, and flavor. Under good conditions, yields of 9-13.5 kg/ha of dried saffron can be obtained, the highest amount produced in the third year after planting. Commercial yields vary from 2.5 kg/ha to 15 kg/ha (Negbi 1990). In the large producing countries (Spain, Iran, Greece), yields have averaged 4-6 kg/ha (Negbi, personal communication). A single flower generally bears 5 to 7 mg of spice (Negbi 1990).About 160000 flowers are required to produce 1 kg of dry saffron, accounting for the very high cost of $2,000.00 (U.S.) retail (Rosengarten 1969; Pandey 1990; Visvanath et al. 1990). A million flowers can be harvested from one hectare; this would produce 6.25 kg of saffron, which could retail for $12,500.00.

Example Cultivars

Cashmirianus

Additional Notes

Chemistry

The important pigments of saffron include crocin and crocetin (the latter mainly responsible for the bright yellow coloring); the bitter principle is picrocrocein (picrocrocin, also known as "saffron bitter"), and the flavor or aroma is due to safranal (Visvanath et al. 1990). Safranal is a volatile aldehyde that is one of the products of the splitting of picrocrocin that occurs during the drying of the stigmas. The essential oil contains safranal, pinene, and cineole (Duke 1985). Saffron's color comes from carotenoid pigments, particularly crocetin (red) and crocin (reddish yellow) (Rinzler 1990). Extensive information on the chemistry of saffron is given in Sampathu et al. (1984) and Simon et al. (1984).

Medicine

Saffron was a highly esteemed medicine in the past, used as a stimulant, sedative, antispasmodic, aphrodisiac, and in other ways. In 1671 a book entitled Crocologia was published, with almost 300 pages, providing instructions for the treatment of diseases using saffron (Mathew 1977). Illnesses that have been treated with saffron include menstrual problems, dysentery, measles, jaundice, fever, scarlet fever, smallpox, colds, asthma, enlargement of liver, enlargement of spleen, infections of urinary bladder and kidney, melancholia, insomnia, cholera, diabetes, cancer, and more (Sampathu et al. 1984). Saffron was also used as an abortifacient, often killing the women to whom it was administered. The species is used today in modem Chinese medicine (Duke and Ayensu 1985). It is also still employed occasionally in India and the Far East as a tonic, but is essentially unused in modem Western medicine. Excessive use can cause inflammation of mucous membranes, cramps, and bleeding (Starý and Jirásek 1973). "An overdose is poisonous, causing sickness and purging to the point of danger" (Quelch 1946). "Saffron is reported to contain a poison of the central nervous system and kidneys that can prove fatal" (Simon et al. 1984). Symptoms of poisoning can include narcosis and extravagant gaiety (Duke and Ayensu 1985).

Nutrition

According to Heywood and Zohary (1995), saffron is the richest source of riboflavin (vitamin B_2). However, since so little is used, its dietary value is insignificant. Saffron contains 12% protein (Duke 1985).

Curiosities

• In Greek mythology, saffron was created by Hermes, the messenger and inventor, also credited with kindling fire. Hermes accidentally mortally wounded his friend Crocos and the god changed the drops of blood falling to the ground to saffron flowers. According to another Greek legend, Zeus, the king of the gods, had a bed of saffron (Toussaint-Samat 1992).

• Because of its expense, saffron was employed by those wishing to flaunt their wealth. In the first century A.D., Nero had saffron sprinkled on the streets of Rome for his entry into the city (Crockett and Tanner 1977). Heliogabalus, another Roman emperor, in the third century A.D. is said to have bathed in saffron-scented water (Rosengarten 1969). In India, saffron was used to show the caste markings of the wealthy (Rosengarten 1969).

• Tiny bits of saffron stigmas have been found in Egyptian mummies. Cleopatra used saffron in her cosmetics (Ward 1988).

• Metrodora was a Greek female physician who between 550 and 650 A.D. wrote what is believed to be the oldest surviving medical text by a woman. In this she gave a herbal cure for hemorrhoids, which included finely ground pine cones, saffron, and wine-soaked dates (Miller 1992).

• Medieval scribes burnished saffron upon foil for use in illuminated manuscripts in the same manner that gold was used for the purpose (Crockett and Tanner 1977).

• Saffron came to be viewed as capable of reviving spirits. It was even put in canaries' drinking water so that they would sing more cheerfully (Rosengarten 1969).

• Because of the value of saffron, it is called "red gold" in Spain (Ward 1988).

• Romantic stories have been told of how saffron was brought to England despite the efforts of Arabs to main-rain a monopoly in the Near East. By legend, saffron was smuggled into England at the end of the 14th century by a pilgrim from the Holy Land who risked his life by hiding a corm in his hollow staff (Rosengarten 1969). The same story is told about how silk-worm eggs were smuggled into England, so it seems one good legend stimulates another (Quelch 1946).

• Ladies risked the wrath of the fathers of the early Christian Church by using saffron to give their hair a yellow tint (Quelch 1946).

• King Henry I of England (1068-1135) became very fond of saffron, supplied by returning crusaders. When the ladies of his court started using up the entire saffron supply to dye their hair, he forbade them to use his favorite spice (Lehner and Lehner 1960).

• Because false saffron (*Carthamus tinctorius*) is the most common adulterant of true saffron, it is sometimes called bastard saffron (Norman 1990; cf. "bastard dittany" in dittany of Crete Curiosities). False saffron will color food but not flavor it (Norman 1990).

• In Ireland it used to be believed that saffron had a sanitizing effect, and so it was thought unnecessary to frequently launder clothes that were dyed with saffron. King Henry the VIII (1491-1547) banned the Irish from dyeing their linen with saffron to encourage them to wash their linen more frequently (Farrell 1985).

Problems and Potential

Because of demanding climatic requirements, low yield, very high labor requirements for harvesting and processing, and established overseas competition, saffron is probably a poor candidate for crop diversification in North America. However, it is easily cultivated as a garden plant, or under glass in North America, and provides those interested in growing their own condiments with an interesting exercise in harvesting the world's most expensive spice.

Biotechnology may offer an alternative to cultivating saffron. It has been suggested that any compound with a cost of over $500/kg deserves to be considered for production by plant cell culture technology, and saffron certainly falls in this category (Visvanath et al. 1990). Attempts have been made to induce high-value metabolites of saffron in tissue culture, with a view to large-scale biotechnological production of saffron by *in vitro*-grown tissues (Visvanath et al. 1990).

Selected References

Rosengarten (1969); Mathew (1982); Sampathu et al. (1984); Simon et al. (1984); Rees (1988); Negbi (1990).

Fig. 134.
Mitsuba *(Cryptotaenia japonica)*, fruiting plant and "seeds," prepared by S. Rigby.
(Based on greenhouse plants grown from seed from Richters.)

Cryptotaenia

Family: Umbelliferae (Apiaceae) (carrot family)

Genus Notes

Cryptotaenia is native to African mountains and north temperate Eurasia and eastern North America. There are about five species of annual and perennial herbs.

Cryptotaenia canadensis (L.) DC. (honewort, wild chervil, white chervil, stone parsley) is closely related to *C. japonica*, the species described in the following, and indeed is sometimes considered to be identical to it. By comparison with *C. canadensis*, Hara (1962) characterized *C. japonica* as having more inflorescence and floral bracts, and with more flowers in the umbellules (ultimate floral clusters). *Cryptotaenia canadensis*, a perennial herb, is found in rich woods and thickets and on the banks of streams from western New Brunswick to Manitoba, south to Georgia, Alabama, Arkansas and Texas. It is a plant of moist forests and floodplains (Baskin and Baskin 1988). In the late spring and early summer, while it is still young and tender, wild plants are collected for use as food. Much like its Japanese counterpart, it is used for soup, as a potherb, in salads, as a root vegetable, and as a seasoning (Fernald et al. 1958; Facciola 1990; Duke 1992*a*). Young leaves, stems, and flowers can be boiled for use as a potherb, or chopped like parsley for addition to salads and green soups. Roots are scrubbed, boiled in salted water for 20 minutes, and served like parsnips with butter or sauce. Seeds can be used to flavor cookies, cakes and breads. Stems can be candied in sugar. Growers in the U.S. have exported crops of the species as a culinary herb to Japan (Duke and Ayensu 1985; cf. Duke 1992a, who notes that an Oregon grower may have grown *C. japonica* for export, believing it was *C. canadensis*).

Cryptotaenia Japonica Hassk,

Scientific (Latin) Synonyms

C. canadensis DC. var. *japonica* (Hassk.) Makino

English Names

Mitsuba
Also: honewort (better reserved for *C. canadensis*), Japanese honewort, Japanese parsley, Japanese wild chervil, trefoil
[Mitsuba is the Japanese name of the plant, simply carried over into English. It is the name used in most seed catalogues listing this species. Mitsuba is Japanese for three leaflets. Several unrelated species, also with leaves with three leaflets, have trefoil as part of their name, and usually the name trefoil alone refers to species of *Trifolium*.]

French Names

Family: Ombellifères, famille de la carotte
Cryptotènie du Japon (f)
Also: mitsuba

Description, Taxonomy, and History

Crypotaenia japonica is a succulent perennial herb of southeastern Asia, which looks somewhat like parsley and smells rather like celery. The plant varies from 20 to 125 cm in height. It is grown particularly for its long, slender, hollow leaf-stalks (10-15 cm long, 2-4 mm thick), and for its leaf blades, made up of three leaflets. When blanched or cultivated under crowded conditions, the leaf-stalks grow to 30 cm or more (Yamaguchi 1990). The plants develop long, stringy roots from a thick, creeping rootstock.

Uses

Mitsuba has a very distinct, pungent flavor, reminiscent of celery, but described as a blend of parsley, celery, and angelica (Larkcom 1984), or somewhat between celery and sorrel (Tsuji 1980). All parts of the plant are eaten. The leaves and leafstalks are eaten raw in salads and sandwiches; boiled or fried and consumed alone; used as a potherb; and added to soups, egg dishes, tempura, and a variety of fried foods. They can also simply be employed as a garnish. The seedlings can be consumed as fresh sprouts. Mitsuba is often served with shabu-shabu, a traditional country dish of Japan (see Recipes), and with cha-wan-musha (also rendered chawan-mushi) (Japanese egg custard) (Shimizu, personal communication). Professional Japanese cooks discard the leaf blades, because their cooking time is shorter than for the leaf stalks, "but it is not necessary to be so fussy" (Tsuji 1980). "Because the leaves become bitter and lose their fragrance when simmered too long or subjected to too much heat, mitsuba should be no more than lightly parboiled or very gently stir-fried in a scant amount of oil if preliminary treatment is required" (Tsuji 1980). Cooking the leaves for more than two minutes may decrease their flavor. Roots can be blanched for 5 minutes, then sautéed or boiled with vegetables. The seeds are used as a seasoning.

Recipe Sources

Tsuji (1980) gives many recipes with mitsuba leaves, including: Sukiyaki, Osaka-style; Nori-roll sushi; Noodles in the pot; Beaten egg soup; Flounder in the woodpile; Sea bream steamed with chestnuts; Noodle sukiyaki; White gruel; Tempura on rice; Tea-silk sushi; and chilled fine noodles with shrimp and mushrooms. Harrington (1978) provides numerous serving suggestions.

Other recipes are: Oriental vegetable salad (Larkcom 1984); Shabu-shabu (with mitsuba) (von Welanetz and von Welanetz 1982).

Importance

Mitsuba is cultivated in Japan, Korea, China, Taiwan, and Indonesia, where it is a well known culinary herb. Productions of over 17 000 t were reported in 1983 and 1984 in Japan (Follett 1990). Mitsuba will often be found in Chinese and Japanese markets in North America, and is grown commercially for the Oriental market near Los Angeles in plastic houses (Yamaguchi 1990). However, it is unknown in most of North America, although sold by several seed supply houses in Canada and the U.S.

Cultivation Notes

Soil

Mitsuba tolerates a range of soils, but does best in moisture-retentive substrates, particularly in loamy soils. Hydroponic culture is common in Japan (Follett 1990). Some growers cultivate the plants on polyfoam blocks which are floated on nutrient solution (Yamaguchi 1990).

Climate

Cryptotaenia japonica, like its counterpart *C. canadensis* of eastern North America, can be cultivated as a perennial as far north as southern Canada, but is more easily grown as an annual. It can tolerate winter temperatures of-10° C for brief periods. Mitsuba thrives in a shady situation, and does not do well in hot, open locations. The leaves tend to turn yellow when plants are grown in full sun. In Japan, it is grown year-round in plastic houses, with the main production from fall through winter (Yamaguchi 1990).

Propagation and Cultivation

This species is normally grown as an annual from seed, planted in spring or autumn. The seeds germinate readily at about 25° C, but the seeds and seedlings need to be kept moist. Once established, plants may self-sow naturally where they are growing. Leafstalks are often blanched (whitened by protection from sunlight) in Japan to increase their tenderness. This is done by hilling earth over the root-

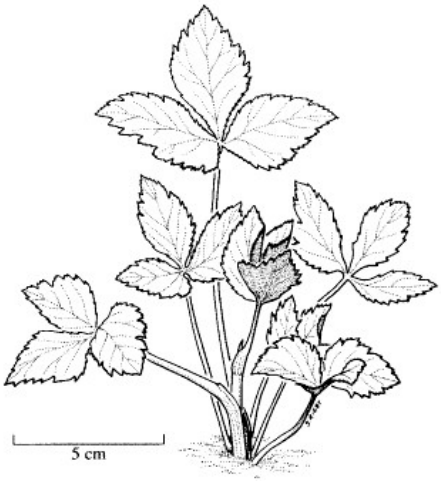


Fig. 135.
Mitsuba *(Cryptotaenia japonica)*, young plant, prepared by S. Rigby. (Based on greenhouse plant grown from seed from Richers.)

stocks in the spring, so that the young leaves have to grow through the earth, keeping the leafstalks from sunlight. Old plants in Japan are sometimes used as forcing material, that is they are lifted and grown in a protected situation for production of early-season or out-of-season leafstalks (Fernald et al. 1958). Home gardeners can make regular sowings for a continuous supply of salad leaves.

Baskin and Baskin (1988) clarified a number of developmental characteristics of *C. canadensis*, the American analogue of *C. japonica*, that are important at least to how the North America plant can be cultivated; the same considerations probably bear on cultivation of the Japanese species. They found that seeds have underdeveloped embryos and require cold stratification to come out of dormancy; and that there is a light requirement for good germination, which may be met by providing light in the spring or during the growth of the embryo that occurs during the winter. Although *C. canadensis* is normally a perennial, flowering in the second year or later, it can be grown as an annual. Flowering plants die after maturing seed, but there is extensive vegetative reproduction by offshoots from the base of the stem.

Harvest and Storage

Single leaves can be picked as needed, or the entire plant can be harvested when young. Plants can be used for salads as early as 2 months following sowing.

Harvested material can be rinsed, wrapped in paper towels, placed inside a plastic bag and stored in the crisper section of the refrigerator for up to a week (von Welanetz and von Welanetz 1982). Roots and seeds can be taken from mature plants. Commercial plantings in Japan have produced, on average, 10.8 t/ha outdoors, and 25.2 t/ha under glass (Follett 1990).

Example Cultivars

Masumori (listed in Facciola 1990), Yanagawa No. 1 (listed in Izaki et al. 1988)

Additional Notes

Chemistry

Compounds present include isomesityl oxide, mesityl oxide, methyl-isobutyl ketone, *trans*-ß-ocimene, and terpinolene (Duke and Ayensu 1985). Okude and Hayashi (1970) investigated the sesquiterpene constituents of the essential oil, and found the main components to be cuparene (ca 24%), (+)-ß-selinene (ca. 20%), (+)- -selenine (ca. 19%), and eremophilene (ca 9%).

Medicine

Mitsuba is an important and widely employed medicinal herb in China, used to treat colds, diarrhea, rheumatism, painful menstruation, and certain glandular conditions (Perry and Metzger 1980, Duke and Ayensu 1985).

Nutrition

Larkcom (1984) lists mitsuba foliage as a source of vitamins B_1 and C. The leaves have about 2.3% protein, 4.4% carbohydrate, and 0.23% fat.

Curiosities

• The generic name *Crypotaenia* comes from the Greek *cryptos*, hidden, and *taenia*, a fillet, referring to concealed oil tubes in the fruits (Fernald 1970).

• In addition to the North American *C. canadensis* and the Asian *C. japonica*, there are many other examples of plant species of eastern North America that have very closely related species in eastern Asia (cf. *Panax* and *Agastache* Curiosities). Baskin and Baskin (1988) point out that some 34 herbaceous genera of plants exhibit this pattern. The floristically similar deciduous forests of eastern Asia and eastern North America seem to be the major survivors of an ancestral forest that formed a continuous band around the northern hemisphere 15 to 20 million years ago (Li 1952; Reznicek 1988). This was fragmented by climatic cooling, uplift of mountains, and continental glaciations.

• According to Li et al. (1973), honewort is very popular in China because of "its asserted power to make the female 'revert' to her husband, and much of its employment is probably to be referred to the wish of Chinese women to stimulate their generative organs, in order to increase their opportunities of bearing children, at present their only function in Chinese society."

• Thirty of the most unusual culinary herbs discussed in this book were grown in a greenhouse in Ottawa to serve as models for illustrations. A groundhog managed to get into this greenhouse, and ate the six available plants of mitsuba down to the root, while merely nibbling on the other herbs.

Problems and Potential

Mitsuba is a well known vegetable and condiment of Asia, although almost unknown in North America. It is easily cultivated, has an attractive and exotic flavor, and should be considered as a potential minor diversification crop for local markets in North America.

Selected References

Harrington (1978); Baskin and Baskin (1988); Follett (1990); Yamaguchi (1990).

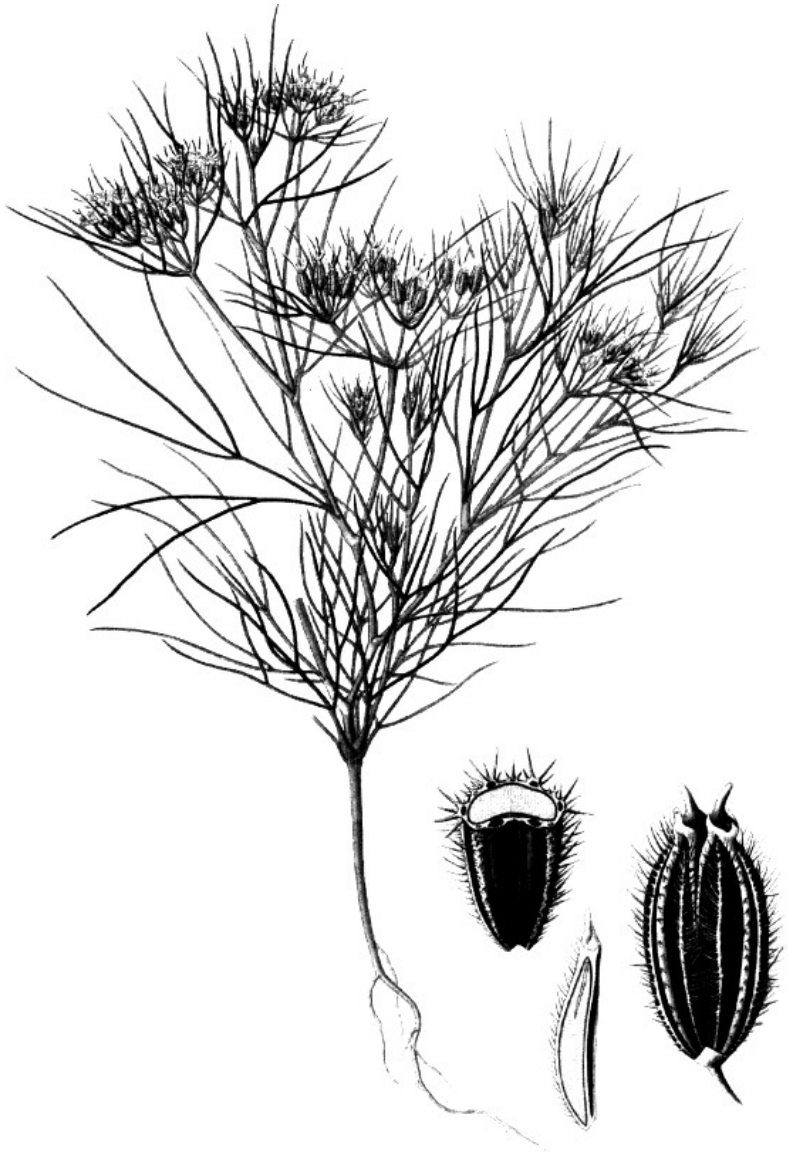


Fig. 136.
Cumin *(Cuminum cyminum)*, from Köhler (1883-1898).

Cuminum

Family: Umbelliferae (carrot family)

Genus Notes

Cuminum includes two slender annual species native from the Mediterranean region south to the Sudan, and to central Asia. One of these is discussed below.

Cuminum Cyminum L.

English Names

Cumin
Also: Roman caraway
[The name Roman caraway alludes to the facts that the Romans used ground cumin seed in the same way that we use pepper (Stuart 1979), and that caraway has largely replaced cumin in western nations. While Roman caraway is cumin, Roman cumin is caraway (Rosengarten 1969)!]

French Names

Family: Ombellifères, famille de la carotte
Cumin (m)
Also: anis âcre, anis aigre, cumin officinal, faux aneth, faux anis (also applied to caraway, *Carum carvi*, treated in this book)
[In central Europe the name cumin is sometimes mistakenly applied to caraway (Bols 1934). Wijk (1911) correctly stated that the French *cumin romain* does not correspond to the English *Roman caraway* (i.e. cumin), but rather to caraway (see above discussion).]

Description, Taxonomy, and History

Cumin is a herbaceous plant, 20-80 cm tall, with threadlike leaves and white, purple or rose flowers. Commercial plants typically grow to a height of about 50 cm in flower, and produce many branches. Wild plants are not definitely known to exist. The species likely originated in the region of the Mediterranean and the Near East, perhaps in Egypt or southeastern Europe (Mansfeld 1986). Cumin from Iran, India and the Middle East differs in seed color, quantity of essential oil, and flavor (Simon et al. 1984).

As with other members of the carrot family, the fruit comprises two distinct halves (technically "mericarps"), each containing a seed. The "half-fruits" are commonly called seeds and this convention is followed here. Cumin seeds resemble those of caraway, and so are sometimes confused with the latter. Caraway seeds are more curved than those of cumin.

Cumin was cultivated in antiquity. It was included in a list of medicinal plants recorded in ancient Egypt in 1550 B.C. (Rosengarten 1969). In the 1st century A.D. it was referred to by the Roman Pliny (62-113) as the best appetizer of all condiments (Rosengarten 1969). Records from 716 A.D. in Normandy indicate that it was used locally in monasteries (Bois 1934). During the Middle Ages, cumin was popular in Europe. In 1419, cumin became a taxable commodity in England (Rosengarten 1969). Usage of cumin declined as the similar tasting caraway (*Carum carvi*) became more popular (Rosengarten 1969), although El-Keltawi (personal communication) is of the opinion that while this may have been true for the West, it is not the case in the East. In the last 300 years, cumin has been largely discarded from European cooking, and is now chiefly used in Indian cooking (Stuart 1979).

Uses

Cumin seeds impart a strong, characteristic odor that has been described as strongly penetrating, irritating, fatty, overpowering, curry-like, heavy, spicy, warm, and persistent, even after drying. The aroma has been compared to the bed-bug odor of coriander, disliked by many (Morton 1976). The aroma has also been described by some as "resembling musty caraway" and "like dirty socks" [Farrell 1985; El-Keltawi (personal communication) advises that the latter analogy is simply not accurate. There are other herbs discussed in this book that are unfamiliar to the Western palate, seem rather repellent to some, and require habituation. Tastes for herbs are often acquired, and a period of accustomization may be needed to appreciate the qualifies of an exotic flavor.]. Norman (1990) described the flavor as slightly bitter, sharp, warm, pungent, and persistent. The flavor is indeed not unlike caraway, although slightly bitter (Farrell 1985) and very hot (Morton 1976).

Cumin seeds are available in whole and ground form. According to Mességué and Peter (1982), the seeds require lengthy cooking, and for this reason are often sold in small quantities in powdered form, which preserves the flavor well and makes it easier to add the right amount. Cumin is a key ingredient of commercial curry and chile powders. The spice is also added to soups, meats, pickles, and sauerkraut. Cumin complements cheddar cheese canapés, salad dressings, and devilled eggs. It adds zest to mild starchy foods like rice, potatoes, and bread. The Dutch and Swiss use it to flavor cheese; the Germans use it to flavor breads

and sauerkraut; and Spaniards combine it with cinnamon and saffron in stews. It is an essential ingredient and predominant flavor in most Egyptian, Indian, and Turkish curries, and is often used in couscous dishes. In India, cumin is generally dry roasted to bring out its flavor (Norman 1990). The combination of ground cumin and coriander leaves is responsible for the characteristic smell of much Indian food (Norman 1990). Cumin is also important in cooking throughout Latin America (Farrell 1985). It is used extensively in Mexican foods. In Texas it is an ingredient of chili con came (Norman 1990).

The oil of cumin is employed commercially in perfumery, and is an essential ingredient of kummel liqueurs and some German baked goods. It is also added to soups and stews, and makes pungent mango pickles and green mango chutney (Farrell 1985). The oil is also used in condiments, sausages, meat sauces and cheeses (Furia and Bellanca 1975; Morton 1976).

Recipe Sources

Muenscher (1978) presents recipes for Cumined vegetables and Cumin seed wafers. Garland (1979) has recipes entitled Lentils with cumin, Roast lamb with cumin, and Tomato and cumin basting sauce for spit-roasted meat. Jaffrey (1981) gives recipes for Yellow squash with onions, tomato, and cumin; and Semolina dosas [pancakes] with cumin seeds. Shulman (1991) has recipes for Buckwheat and whole wheat bread with cumin, Celery au cumin, Leek and potato quiche with cumin, and Potato-cheese soup with cumin.

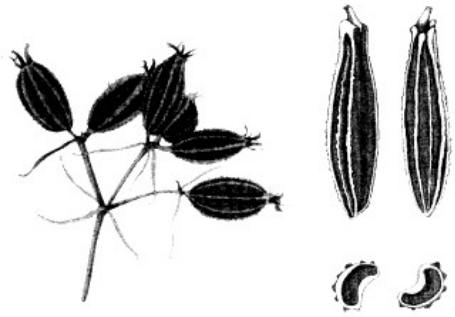


Fig. 137.
Cumin *(Cuminum cyminum)*, prepared by M. Jomphe.
(Based on "H. Fries, July 2, 1951" at Agriculture
and Agri-Food Canada herbarium, Ottawa.)

Other recipes are: Cumin bean beef roll (Rosengarten 1969); Raita [a side dish served with Indian meals] (Hériteau 1975); Potatoes with asafetida and cumin (Jaffrey 1975); Chicken in garlic and cumin (Kennedy 1978); Carrots with cumin (Brennan et al. 1985).

Importance

World production has been estimated at about 50 000 t/ year (Lewis 1984). Cumin is cultivated primarily in China, India, Morocco, Cyprus, Turkey, and southern Russia. About 5 000 t are produced annually in Egypt (El-Keltawi, personal communication). Iran was a major exporter until recently. Cumin is extensively consumed in India, North Africa, the Middle East, Mexico and the U.S. It used to be widely employed in baking in central and eastern Europe, but is little used today in Europe (Norman 1990). The value of cumin imported to the U.S. averaged $12.0 million (U.S.) from 1990 to 1994, more than twice the average from 1980 to 1990 (Buzzanell et al. 1995). During 1990-94, the volume of imports to the U.S. averaged 5580 t (Buzzanell et al. 1995). Pakistan and Turkey were the leading exporters. The expanding market for cumin in the U.S. reflects growing use in both Hispanic and Asian foods (Buzzanell et al. 1995). No statistics seem available on importation of cumin into Canada, where there does not seem to be any commercial production. Cumin does not appear to be commercially produced in the U.S., although American cultivation is possible (see below).

Cumin essential oil is of minor value. Verlet (1993) estimated the annual world value of cumin essential oil to be $960,000.00 (U.S.).

Cultivation Notes

Soil

A rich, well-drained, sandy loam soil is best for cumin production (Lewis 1984). The recommended pH level is 6.8-8.3 (Duke and Hurst 1975), with a tolerance range of 4.5-8.3 (Duke 1978).

Climate

Cumin is not frost-hardy, and grows at temperatures between 9 and 26°C. It requires a long season (3-4 months) of warm growing conditions, in full sunlight. Cumin is intolerant of long periods of dry heat (Simon et al. 1984). Flowering of this short-day plant is initiated by shortening days of late summer. The seeds ripen as far north as Norway (Stuart 1979). Supplementary watering is beneficial during dry periods (Rosengarten 1969). In North America, cumin is adapted to the Gulf Coast and Pacific Coast states of the U.S. (Sievers 1948).

Propagation and Cultivation

Propagation in North America is best done by seeds sown indoors and transplanted after danger of frost. Control of weeds is necessary during the growing season. In commercial production in warm regions, seeds are broadcast after winter crops, and seedlings are then hand-thinned (Lewis 1984).

Harvest and Storage

Cumin is ready for harvest when the plants begin to wither. In the eastern Mediterranean the harvesting, drying, and threshing is done by hand. Under favorable conditions a yield of 450-560 kg/ha of dried seeds can be realized (Rosengarten 1969). The home gardener can cut the as they begin to change color and hang them to ripen in a dry place, with a cloth beneath to catch the seeds (Garland 1979).

Example Cultivars

The cultivar Black is available in North America (Facciola 1990). It appears to be based on a variety of cumin found in Kashmir, Pakistan and Iran, used mostly in north Indian and Moghul cooking (Norman 1990). Black is grown as an expensive spice, occasionally sold in India (where it is called "Siyah Zeera," kala jeera or "Shah Zeera"). It is known as black cumin, or occasionally as black caraway. The seeds are darker, often rather small and sweet-smelling, with a more complex flavor than ordinary cumin. According to Norman (1990) "the taste of black cumin falls between that of cumin and caraway; its smell resembles that of a haystack." [This cultivar is sometimes confused with *Nigella sativa*, also called black cumin, and discussed elsewhere in this book. Confusion is also possible with *Bunium persicum*, an aromatic herb marketed in the Middle East as black cumin (see discussion of *Nigella sativa*).]

Additional Notes

Chemistry

Dried cumin seeds have 2.5-5% essential oil on a dry weight basis (Simon et al. 1984). The fleshly crushed seeds are steam-distilled for 10-12 hours to obtain a colorless to yellow oil, which darkens with age. The oil contains 35-40% aldehydes, mostly cuminaldehyde, although in the natural state the aldehyde in cumin seed is 1-4-*p*-menthadien-7-al. The cuminaldehyde appears to form as an artifact of storage of the ground seeds, or through distillation (Baser et al. 1992). Synthetic cuminaldehyde is sometimes added to the oil and is difficult to detect (Lewis 1984). The aldehydes are responsible for the characteristic odor of cumin (Simon et al. 1984).

Fig. 138.
Cumin *(Cuminum cyminum)*, from Harter (1988).

Other constituents are *d*, *l*-pinene, *d*- -pinene, *p*-cymene, ß-pinene, dipentene, and cuminyl alcohol (Simon et al. 1984). Lawrence (1987*b*) reviews the somewhat different analyses of cumin oil that have been reported, and personally reported the following: cuminaldehyde (18.8%), *p*-mentha-l,3-dien-7-al (16.0%), ß-pinene (21.8%), -terpinine (24.4%), and *p*-cymene (10.1%).

Medicine

In Indian folk medicine, cumin seeds have traditionally been employed as a stimulant and for treatment of such digestive tract problems as diarrhea and colic. The seeds have also been used to treat spasms (Rosengarten 1969; Farrell 1985). The oil is used chiefly in veterinary medicine (Stuart 1979).

Nutrition

Rinzler (1990) provides a nutritional analysis of cumin seeds, which are not notable for their nutritional content.

Curiosities

• As early as 5000 B.C. the ancient Egyptians preserved the bodies of their kings by mummifying them in cumin, anise, and marjoram (Farrell 1985).

• Cumin is referred to in Isaiah 28: 27: "...but the fitches are beaten out with a staff, and cummin with a rod." Cumin is still threshed with a rod on many poor farms in the eastern Mediterranean region (Rosengarten 1969).

• In the 23d verse of the 23 chapter of Matthew, cumin is one of the three tithes mentioned (Farrell 1985): "Woe unto you, scribe and Pharisees, hypocrites! for ye pay tithe of mint and anise and cummin and have omitted the weightier matters of the law, judgement, mercy and faith."

• Among ancient Greeks, cumin was the symbol of greed; ancient Roman misers were said to have eaten it in the belief that it prevented theft of their objects, and Marcus Aurelius of ancient Rome was nicknamed "Cumin" because of his greed (Farrell 1985).

• Pliny recommended smoking cumin seeds to cultivate "an impressive scholastic pallor" (Garland 1979). Students were said to consume cumin to acquire paleness to make it appear that they had spent long hours in study (Fox 1933).

• During the Middle Ages, cumin was believed to keep lovers from becoming fickle and poultry from straying from home. At German weddings the bride and groom carried this spice along with dill and salt in their pockets during the ceremony to ensure their faithfulness (Fox 1933).

• Cumin is widely used in curry and chile powders, and its high content of cuminaldehyde contributes to the burning sensation of these condiments. As cuminaldehyde is practically insoluble in water, drinking iced water doesn't cool the burning sensation caused by eating a hot curry or chile-flavored dish. Rinzler (1990) recommends drinking alcohol (e.g. beer) or whole milk, both of which dissolve cuminaldehyde, to ease the stinging in the mouth from eating too much curry or chile. (Compare recommendations for treating a chile pepper burn in this book.)

Problems and Potential

Cumin is a plant best adapted to warmer climates than Canada and most of the northern U.S., although short-season cultivars could certainly be bred for northern North America. However, the taste for this spice is traditionally popular in warmer areas. There is little commercial potential in northern North America for this minor crop, which will likely remain a curiosity of home gardens.

Selected References

Garland (1979); Farrell (1985).

Cymbopogon

Family: Gramineae (Poaceae) (grass family)

Genus Notes

Cymbopogon has about 60 species of aromatic, usually perennial grasses originating in the Old World tropics. In addition to the two species discussed in detail here, those mentioned below are of economic importance, mainly for a variety of essential oils and for erosion control (Mansfeld 1986; Huxley et al. 1992). Several other species not mentioned below have been used to breed high-yielding essential oil cultivars (e.g., Atal and Bradu 1976; Rao and Sobti 1987).

Cymbopogon flexuosus (Nees ex Steud.) J.F. Watson is known as East Indian lemon grass, Malabar (lemon) grass, and Cochin grass. Wild plants are found in parts of India (Stapf 1906). Cultivated selections are grown in India, southeast Asia (including China), equatorial Africa, Guatemala, and Paraguay (Roecklein and Leung 1987). Steam distillation produces an essential oil called Indian lemongrass oil, Cochin lemon grass oil, and Malabar oil, one of the world's major essential oils (Kulkarni and Ramesh 1992). The major component of the oil is citral, which is important in the synthesis of vitamin A, nontoxic adhesives, cosmetics, and geraniol used in perfumes (Singh et al. 1989). Food manufacturers add lemon grass oil to beverages, ice cream, candy, baked goods, gelatin desserts and chewing gum (Morton 1976). In Asia, the oil is extensively used in hospitals and hotels as a room deodorant and disinfectant (Thomas, personal communication).

Cymbopogon martinii (Roxb.)Wats. is native to southern Asia. Variety *martinii* is known as palmarosa grass, East Indian geranium, Turkish geranium and rosha grass. It is cultivated in India, east Asia, Angola, and Brazil for its essential oil called palmarosa oil, rusa oil, East Indian geranium oil, or Turkish geranium oil. The oil contains geraniol and is used to flavor ice cream, gelatin desserts, chewing gum, and bakery products (Tanaka 1976; Facciola 1990). Another variety, *C. martinii* var. *sofia* Gupta, known as ginger grass, is cultivated in India to produce ginger grass oil. Verlet (1993) estimated the annual world value of gingergrass essential oil to be $25,000.00 (U.S.). Considerable information on *C. martinii* is found in Duke and duCellier (1993).

Cymbopogon Citratus (DC. Ex Nees) Stapf

Scientific (Latin) Synonyms

Andropogon citratus DC., *A. nardus* var. *ceriferus* Hack., *A. roxburghii* Nees

English Names

Lemon grass
Also: citron grass, fever grass, lemongrass, sere grass, West Indian lemon grass
[The spellings lemon grass and lemongrass are both frequently encountered.]

French Names

Family: Graminées, famille des graminées
Verveine des Indes (f)
Also: citronelle (a name more commonly applied to *C. nardus*, treated next; see lemon balm (*Melissa*) for other species called citronelle), lemongrass (Arctander 1960, Furia and Bellanca 1975), lemon-grass (Bois 1934)
[The essential oil of lemon grass, as well as of several other species of *Cymbopogon*, is sometimes called oil of verbena or East India verbena oil because of its similar odor to true verbena oil, hence the French common name, "verbena of the Indies." (Cf. verveine citronelle, a name for *Aloysia citriodora*, discussed in this book.) Simon et al. (1984) list "jonc odorant" as applying to both *Cymbopogon citratus* and *C. flexuosus*.]

Description, Taxonomy, and History

Lemon grass is a perennial, tall tropical grass growing in dense clumps or tufts 70-150 cm or more in height. The plants seldom flower under cultivation (Roecklein and Leung 1987). The slightly enlarged, bulbous, juicy base is the most palatable portion. All parts are strongly lemon-scented. According to (1906), wild plants are unknown. However, Huxley et al. (1992) give Ceylon and southern India as the native geographical range, and Duke and duCellier (1993) reported that lemon grass is native to Bengal and Mysore. Lemon grass likely originated in southern India, Ceylon, or perhaps Indonesia, where wild-growing plants are presently found. With immigration

Fig. 139.
Lemon grass *(Cymbopogon citratus)*, from Hooker (1909).

into North America, lemon grass has often become available in Oriental markets, particularly Thai, Vietnamese, Cambodian, and Laotian.

Note

Except for young, tender, basal portions, lemon grass remains fibrous after cooking, and is generally removed before serving. Avoid chewing or swallowing the tougher parts of this herb.

Uses

In Southeast Asia the base and lower shoots of the plant are eaten. This herb is employed to impart its distinctly lemon-like aroma and flavor to food. Finely chopped basal portions of the leafy shoots can be eaten raw or cooked with fish, sauces, marinades, stir-fries, and curries. Lemon grass is compatible with garlic, shallots, and chile. The taste combines well with cilantro in flavoring fish, shellfish, chicken and pork. Raw pieces are added to salads, particularly those containing cold meats or fish. The flavor is sufficiently versatile to be used in many parts of a meal from soup to tea. Teas are usually steeped from the dried herb, which imparts less flavor than the fresh leaves. Rinzler (1990) equates one stalk of lemongrass to about 2-3 tablespoons of dried lemongrass. The fresh bulbous base and leaves make the best tea. The tough, straw-like, outer leaves may be tied in a loop and cooked with rice, fruit, and vegetable dishes, flavoring them, but removed before serving. They can also be placed in the cavity of fish or chicken, and steamed for a subtle flavor. The leaves do not become bitter with long cooking. Leaves and stems should be pounded lightly with a heavy object to help release the volatile oils (Schneider 1986). The tender hearts of the young shoots are served as a vegetable with rice. Trahanas are a fermented combination of milk and cereal. Lemon grass is substituted for yoghurt in the preparation of "nistisemos trahanas" (fasting trahanas), eaten during religious holidays in Greece and Turkey, where the regular type of trahanas made with animal milk would be sacrilegious (Facciola 1990).

Lemon grass oil is widely used as a flavoring and aroma ingredient in food and drinks. Lemon grass oil is used in alcoholic and nonalcoholic drinks, frozen dairy deserts, candy, baked goods, gelatins, puddings, meat and meat products (Duke and duCellier 1993).

Citral oil from lemon grass is used in cosmetic creams, lotions, perfumes, bath salts, and toilet soaps (Watt and Breyer-Brandwijk 1962). The oil is also employed to make a furniture polish (Duke and duCellier 1993). The pulp remaining after lemon grass has been employed for oil

Fig. 140.
Lemon grass *(Cymbopogon citratus)*, prepared by
S. Rigby. (Based on greenhouse plant from Richters.)

extraction has been used to make paper (Anon. 1952; Guha et al. 1973). In Australia, lemon grass is cultivated mainly for adding aroma to dishwashing liquids (Schneider 1986). Lemon grass in Florida is used not just for oil, but also for cattle feed (Duke and duCellier 1993). The spent grass after the extraction of the oil serves extensively as roughage for cattle in south India (Thomas, personal communication). It forms an excellent medium for cultivation of paddy straw mushrooms and is also used as a good source of mulching material for cultivation of spices such as ginger and turmeric (Thomas, personal communication).

Recipe Sources

Ngo and Zimmerman (1986) give the following recipes: Barbecued beef with lemon grass and noodles, Stir-fried beef with green peppers and broccoli, Ground beef with lemon grass and shrimp sauce, Pork hock simmered with lemon grass, Fried chicken with vinegar and lemon grass, Beef soup with lemon grass, and Hue beef noodle soup with lemon grass. Schneider (1986) gives the following recipes: Thai calamari [squid] salad with lemon grass, Chilled aromatic shrimp with lemon grass dip, Lemon grass seasoning paste, and Aromatic broth with vegetable slivers. Hutson (1987) gives recipes for Spicy hot and sour shrimp salad (Plágoong), Spicy Oriental shrimp boil, Thai hot and sour soup (Tom Yum Goong), Lovely lemon vinegar, and Chinese 5 vinegar.

Recipes by others include: Stuffed lemon grass stalks (Sing 1981); Forgotten harvest iced tea (Tolley and Mead 1985); Grilled tuna fish with coconut, lemon grass, and coriander sauce (Holt 1991); Chicken with lemon grass (Solomon 1992).

Importance

Lemon grass is widely grown as a culinary herb, but mostly as a source of essential oil. It is cultivated in tropical to warm temperate areas, including southern and east Asia, western Africa, the West Indies, Central America, Brazil, Australia, and the southern parts of California and Florida (Mansfeld 1986; Roecklein and Leung 1987). It is grown on a vast scale in India (Duke and duCellier 1993). Verlet (1993) estimated the annual world value of "lemongrass" essential oil to be $4,340,000 (U.S.). In 1988, the U.S. imported 73.7 t of lemon grass oil valued at $934,500, mostly from Guatemala (Anon. 1989*b*). The U.S. imported 37 193 kg of lemongrass oil worth $330,400 in 1991; 86 608 kg worth $579,200 in 1992; and 67 796 kg worth $479,400 in 1993 (Dull 1994*a*). Duke and duCellier (1993) discuss recent production and importation statistics for the U.S. United States imports have declined considerably in the last decade, as citral is increasingly being manufactured synthetically, and precursors are being obtained from alternative foreign plant sources (Duke and duCellier 1993). Citral from lemon peel rather than from lemon grass is often used in the production of artificial lemon flavors (Norman 1990).

Cultivation Notes

Soil

Lemon grass grows naturally in medium and heavy-textured dry soils in its native habitat. However, the plant is very sensitive to water logging, and therefore may not thrive on compact, water-retentive soils (Thomas, personal communication). Sandy soils promote a higher content of the essential oil (Norman 1990). The best soils for lemon grass are on well-drained sandy loams, although the plant grows well on light sands, and in the Florida Everglades it thrives on muck (Duke and duCellier 1993). Under glass, lemon grass does best in well-drained but moisture-retentive sandy loam soils. The pH range tolerated is 4.3-8.4 (Duke 1979). Lemon grass has been grown hydroponically, using as substrate a mixture of gravel and volcanic slag (Thomas, personal communication).

Climate

Lemon grass is best treated as a greenhouse or potted plant in Canada and the northern U.S. It should not be exposed to prolonged temperatures below 10°C. Growth occurs between 18 and 30°C. It has been shown that -2°C kills the plants to the ground and that -4°C also is deadly for the roots (Hood 1917). Campbell (1991) noted that he had grown lemon grass outdoors in Minnesota for several years, bringing the plants indoors during the winter. Abundant water is necessary during growth (Huxley et al. 1992). In commercial production, full sunlight is necessary to obtain maxium yields of essential oil (Duke and duCellier 1993). As a potted house plant, it should be provided with as much sunlight as possible.

Propagation and Cultivation

Lemon grass is propagated by seed or vegetative division. Richters (1995) states "we are pleased to be the first to offer seeds in North America." Seeds are often not formed, and propagation is mainly by division of clumps. From each clump many divisions are easily separated by tearing them from the base of the mature plant, or using a sharp knife to section away stalks, one at a time, cutting downward into the soil, while leaving the remaining shoots intact. Before planting the leaves are cut back to about 8 cm. If a stalk with a portion of root is obtained, this can be kept with its base in water, where roots quickly develop. Rooted plants should be placed in a large pot to allow them to spread. Living plants are sold through North American garden catalogs. Fresh lemon grass is often found in the produce bins of Thai markets. Portions with vestiges of roots can be used to establish plants as described above.

Harvest and Storage

In commercial production in tropical and subtropical areas, two or three crops are harvested the first year after establishing a crop, and then three or more harvests are

taken in subsequent years. The leaves are mowed about 20 cm above the ground. When commercially grown plants are continuously harvested, they do not flower (Duke and duCellier 1993). The leaf material close to the ground is lower in the desired essential oils so that there is limited advantage in cutting the leaves to the ground (Hood 1917). There is some loss of essential oil content through drying. In tropical areas, fresh yields can be as high as 140 t/ha (Duke and duCellier 1993). An experimental planting in Australia yielded 419 L/ha/year of essential oil based on harvests every 60 days (Beech 1977).

The home gardener interested in using lemon grass as a condiment should separate the lower basal portion from the upper, leafy part of the stem, wrap both in foil, and store the material in a refrigerator (for up to 2 weeks). Lemon grass "freezes fabulously well" (Schneider 1986), and will keep in a freezer with minimum loss of flavor. The stalk can also be cut into small pieces, air dried, and stored in an airtight container that does not admit light (Schneider 1986). The strong aroma of lemon grass can taint other foods in storage unless well-wrapped (Huxley et al. 1992). Commercially dried lemon grass may be encountered as a powder, as dried strips (like lemon peel), and as dried leaves. Dried foliage is hard and fibrous, and "doesn't have the clean, refreshing taste of the fresh variety" (Norman 1990). Therefore, the home gardener is advised to keep a fresh supply on hand as living, potted plants.

Example Cultivars

Cultivars seem unavailable in North America.

Additional Notes

Chemistry

About 0.2-0.4% of the fresh grass is made up of a volatile oil. This lemon-scented essential oil is obtained by steam distillation. The major chemical component (65-85%) is generally reported to be citral. The oil is used to manufacture synthetic violet odor (ionones) for perfumed soaps and cosmetics (Duke and duCellier 1993). Tonone, produced from citral, is the name of one artificial violet perfume commonly encountered in trade. Citral is also used to adulterate lemon oil (Grieve 1931) and in the synthesis of vitamin A (Rinzler 1990). Abegaz et al. (1983) reported that Ethiopian *C. citratus* contained geraniol as the main component (about 40%) of the essential oil. Other chemical components noted in Furia and Bellanca (1975) include isovaleric aldehyde, furfural, myrcene, dipentene, methylheptenone, aldehyde C_{10}, citronellal, various esters, linalool, nerol, and other terpenoids.

Medicine

The name "fever grass" for *Cymbopogon* arose in southern India and Ceylon, because of the alleged curative properties of infusions made with it (Gilbertie 1988). In southeast Asia and western Africa, fever (lemon) grass is used to combat malaria (Schneider 1986). Natives of Guatemala have used lemon grass in folk medicine for fever, grippe, flatulence, and low blood pressure (Girón et al. 1991). Lemon grass is one of the most employed plants in Brazilian folk medicine, the leaves used in a tea for the treatment of nervous and gastrointestinal disturbances as well as for fever (Carlini et al. 1986; Wannmacher et al. 1990*a*). In Vietnam, lemon grass is combined with rose hips and rose petals as a restorative bath for women after childbirth (Schneider 1986). In India, the grass is generally employed as an infusion, used to treat stomach problems in children, typhoid fever, disordered menstruation, vomiting, and diarrhea, while the oil is applied externally to treat lumbago, rheumatism, neuralgia, sprains, and other painful afflictions (Thomas, personal communication). In the Philippines, the root is used for toothache and headache (Watt and Breyer-Brandwijk 1962). In China, the leaves are used to treat headache, abdominal pain, colds, rheumatic pain, and stomach ache (Duke and Ayensu 1985). Additional folk uses are listed in Duke and duCellier (1993).

Tests on rats and mice failed to show that oral therapeutic use of lemon grass was useful for fever, and nervous and gastrointestinal disorders (Carlini et al. 1986). However, another study concluded that lemon grass does produce a dose-dependant pain-reducing (analgesic) effect in rats, largely due to myrcene, a component of the essential oil (Lorenzetti et al. 1991). Still another study concluded that use of lemon grass as prescribed in folk medicine is not toxic but does not alleviate depression (Leite et al. 1986). There is some evidence that the essential oil of lemon grass may lower cholesterol levels in humans (Elson et al. 1989).

Rinzler (1990) states that prolonged handling of lemon grass may cause contact dermatitis and photodermatitis (a rash developed upon exposure to sunlight).

Nutrition

The fresh leaves contain 74% water, 1% protein, 1.4% fat, 22% carbohydrate, and other components (Duke and Ayensu 1985). Duke (1977) characterized the content of fiber, iron, niacin and vitamin A as high. Citral from the oil is convened to violet-scented ionones, which are used in the commercial synthesis of vitamin A (Roecklein and Leung 1987).

Curiosities

• The English name "lemongrass" is the same in French, Spanish, and Italian, and almost the same (lemongras) in German (Furia and Bellanca 1975).

• The taste of lemon seems universally attractive to various cultures, and different plants have furnished the aroma to different societies (Miske 1994). Throughout Southeast Asia, where lemons were not available historically, lemon grass was and remains the dominant source of lemon flavoring `Sing 1981).

• *Cymbopogon citratus* is listed by Watt and Breyer-Brandwijk (1962) as one of many plants capable of producing hydrocyanic acid (or prussic acid). This gas is so toxic that inhalation of a small amount may produce death in a few minutes; fortunately, the gas is not produced normally by such plants, but is chemically combined in the form of a cyanogenetic glucoside. However, this glucoside is often associated with an enzyme capable of decomposing it and freeing the hydrocyanic acid, and this can occur in a bruised or wilting plant, or much more dangerously in the alimentary tract of an animal (even without the enzyme). Cases of poisoning of stock animals from hydrocyanic plants are occasionally reported. Note the cases of human poisoning by cherry laurel, discussed in bay (*Laurus*) Genus Notes. In some plants, this potential for poisoning animals protects the plants against being consumed. There does not seem to be any literature suggesting that the cyanogenetic potential of lemon grass poses a hazard for man. To those alarmed by this poisonous potential of lemon grass, note that several commonly consumed plants, including rice, oats, sugar cane, and corn (Watt and Breyer-Brandwijk 1962), and lima bean, cherries and apple (Kingsbury 1964) are also cyanogenetic.

• The rhizome of lemon grass is chewed by Latin Americans until it is frayed, then used as a toothbrush (Duke and duCellier 1993).

• Lemon grass is one of the crops being promoted as a substitute for coca (*Erythroxylon coca* Lam., from which cocaine is obtained) in the Huallaga Valley, the main coca-producing region of Peru (Ugás, personal communication).

Problems and Potential

Lemon grass is a plant adapted to climates warmer than those found in Canada and the northern U.S. There is little likelihood of commercial production of lemon grass essential oil in northern North America. There is the possibility of small-scale greenhouse production of lemon grass for specialty local herb markets near large cities.

Selected References

Hood (1917); Gupta and Jain (1979); Schneider (1986); Duke and duCellier (1993).

Cymbopogon Nardus (L.) Rendle

Scientific (Latin) Synonyms

Andropogon nardus L., *A. ampliflorus* Steud.

English Names

Citronella grass
Also: Ceylon citronella grass, Ceylon lemongrass, citronella, mana grass, lenabatu grass, nard grass, nardus grass

French Names

Citronnelle (f)

[See lemon balm, *Melissa officinalis*, for a discussion of other species called citron(n)elle.]

Description, Taxonomy and History

Citronella grass is a robust perennial, growing from a stout woody rhizome to a height of 1.3-2.6 m. It almost never flowers (Duke and duCellier 1993), although plants used for illustrations for this book did flower in a greenhouse in Ottawa (Fig. 141). According to Stapf (1906), wild forms are unknown. However, Huxley et al. (1992) report that it is native to N. Africa and N. India, and Duke and duCellier (1993) state that it grows wild in the hotter parts of India. Two types of plant are recognized: Java and Ceylon. The Ceylon variety (sometimes referred to as *C. nardus* var. *lenabatu* or Ceylon citronella) is cultivated in southern Sri Lanka, and the oil is used in low-priced preparations such as detergents, sprays, and polishes. The Java variety is more productive, and is much more widely grown. It is used to produce perfumes and synthetic menthol. However, the Java variety is less hardy and less long-lived than the Ceylon variety (Roecklein and Leung 1987). The Java form has been called *Cymbopogon winterianus* Jowitt, *C. nardus* var. *mahapengeri*, and Java citronella; it is also known as Winter's grass, because it was grown almost exclusively by Messrs. Winter & Son (Stapf 1906). Whether or not it should be recognized as a different species has been argued (Bor 1965).

Uses

Citronella grass is cultivated mostly for its essential oil, known as citronella oil, obtained from the leaves. The oil is used to scent perfumes, soaps, toilet water, and

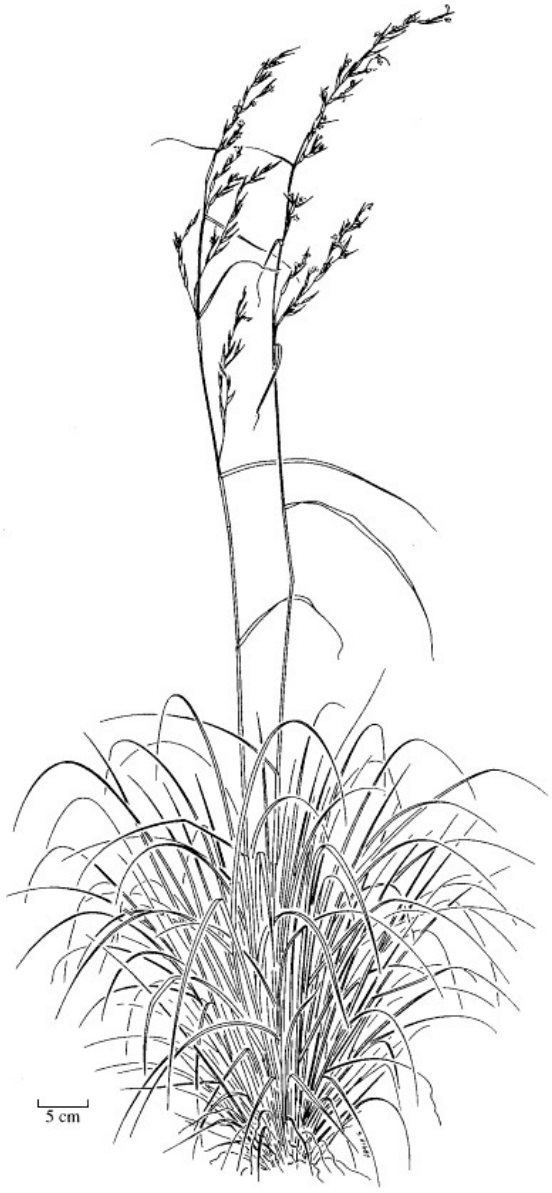


Fig. 141.
Citronella grass *(Cymbopogon nardus)*, prepared by S. Rigby.
(Based on greenhouse plant from Richters.)

household disinfectants. It is also used in varnishes, shoe polishes, and insecticides. Commercial geranium oil is in part derived from geraniol obtained from this and other species of *Cymbopogon*. Citronella oil serves as a starting material for the extraction of geraniol and citronellal, which are easily converted into aroma chemicals such as citronellol, hydroxy citronellol, synthetic menthol, and esters of geraniol (see Chemistry). The oil is extensively used as insect and mosquito repellent. As with lemon grass, the pulp remaining after the Java variety of citronella grass has been employed for oil extraction has been used to make paper (Guha et al. 1974).

Culinary uses are limited. The leaves are used to flavor soups, cooked fish and curry, and to prepare tea. Essential oil components are used as flavoring (see Chemistry).

Recipe Sources

Recipes do not seem to be available for this plant. Note the above discussion for suggestions regarding culinary uses.

Importance

Citronella grass is cultivated commercially for its essential oil, sometimes used as a flavoring, but it is rarely planted for culinary consumption of the herb. The species is grown in India and Sri Lanka, and to a lesser extend in Java and Seychelles (Duke and duCellier 1993). Limited cultivation occurs in southern California and southern Florida (Bailey and Bailey 1976). The world production of citronella grass oil is about 550 t annually, mostly in Sri Lanka, with small amounts from Burma and Java (Duke and duCellier 1993). Verlet (1993) estimated the annual world value of citronella essential oil to be $13,110,000.00 (U.S.). The U.S. imported 355,711 kg of citronella oil worth $1,411,600 in 1991; 567,597 kg worth $2,267,100 in 1992; and 885,843 kg worth $3,955,200 in 1993 (Dull 1994*a*).

Cultivation Notes

Soil

This species grows well on poor, dry soils in the tropics. While the plant grows well under varied soil conditions, optimum growth and yield are obtained in sandy loam soil with abundant organic matter (Thomas, personal communication). It has been found on soils ranging from a pH of 4.3 to 8.0, but grows better on alkaline than on acid soils (Duke and duCellier 1993).

Climate

Citronella grass will not grow below 16°C, and requires a warm growing season of at least 6 months. Accordingly the species can only be grown in northern North America as an indoor potted plant. The plant is highly sensitive to water logging (Thomas, personal communication).

Propagation and Cultivation

Commercial cultivation techniques for this tropical plant are discussed in Duke and duCellier (1993). In northern North America it is propagated by division, for use as a house or greenhouse plant. Living plants are available from some Canadian and U.S. garden catalogs.

Harvest and Storage

Commercial techniques used to harvest citronella grass in the tropics are discussed in Duke and duCellier (1993). As a house plant, leaves can be harvested fresh for culinary

Fig. 142.
Citronella grass *(Cymbopogon nardus)*,
from Engler and Prantl (1887).

use, or dried for future use. Commercially, about 0.8-1.2% of the plant furnishes oil, and 200-250 kg oil/ha are obtained annually in the tropics (Thomas, personal communication).

Example Cultivars

Cultivars do not seem to be available in North America.

Additional Notes

Chemistry

Duke and duCellier (1993) discuss the chemistry of citronella grass. Good quality citronella oil contains more than 45% citronellal, 16% geraniol, and 12% citronellol (Thomas, personal communication). Rajendrudu and Ram Das (1983) examined a sample of *C. nardus* with less than 6% citronellal and more than 64% geraniol. The essential oil is a source of geraniol, citral, and citronellal, used for flavoring foods and drinks. Citral is used in the production of imitation apple, lemon, strawberry, and vanilla flavor (Tanaka 1976). Java citronella grass has a much higher oil yield than the Ceylon variety. The Java type contains 40-50% citronellal, and is used to synthesize perfumed products and synthetic menthol (Roecklein and Leung 1987).

Medicine

Medicinal properties of citronella grass are discussed by Duke and duCellier (1993). The plant has been used in southern Africa to treat worms, fever, and colds (Duke and duCellier 1993). In the Ayurvedic system of medicine in India, an infusion of leaves is used as a gastric stumulant and to relieve flatulence. The oil is used as an antispasmodic (to relieve, prevent or control spasms), carminative (to relieve flatulence), diaphoretic (to promote sweating), stimulant, and rubefacient (to redden skin). In Cambodia, the roots are considered to be diuretic (to promote flow of urine), sudorific (cause sweating), and anti-periodic (to prevent the periodic recurrence of a disease).

Nutrition

No nutritional information for citronella grass seems available.

Curiosities

• In Sri Lanka, where most of the world's citronella grass is cultivated, the crop is harvested by women using sickles (Duke and duCellier 1993).

Problems and Potential

Citronella grass is a plant adapted to climates warmer than those found in Canada and the northern U.S. There is no possibility for commercial production of essential oil from citronella grass in northern North America. Its use as a culinary herb is very limited, and it is much less desirable than lemon grass, discussed above, as a potential herb for growth in small-scale greenhouses for specialty local markets near large cities.

Selected References

Gupta and Jain (1979); Roecklein and Leung (1987); Duke and duCellier (1993).

Fig. 143.
Vietnamese balm *(Elsholtzia ciliata)*, from Hallier (1880-1888).

Elsholtzia

Family: Labiatae (Lamiaceae) (mint family)

Genus Notes

Elsholtzia has 38 species of annual herbs or perennial shrubs growing in central and east Asia and northeastern Africa. In addition to the species discussed below, *E. stauntonii* Benth., mint shrub, has been grown experimentally in the Crimea for its essential oil (Mansfeld 1986). This subshrub is encountered in North America as an ornamental.

Elsholtzia should not be confused with *Eschscholzia*, a small genus of the poppy family, particularly known for the ornamental California poppy (*E. californica* Cham.).

Elsholtzia ciliata (Thunb.) Hylander

Scientific (Latin) Synonyms

E. cristata Willd., *E. patrinii* (Lepech.) Garcke

English Names

Vietnamese balm
[The Vietnamese name for this plant is *rau kinh gió'i.*]
Also: lepechin (Shi-Chen et al. 1973)

French Names

Family: Labiées, famille de la menthe
Baume vietnamien (m)
[The above name was coined and suggested by H.S. McKee (personal communication).]
Also: Elsholtzia à crête

Description, Taxonomy, and History

Vietnamese balm is an annual, lemon-scented, herbaceous, bushy plant growing 30-60 cm tall. It produces attractive spikes of light purple flowers in late summer or fall, if not killed by frost. This native of temperate central and eastern Asia, including China, Taiwan, Mongolia, Russia, Korea, Japan, northern Vietnam, Laos, Cambodia, Malaysia, Myanmar, Thailand, Pakistan, and India, has escaped from cultivation to become established in parts of Europe and North America. In Asia it often occurs on hills, sunny terraces, waste areas, riverbanks and in forests, from sea level to over 3000 m in altitude. In Canada it is occasionally found along roadsides and in old fields in Manitoba, Ontario, Quebec, and New Brunswick (Scoggan 1978-79). The species is naturalized in the eastern U.S., where it has been collected in Maine (Fernald 1970), Vermont and Massachusetts (Grayum and Rohman 1986).

Uses

Young plants of Vietnamese balm are finely cut and eaten raw in salads, boiled as a potherb, or used as an aromatic condiment in vegetable dishes (Facciola 1990). The flavor is reminiscent of lemon balm (*Melissa officinalis* L.), also treated in this book. Keys (1976) described the taste as pungent. The aroma has been described as "a vibrant lemon scent with sweet floral undertones" (Miske 1994). This herb can also be added to seafood dishes or brewed for tea. In India, the seeds are sometimes eaten raw, and oil from the seeds is used for cooking purposes (Ansari and Nand 1987).

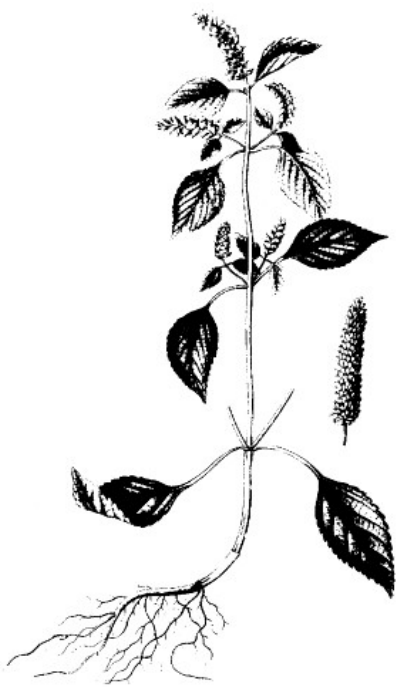


Fig. 144.
Vietnamese balm *(Elsholtzia ciliata)*,
from Oeder et al. (1761-1883).

In addition to its culinary uses, Vietnamese balm is cultivated as an ornamental, considered attractive for its very aromatic foliage and interesting, upright habit. It has insecticidal properties (Kubold et al. 1987), and is said to be a good bee plant (Bailey 1909).

Recipes Sources

None found.

Importance

Vietnamese balm has been used for many years in East Asia as a medicinal and culinary plant. It was also formerly grown in eastern Europe with some cultivation still occurring in Austria (Mansfeld 1986). In areas of Texas where Vietnamese emigrants have settled, it is occasionally sold in Vietnamese stores (Kuebel and Tucker 1988).

Cultivation Notes

Soil

No information found. As this species appears to escape from cultivation to various habitats, it may be rather tolerant of different soil types.

Climate

Since this species has been collected growing wild as far north as southern Canada, it can be grown in most climates of northern North America. In northern areas it may flower late or not at all, but this is of no consequence since the plant is harvested for its leaves. However, it does not seem possible in northern North America to produce seeds outdoors because of the limited season (see below). *Elsholtzia ciliata* grows best in full sunlight.

Propagation and Cultivation

Vietnamese balm is propagated by seeds sown in the ground after all danger of frost. In Canadian seed catalogs it is apparently only offered as living plants. Miske (1994) notes that commercial seed sources for North America are unlikely to be found, and that a nursery she contacted buys fresh sprigs from an Oriental produce market and roots the sprigs each spring, which are then offered for sale to the public. Plants grown indoors may not set seed. Miske (personal communication) found that for 2 consecutive years her greenhouse plants flowered in November but did not produce seed; and in the next year a plant she overwintered indoors produced abundant seed, which germinated readily. She suggests that perhaps the plant requires insect pollination, and some stray bees that found her way into her greenhouse were responsible for the production of seeds.

Fig. 145.
Vietnamese balm *(Elsholtzia ciliata)*,
from Lamarck and Poiret (1791-1823).

The plants are offered by some nurseries as tender perennials. However, Miske (1994) states that the plants can only be grown as annuals, and after flowering they die.

Harvest and Storage

No information found.

Example Cultivars

No information found.

Additional Notes

Chemistry

The leaves and inflorescences of *E. cristata* of Japan and Kashmir contain up to 85% elsholtzia ketone (2-isovaleryl-3-methylfuran) (Mansfeld 1986; Kubold et al. 1987). A distinctive chemotype (plant chemical race) from the Kumaun region, Nainital, India, has almost 90% dehydroelsholtzia ketone [3-methyl-2-(3-methylbut-2-enoyl)-furan] along with minor acylfuran derivatives (Kubold et al. 1987). Bakova et al. (1988) found that the content of certain components of the essential oil vary with plant origin, and also with

soil and climatic conditions. Zheng et al. (1990), identified the following compounds in *E. cristata*: 6-methyl-tritriacontane, 13-cyclohexyl-hexoacosane, ß-sitosterol, palmitic acid, linoleic acid, linolenic acid, ursolic acid, 5-hydroxy-6,7-dimethoxyflavone, 5-hydroxy-7, 8-dimethoxyflavone, 5,7-dihydroxy-4'-methoxyflavone, 5-hydroxy-7,4'-dimethoxyflavone, ß-sitosterol-ß-D-glucoside,5-hydroxy-6-methylflavanone-7-O- -D-galacopyranoside, and acacetin-7-O-ß-glucoside.

Medicine

In Japan, the oil of *E. cristata* used to be employed to promote urine flow and to reduce fever (Bisht et al. 1985). In China, the plant has been used to treat stomach problems, to expel gas from the alimentary canal, and to promote

Fig. 146.
Vietnamese balm *(Elsholtzia ciliata)*,
prepared by M. Jomphe.

Fig. 147.
Vietnamese balm *(Elsholtzia ciliata)*, from Bailey (1900).

urine flow (Keys 1976). It has also been used in China to treat nosebleed and burning of the feet (Shi-Chen et al. 1973). In contemporary medicine such uses are considered obsolete (Bisht et al. 1985).

Nutrition

No information found.

Curiosities

• *Elscholtzia* commemorates a German physician and botanist with the imposing name of Johann Siegesmund Elsholtz (1623-88) (Fernald 1970).

Problems and Potential

Vietnamese balm may have some very minor commercial potential in North America as a greenhouse herb sold to specialty markets and restaurants. At present it is too poorly known and insufficiently attractive to warrant economic or market development.

Selected References

Miske (1994).

Fig. 148.
Fennel *(Foeniculum vulgare)*, from Hallier (1880-1888).

Foeniculum

Family: Umbelliferae (carrot family)

Genus Notes

Foeniculum has one, two, or three perennial, Old World species, the number recognized depending on authority (Bailey and Bailey 1976; Huxley et al. 1992).

Foeniculum Vulgare Mill.

Scientific (Latin) Synonyms

F officinale All.

This species is a yellow-flowered, hollow-stemmed biennial or perennial herb, growing as tall as 2 m in flower. It is native to southern Europe and the Mediterranean area. Its infraspecific classification requires study. A common scheme is to recognize cultivated fennel as subsp. *vulgare*, and to place three cultivated varieties in it (Tutin et al. 1968; Bailey and Bailey 1976; Mansfeld 1986). (For different classification schemes, note references in Simon et al. 1984; and see Hunault et al. 1989.) All three are grown for their seeds, while one is grown for edible leaf stalks and another for edible leaf blades, as noted below. Several kinds of fennel with different appearance and leaf color have also been selected for use as ornamentals (Simon et al. 1984).

Wild plants have been taxonomically separated in various ways. Subspecies *piperitum* (Ucria) Cout. is a wild native perennial of the Mediterranean and southern Europe, where it grows on sea cliffs and has become naturalized in waste places (Clapham et al. 1987).

Variety *vulgare*, commonly known as bitter fennel, is also known as wild fennel, a rather confusing name since it is cultivated. Just how different it is from truly wild fennel is unclear. It is occasionally used to produce essential oil from the seeds. The oils are of a more bitter nature than those obtained from var. *dulce* (see below).

Variety *azoricum* (Mill.) Thell., known as Florence Fennel and finnochio, develops an edible swollen base composed of enlarged leaf bases. It is grown as an annual. Florence fennel is not appropriately considered to be a herb; it is discussed in detail as a vegetable in Munro and Small (1997). (See discussion of anise, *Pimpinella anisum*, for confusion in the use of the name anise for this herb and for the vegetable Florence fennel.)

Variety *dulce* (Mill.) Battand. & Trabut, known as fennel or sweet fennel, has thin leaves and a non-bulbous base, and is used as a herb for flavoring. Annuals are much more common than biennials (Hunault et al. 1989).

Some of the literature confuses varieties *azoricum* and *dulce*. For example, the recent authoritative *The new Royal Horticultural Society dictionary of gardening* (Huxley et al. 1992) at one point refers to Florence fennel as vat. *dulce* and at another as vat. *azoricum*. This confusion traces to the independent coining of the names *F. dulce* by A.P. de Candolle and by P. Miller, the names designating different things; Bailey and Bailey (1976) and Huxley et al. (1992) disagree about which designates fennel and which designates Florence fennel. Other taxonomic disagreements about the infraspecific classification of *F. vulgare are* indicated in Simon et al. (1984).

In North America, fennel is found growing outside of cultivation on roadsides and dry fields as far north as southwestern British Columbia, southern Ontario, southwestern Quebec, and possibly Alberta (Scoggan 1978-79). As with many cultivated plants with similar weedy relatives, it is unclear whether the weed is simply an escape from cultivation or is a truly wild plant introduced independently of the cultigen.

The following presentation applies to both herbal kinds of *F. vulgare*, fennel (var. *dulce*) and bitter fennel (var. *vulgare*).

Foeniculum Vulgare Mill. var. Dulce Batt. & Trab.

English Names

Fennel
Also: Roman fennel, sweet fennel
["Fennel flower" and "small fennel" are names for black cumin, *Nigella sativa*, discussed in this book. Common giant fennel is *Ferula communis* L., a perennial herb of North Africa, cultivated as a tall (up to 4 m, hence "giant") yellow-flowered ornamental, and the source of Ammoniac of Morocco, a gum (also note an ancient use in Curiosities).]

French Names

Family: Ombellifèeres, famille de la carotte
Fenouil (m)
Also: fenouil de Provence (Maghami 1979), fenouil doux, fenouil sucré

Foeniculum Vulgare Mill. var. Vulgare

English Names

Bitter fennel
Also: common fennel, wild fennel

French Names

Fenouil amer (m)
Also: fenouil allemand (Maghami 1979), fenouil commun, fenouil de type saxon (Maghami 1979), fenouil des champs, fenouil des vignes, fenouil officinal

Description, Taxonomy, and History

Fennel is a perennial herbaceous plant that is grown as an annual in most parts of northern North America. The leaves are used as a herb and garnish, and the seeds as a

Fig. 149.
Fennel *(Foeniculum vulgare)*,
from Syme et al. (1863-1886).

spice in some food dishes. Like most other species in the carrot family, the fruits are dry and composed of two separate segments (called mericarps), each of which contains a seed.

Fennel has been employed since the ancient Egyptian period as a medicinal and food plant (Morton 1976). During Roman times meats were commonly seasoned and vinegar sauces served with fennel flavoring added. The Frankish king Charlemagne (742-814) stimulated the spread of fennel in central Europe by requiring its cultivation in the imperial gardens (Hedrick 1972). Fennel was often mentioned in Anglo-Saxon medical recipes, such use known as early as the 11th century A.D. Spanish priests brought fennel to North America, where it is still found growing wild around old missions (Barash 1993).

Uses

The thread-fine leaves are minced for use in salads and to add flavor to sauces for vegetable dishes. The aniseed flavor of fennel goes well with tomato, cucumber and salsify salads, and provides an interesting garnish for asparagus. Fennel is often added to fish dishes (especially fish with strong odor), employing the fresh leaves for stuffing the fish or simply adding the leaves to the water for poached fish. A curious French dish is the Provençal "grillade au fenouil," with grilled sea bass, red mullet, or trout that is flamed in brandy on a bed of dried fennel, which bums and imparts a unique flavor. In Italy fennel is added to pork and veal dishes (Stobart 1977).

The seeds of all forms of fennel are used both in the home and in the food and flavor industry. Sometimes wild fennel seeds are collected, but the seeds of cultivated fennels are preferred. The flavor enhances meats, fish, vegetable products, soups, salad dressings, stews, breads, cookies, cakes, teas, and alcoholic beverages. The seeds are an important addition to meat balls, spaghetti, and tomato sauce. They are also put in sweet pickles, sauerkraut, apple and other pie fillings, and confections. The sprouted seeds can be an interesting component of salads. A tea is sometimes made from steeping the seeds or leaves (Facciola 1990). Fennel seeds or extracts are used in condiments, ice creams, seasonings for prepared meats such as pepperoni and hot Italian sausages, and liqueurs such as anisette. Crashed seeds have been used as a juniper substitute for flavoring gin (Simon et al. 1984). The extracts are also employed to scent soaps, creams, and perfumes. Sweet fennel oil is a component of the brandy anisette, candy, cough drops, and ice cream. Common fennel oil is useful in flavoring liqueurs and in household sprays used to mask odors (Morton 1976).

Bronze fennel (referred to in the following discussion) can be used to produce a striking effect in a perennial ornamental border (Barash 1993).

Recipe Sources

Seeds

Rosengarten (1969) gives recipes for Fennel seed bread, and Rice with fish and fennel seed. Hutson (1987) presents the following recipes: Portuguese white bean and fennel [seed] soup with sausage, and Pasta salad with pepperoni and fresh fennel (uses both fennel seeds and the vegetable, Florence fennel).

Other recipes are: Fennel seed cookies (Day and Stuckey 1964); Shredded wheat gluten and cabbage with fennel seeds (Jaffrey 1981); Fennel tea (Marcin 1983; recipes for both leaves and seeds are provided); Fruit cup with fennel seeds (Jeanneret 1987); Fennel ran (recipe with Florence fennel and fennel seeds) (Bremness 1988).

Leaves

Michael (1980) has the following recipes: Fish with fennel sauce, Fennel and gooseberry sauce with mackerel, and Creamy fennel sauce with fish, or with pork chops. Holt (1989) gives the following recipes: Sea bass flamed over dried fennel, Noisettes of lamb with olives and fennel, Baked fennel with crab (with leaves and the vegetable Florence fennel), Seafood salad with citrus and fennel dressing (with leaves and optionally also with flowers), and Smoked salmon trout mousse with fennel (with leaves and optionally also with flowers). Richardson (1991) has six fennel recipes, notably Barbecued cod with fennel, Fennel cheese sauce for pasta, and Roast pork with fennel. Other recipes are: Cold vegetable salad with fennel (Hériteau 1975); Fabulous fennel butter with Pernod (Hutson 1987).

Flowers

Leggatt (1987) has recipes for Baked trout with fennel and fennel flowers, and Grapefruit and prawn salad with fennel and anchusa flowers. Barash (1993) has four recipes with fennel flowers.

Importance

Few statistics seem available on the economic importance of fennel. It is grown mainly in Europe and Asia. In 1988, the U.S. imported 1,754 t of fennel seeds, valued at $1,813,030 U.S. the majority of which came from Egypt (Anon. 1989a). Value of imports averaged $3.4 million over the period 1990-94, Egypt and India together accounting for 90% of imports (Buzzanell et al. 1995). Other major producers of fennel seed are India, Argentina, and Bulgaria (Rosengarten 1969), and China, Indonesia and Pakistan (Simon et al. 1984). India regularly produces 20,000 t annually of fennel seed of which about 2,000 t are exported (Lewis 1984).

Verlet (1993) estimated the annual world value of fennel essential oil to be U.S.$2,400,000. Fennel oil production is rather irregular from year to year. Spain is the major producing region for fennel oil, with 18 t produced in 1984 (Ference 1989), while total production of fennel oil in the world that year was about 30 t. In 1981, 900 t of essence and 56 t of pure anethole were produced in France (Hunault et al. 1989).

No statistics seem available on use of fennel herb or seeds in Canada. The seeds are sold as a spice and are likely all imported. There appears to be no commercial cultivation of fennel for essential oil production in any region of Canada (Ference 1989).

Fennel seed for use as a spice can be produced in the U.S. and limited production has occurred periodically. Commercial production is only profitable in the U.S. when yields of seed are high and production costs are low (Simon 1989). However, demand is limited, and supplies are usually most economically obtained overseas, principally from Egypt and India (Simon 1989).

Fig. 150.
Fennel *(Foeniculum vulgare)*, from Duthie (1893).

Cultivation Notes

Soil

Although fennel grows well on almost any good soil, it performs best on limy (nonacid), well-drained loams (Sievers 1948). Tolerance ranges of pH of 4.8-8.2 (De Baggio 1987) and 4.8 to 8.3 (Duke 1978) have been reported. Crockett and Tanner (1977) recommend a pH of 6.0-8.0.

Climate

Fennel is a perennial plant suited to mild climates (Rosengarten 1969), with growth occurring between 7 and 32°C. Much of Canada appears to be too cold for successful overwintering of fennel. However, Lima (1986) noted that the Bronze cultivar appears more hardy than others and has overwintered successfully for several years in Ontario and, indeed, is spreading from seeds. Maghami (1979) stated that bitter fennel (var. *vulgare*) in France is cold resistant and can be grown as a perennial, while sweet fennel (var. *dulce*) has to be grown as an annual because it is susceptible to freezing. Supplementary water is beneficial during dry periods. The plant should be positioned in full sunlight, although it will tolerate slight shade. In the home garden, fennel is best grown in an area protected from wind, or it should be cultivated near a fence or wall, or staked (Crockett and Tanner 1977).

Propagation and Cultivation

Propagation is usually by seeds sown once the ground can be worked. Seeds should be planted 6-13 mm deep, with soil temperatures best between 15 and 18°C (Wang et al. 1993). Seedlings usually emerge in 10-14 days. The plants should be thinned to 20 cm apart. Occasional weeding is desirable. It is also possible to reproduce the plant by dividing established plants in the spring, spacing the divisions 30-35 cm apart (Huxley et al. 1992). Fennel is susceptible to white fly and aphids (Rosengarten 1969), but few other problems. Although a perennial, it is generally grown as an annual or biennial.

Harvest and Storage

In commercial production in warmer countries, the yield of seeds is low the first year but increases to 1200-2000 kg/ha by the third year after planting. The mature umbels (seed heads) are harvested, threshed, and dried indoors on screens, or in the open when weather is favorable (Lewis 1984; Rosengarten 1969). The home gardener can harvest fennel seeds when they ripen in the fall, spread them in a thin layer on a screen in the shade to dry, turning them often (Crockett and Tanner 1977).

Fennel leaves can be harvested by the home gardener during the summer right up to frost (Crockett and Tanner 1977). Potted plants can be grown indoors for a source of fresh leaves during the winter. The leaves can be dried and stored in an airtight container (Crockett and Tanner 1977). However, they are difficult to store dry, and are preferably deep frozen (Huxley et al. 1992).

Example Cultivars

Bronze (apparently more winter hardy than most selections), Greek [previous two described by Facciola (1990)], Purpurascens [described in Huxley et al. (1992)]. Page (1980) described the cultivar Carosella as having large succulent flowers stems, which can be cut before seeding, and peeled and served for use as a salad.

Bettencourt and Konopka (1990) list institutions in various countries conserving fennel germplasm.

Additional Notes

Chemistry

Both bitter fennel (var. *vulgare*) and sweet fennel (var. *dulce*) are grown as an oil crop. Seeds average 3.5% essential oil (Duke 1985). The oil of both varieties contains anethole, fenchone, -pinene, camphene, é-pinene, sabenine, myrcene, -phellandrene, limonene, *cis*-ocimene, *p*-cymene, camphor, and other chemicals (Simon et al. 1984). The essential oil of bitter fennel contains 50-60% *trans*-anethole and 10% or more fenchone. The presence of the ketone fenchone imparts a somewhat camphoraceous and harsh flavor. According to Lewis (1984) seeds of sweet fennel do not contain any fenchone, hence the sweetness in flavor and aroma. However Simon et al. (1984), noting that some analyses have indicated a lack of fenchone in sweet fennel, simply state that bitter fennel oil is thought to contain more fenchone and less anethole than sweet fennel oil. Some analyses have also indicated a higher concentration of limonene in bitter fennel (Simon et al. 1984). Anethole is the main desirable flavor and aroma constituent. The odor of the essential oil has been characterized as aromatic, pleasantly fresh, warm, spicy, and anise-like. As noted above, it can be slightly camphoraceous, depending on the form of fennel used (Farrell 1985). Lawrence (1984a) provided a review of studies on fennel oil, including that found in the vegetable Florence fennel (var. *azoricum*).

Medicine

The ancient Chinese and Hindus employed fennel as a snake-bite remedy, a use that spread to Europe (Rosengarten 1969). The medicinal use of wild fennel was

also familiar to the ancient Egyptians, Greeks, and Romans (le Strange 1977). Ancient scholars considered the leaves of fennel to have aphrodisiac qualities and to be an aid in growing slim. Early Greeks training for the Olympic Games ate the seeds to help control their weight (le Strange 1977). The leaves were said to sharpen eyesight, stop hiccoughs, cure wheezing, and improve a pallid face following sickness. It was also reputed to fill women's breasts with milk (Farrell 1985). More recently in folk herbal medicine, fennel water, an infusion made of powdered fennel seed and water, was mixed with sodium bicarbonate and syrup and given to infants (Grieve 1931). Fennel is still used today by herbal practitioners, particularly for stomach and intestinal problems (Halpin 1978). Fennel seeds and oil are currently employed in Chinese medicine to treat a variety of ailments (Duke and Ayensu 1985). Duke (1985) lists numerous folk medicinal uses in various cultures, some persisting to the present. Morton (1981) outlines folk uses in Middle America.

In western medicine today, fennel is considered useful in treatment of diseases of the chest, spleen, and kidney. It reportedly is a stimulant and relieves alimentary canal gas. The oil of fennel has been experimentally shown to relieve muscle spasms, perhaps explaining fennel's effectiveness in expelling gas (Tyler 1993). Fennel seed has been regarded as useful, purportedly alleviating gastrointestinal problems, stimulating lactation, and relieving colic and flatulence in infants (Halpin 1978; Simon et al. 1984; Splittstoesser 1990). Studies have shown that the polymers of the essential oil anethole are estrogenic agents and may be therapeutically useful to allay symptoms in menopausal women (Albert-Puleo 1980). Shukla and Tripathi (1987) examined the essential oil of fennel seed and determined that it had significant antifungal activity against *Aspergillus* and *Penicillium* fungi.

Oil of fennel causes contact dermatitis in sensitive individuals. There is some evidence that the plant causes photodermatitis (a rash resulting from ingestion of the plant followed by exposure to sunlight) (Simon et al. 1984). The volatile oil extracted from the seeds has caused nausea, vomiting, seizures, and pulmonary edema in humans from misuse (Mitchell and Rook 1979; Simon et al. 1984). Fennel oil is a narcotic that can cause epileptiform madness and hallucination (Duke 1985). The oils of dill, anise and parsley (all dealt with in this book) have similar properties, apparently due to a chemical transformation (amination) *in vivo* (in the living body, after ingestion) resulting in the production of hallucinogenic amphetamines (Duke 1985). Because as little as 1 mL of the oil can produce medical

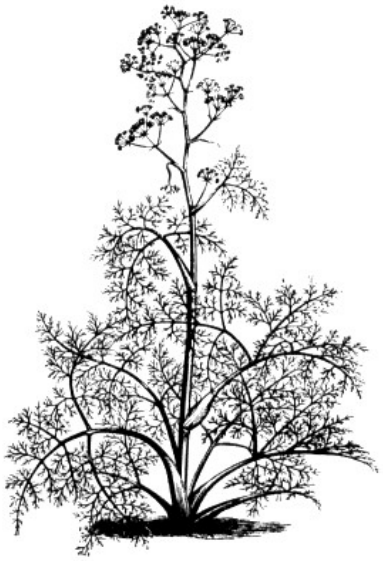


Fig. 151.
Fennel *(Foeniculum vulgare)*, from Harter (1988).

problems, obviously the oil should never be used by individuals for culinary purposes (industrial culinary uses are safely conducted by qualified personnel).

Nutrition

The leaves contain about 3% protein, some é-carotene, thiamine, riboflavin, niacin and ascorbic acid, while the seeds have iodine and vitamin A (Duke 1985).

Curiosities

• The genus name *Foeniculum* is derived in part from the Latin *foenum*, hay, presumably an allusion to the abundant thread- or straw-like segments of the leaves (Fernald 1970). The same Latin root is used in the name *Trigonella foenum-graecum* (see fenugreek Curiosities).

• Wood (1957) provided the following information: the Greek word *Marathon* means fennel; the celebrated battle of Marathon in 490 B.C. was fought on a field of

fennel; the statues of the Athenian athlete Pheidippides who ran the 150 miles to Sparta for aid against the Persians always show him holding a sprig of this herb (the so-called marathon race first run at Athens, Greece at the new Olympic Games set up in 1896 standardized the run at 26 miles, 385 yards, approximating the length of a road from Marathon to Athens).

• According to ancient Greek legend, Prometheus brought down fire from heaven "hidden in a stalk of fennel." The "fennel" was the giant fennel, *Ferula communis* (see Genus Notes). This has a hollow stem occupied by pith which, when dry, can be set on fire, so that the stem bums internally very slowly, allowing ancient peoples to bring fire from place to place (Foley 1974).

• Pliny, in the 1st century, mentioned that snakes, casting off their skins, ate fennel to restore their sight. This gave rise to the belief that fennel was good for eyesight (Rosengarten 1969).

• According to another old legend, female deer were said to purge themselves with fennel before giving birth (Fox 1933).

• In the Middle Ages, fennel was hung over doors, and keyholes were even stuffed with fennel seeds, to ward off evil spirits (le Strange 1977). Fennel paste was smeared on cows' udders to prevent their milk from becoming bewitched (Rosengarten 1969).

• Fennel was once used in large quantities by the rich. In records of accounts from the household of Edward I (1239-1307) of England, about 4 kg of fennel were bought monthly (Grieve 1931).

• During the Middle ages churchgoers ate fennel seeds during fasts to diminish hunger (Lust 1974). This tradition was maintained by Puritan churchgoers in colonial America, who endured long sermons with the aid of a pocket full of tasty fennel seeds that they called "meetin' seeds" (Rosengarten 1969). A less kind interpretation is that many of the Puritans steeled themselves with whisky for the interminable sermons, and chewed fennel seeds to mask the odor (Castleman 1991). Fennel seeds are still sometimes chewed after meals.

• Reminiscent of the belief that fennel was good for the eyes (see above), in his poem "The Goblet of Life," the American poet Henry Wadsworth Longfellow (1807-1882) wrote of fennel (Farrell 1985):

Over the other flowers it towers,

The fennel, with its yellow flowers,

And in an earlier age than ours,

Twas gifted with wondrous powers -

Lost vision to restore.

• The Portuguese discovered Madeira in 1418, where they found an area dominated by the aroma of wild fennel. They called the fragrant area *funcho*, the Portuguese word for fennel (Norman 1990).

• Fennel is sometimes the host for an impressive caterpillar which is tiger-striped green, cream, and black with orange spots, and found on many members of the carrot family. This so-called "parsley worm" is the larval stage of the beautiful swallowtail butterflies, *Papilio* (cf. Lima 1986; also see parsley Curiosities). These rare magnificent butterflies are well worth the sacrifice of some leaves.

• According to Page (1980), "If dill is grown for a seed crop it must never be sown in the vicinity of fennel, as the two plants hybridize readily and the resulting seed will be inferior to the seed of either plant."

Problems and Potential

There is likely little potential for commercial production of fennel or fennel seed in Canada and the northern U.S., although a few producers may be able to market small amounts. Overwintering of fennel is difficult in the cold climates of much of northern North America, and the season is too short for most cultivars to mature seed.

Ference (1989) analysed the economic feasibility of growing fennel for oil in Canada, and his conclusions are as follows. Fennel oil might appear to be promising, since the relatively cool climates of northern North America are thought to boost oil yields from members of the carrot family. However, natural sources of anethole have proved very competitive to date. Another constraining factor on the production of fennel oil has been the manufacture of synthetic anethole, the most important product from fennel oil. Synthetic anethole is prohibited in food in several countries, on the basis of alleged toxicity. Accordingly, the market for fennel oil could improve in the future. On the whole, however, there does not appear to be any significant economic opportunity for increased domestic production of fennel.

Selected References

Rosengarten (1969); Lewis (1984); Farrell (1985).

Galium

Family: Rubiaceae (madder family)

Genus Notes

Galium has 300-400 species, or about 600 if the genus *Asperula* is combined with it, as is sometimes recommended. The species are mostly slender, weak annual or perennial herbs, found generally in the temperate regions of the world. A few species are grown as ornamentals.

Galium verum L., yellow bedstraw, our-lady's bedstraw, is a Eurasian perennial that has become a weed in North America. Its springy stems and leaves were once used to stuff mattresses (Crockett and Tanner 1977). Another of its common names is cheese rennet, reflecting its use in curdling the milk of sheep and goats for cheese (Morton 1976). This is brought about by an enzyme in the leaves and flowers. A yellow dye from the stems and leaves was also used to color the cheese, as well as butter (Morton 1976). The flowering tops have been used to prepare a refreshing acidic beverage (Facciola 1990).

Galium aparine L., cleavers, is a widespread weed in North America (both native and introduced from Eurasia), sometimes eaten by wild food enthusiasts. The young leaves and stems are consumed as a vegetable or used in soups, stews and Lenten pottage; the seeds can be used as a substitute for coffee; and the dried leaves can be used to brew tea (Facciola 1990).

Galium odoratum (L.) Scop.

Scientific (Latin) Synonyms

Asperula odorata L.

English Names

Woodruff
Also: hay-plant, master of the woods, moth plant, moth-herb, muge-de-bois (from the Old French for "wood musk"), mugweed, mugwet, rockweed, scented woodruff, star grass, sweet star grass, sweet woodruff, sweetscented woodruff, waldmeister (from the German for "master of the forest"), waldmeister tea, wood rova (wood-rova), wood-rose, woodward
[Woodroof often substitutes for woodruff.]

French Names

Family: Rubiacées, famille du gaillet
Aspérule (f)
Also: aspérula, aspérula odorante, aspérule des champs, aspérule odorante, belle étoile, hépatique des bois, hépatique en forme d'étoile, hépatique étoi1ée, hépatique odorante, muguet, muguet des bois, muguet des dames, muguet reine des bois, muguet vert, petit muguet (des bois), reine des bois (reine-des-bois), thé suisse

Warning

This species contains coumarin, a liver toxin. Consumption of large amounts of sweet woodruff can cause dizziness and vomiting, and may pose medical risks (see Medicine).

Description, Taxonomy, and History

Galium odoratum is a fragrant, low, white-flowered, clump-forming perennial growing 15 to 45 cm in height. The rhizome produces both fertile (flowering) and sterile (vegetative) stalks. The leaves are strikingly arranged in verticils (whorls, arising around the stem at one point, like the spokes of a wheel). The flowers are fragrant, and the leaves, normally odorless, give off a pleasant coumarin scent when crushed. The fruits are covered with hairy bristles that attach to the fur and feathers of animals and birds. Woodruff grows in moist, wooded locations, and produces small, white flowers in the spring. The species is native to Europe, North Africa, and western Asia. It was introduced to England in 1440 (le Strange 1977). The crushed plant has a sweet scent of new-mown hay and vanilla. The principal use of woodruff during the medieval period in Europe was as a deodorizer, strewed on floors (especially bedchambers), stuffed in mattresses, placed in linen cupboards, and hung in bunches about the house (le Strange 1977). Woodruff was also commonly used during the Middle Ages in Europe as a medicinal plant, although its most famous historical use is for flavoring German May-wine.

Uses

Fresh leaves are employed to flavor both alcoholic and nonalcoholic beverages. Woodruff has a distinctive, scented, astringent, bitter flavor, not suited for cookery. In Germany, fresh young shoots are steeped in wine. The result is termed Maybowl or May wine, and is drunk on the first of May by tradition. It is not to everyone's taste: Elbert and Elbert (1974) stated that woodruff "lends a nauseatingly cloying flavor and odor to May wine."

Fig. 152.
Woodruff *(Galium odoratum)*, from Thomé (1903-1905).

Woodruff is also used to flavor apple jellies, sorbets, creams and fruit salads. Woodruff tea has been said to be mild and sweet, with a woodsy taste, resembling Darjeeling tea (Marcin 1983). Sometimes a bitter flavoring principle is extracted from the leaves (but see below). The sweet-scented flowers are sometimes eaten or used as a garnish (Facciola 1990).

Woodruff is used for a variety of non-food purposes. Dried leaves are employed in sachets and snuffs. The herb is used in pharmaceutical preparations in some countries, although not in the U.S., where coumarin-containing flavorings are restricted (Morton 1976). Extracts are sometimes used in perfumery (Morton 1976). The dried leaves

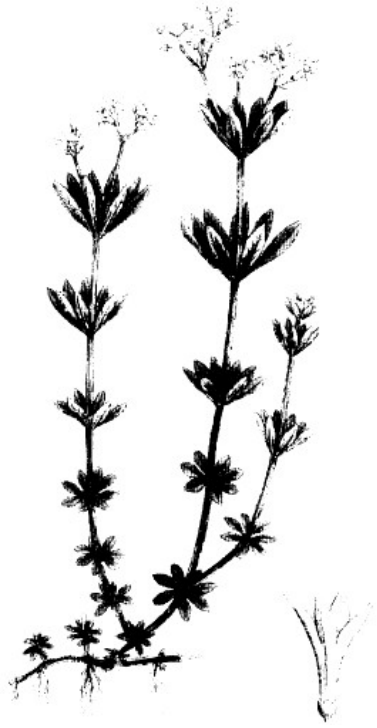


Fig. 153.
Woodruff *(Galium odoratum)*,
from Syme et al. (1863-1886).

serve as an insect repellent (note the various common names suggesting use as a moth repellent). The roots contain a red dyestuff. As a horticultural plant, sweet woodruff is useful as a ground-cover in shady areas, such as under trees.

Recipe Sources

Leggatt (1987) gives recipes for Cherry soup with sweet woodruff, Fresh raspberry snow with sweet woodruff, and Summer ale cup with sweet woodruff. Belsinger (1991) has recipes for May wine with sweet woodruff and strawberries, and Berries with sweet woodruff. Barash (1993) has recipes for May wine, Sweet woodruff ice cream, and Sweet woodruff yoghurt custard.

Other recipes are: Maydrink (Fox 1933); Woodruff cakes (Leyel 1938); Woodruff mead (Crowhurst 1973); May bowle (Waldmeister Bowl, Maibowle, Maitrank) (Smith 1973; Michael 1980); Candied woodruff flowers (Smith 1973); Woodruff tea (Smith 1973; Michael 1980; Marcin 1983); Woodruff cup (Loewenfeld and Back 1974); May wine punch (Hériteau 1975); Herb soup à la Alexander von Humbold (Launert 1981); May wine bowl (Creasy 1988); May wine (Garland 1979; Kublick 1990).

Importance

Dried woodruff is commercially available throughout Europe (Furia and Bellanca 1975). It is generally collected from wild plants, but it can be grown. The species has been successfully cultivated in parts of Europe and North Africa (Roecklein and Leung 1987). Germany is the main producer (Prescott-Allen and Prescott-Allen 1986). Woodruff is not a significant crop.

Cultivation Notes

Soil

Woodruff prefers moist, rich soil. A heavy mulch of organic matter (providing high humus content) with adequate drainage is advisable. Slightly acid soil is recommended (Marcin 1983). A pH tolerance range of 4.5-8.5 has been reported (Duke 1978). Falkengren-Grerup and Tyler (1992) showed that woodruff could survive a substrate pH of 4.0, but not 3.5. Crockett and Tanner (1977) recommend a pH range of 4.5-5.5.

Climate

Woodruff, naturally a woodland plant, grows best under shade. According to Muenscher and Rice (1955), the flavor and growth of the plants are improved by full or partial shade and moist soil. If exposed to full sunlight, woodruff

Fig. 154.
Woodruff *(Galium odoratum)*,
from Hallier (1880-1888).

turns brown and dies (Crockett and Tanner 1977). Irrigation should be provided during hot, dry summers to prevent foliage dieback. The plant can be grown as a perennial where winters are not severe, but in colder areas may need to be kept indoors or in a cold frame during the winter.

Propagation and Cultivation

Woodruff can be grown from seeds, but they are very slow to germinate, taking up to 200 days (Reppert 1985). According to Crockett and Tanner (1977), fresh seeds germinate well, but old seeds often need to be in the ground about a year before they sprout. Seeds should be planted at a depth of 6 mm or less, ideally soon after ripening in the early fall, in which case the seedlings may emerge in 10-16 days (Wang et al. 1993). The soil in which seeds are planted should be soaked well, and kept moist but not soggy (Crockett and Tanner 1977). The plants are best propagated by dividing the runners (rhizomes) into portions with roots and shoots attached, preferably in the spring or early fall. Stem cuttings are also often used for propagation. These can be taken from mature plants in the spring or fall, and set in wet sand. The cuttings will usually root in 3 weeks or less. Once established, woodruff will self-sow and spread. During hot summers the plants may show dieback and dormancy, sometimes reviving in the cool autumn.

Woodruff can be potted and taken indoors. As a house plant, it should be provided with a well-drained acid soil, cool temperatures, and at least 5 hours of filtered sunlight daily.

Harvest and Storage

Woodruff leaves can be harvested just before flowering or during early flowering, in late spring. The leaves should be dried at low temperature, preferably in a cool dark place so that they remain at least partly green. When thoroughly dry, the leaves are stripped from the stem and stored loosely packed in airtight containers.

Example Cultivars

No information found.

Fig. 155.
Woodruff *(Galium odoratum)*,
prepared by M. Jomphe.
(Based on Dore 22140 at
Agriculture and Agri-Food
Canada herbarium, Ottawa.)

Additional Notes

Chemistry

Major constituents include coumarin, tannins, asperuloside, fatty acid, essential oil, and a bitter principle (Simon et al. 1984). The new-mown hay aroma of dry (but not fresh) leaves is due to the coumarin. The plant does not yield an essential oil upon steam distillation (Furia and Bellanca 1975). However, Woerner and Schreier (1991) were able to identify 224 volatiles as woodruff constituents.

Medicine

Woodruff was used in folk medicine to treat jaundice and nervousness, to heal wounds, sedate, regulate heart activity, and improve the taste of medicine (Simon et al. 1984). Other illnesses treated include bladderstones, insomnia, migraine, and neuralgia (Duke 1985).

Large amounts of sweet woodruff tea may cause dizziness and vomiting (Rinzler 1990). According to Bunney (1992), strong doses may also cause headache. Coumarin, the chief flavoring agent, is toxic, known in experimental animals to cause liver damage, retard growth, and cause cancer (Weiss 1988) and testicular atrophy (Duke 1985). The coumarin content almost certainly explains the toxic reaction of cattle that have consumed it while foraging (Watt and Breyer-Brandwijk 1962). In the U.S. coumarin is approved for use as a flavoring agent in alcoholic beverages (Duke 1985), but is no longer allowed in food (Rinzler 1990).

Nutrition

No nutritional advantages of consuming woodruff have been identified. Niacin (nicotinic acid) has been recorded (Watt and Breyer-Brandwijk 1962). Coumarin in woodruff is a vitamin K antagonist (Rinzler 1990), and so it may actually be an anti-nutritional factor. Vitamin K is synthesized by bacteria in the intestines of humans, and enables the liver to produce prothrombin, which allows blood to clot.

Curiosities

• The genus name *Galium* comes from the Greek *gala*, milk, in allusion to the former use of *G. verum*, yellow bedstraw, to curdle milk for manufacturing cheese (Huxley et al. 1992).

• The name woodruff is said to be derived from wood-rove, the wood referring to its living in woods, and the rove derived from the French *rovelle*, a wheel, an allusion to the arrangement of the leaves in whorls (Grieve 1931).

• In Medieval times, woodruff was hung in bunches along with several other herbs on the feast days of St. Peter and St. Barnabas (Marcin 1983).

• Teutonic warriors wore a sprig of woodruff in their helmets believing that this would bring success in battle (Lust 1974).

• Queen Elizabeth I (1533-1603) is thought to have given a sprig of woodruff to individuals she wished to favor (Lust 1974).

• As noted in Nutrition, the coumarin in woodruff has been related to an ability to reduce the clotting potential of blood plasma. Warfarin, a derivative of coumarin, is a well known rat poison, which kills by causing the animals to hemorrhage to death (Rinzler 1990).

Problems and Potential

Woodruff is an old-fashioned herb of very limited culinary significance. Its use in industry is unlikely to increase, and it has very limited potential as a crop. For the home gardener, it is one of the few culinary herbs that is completely suited to moist, shady locations.

Selected References

Grieve (1931); Simon et al. (1984).

Fig. 156.
Woodruff *(Galium odoratum)*,
from Vilmorin-Andrieux et C^{ie} (1883).

Fig. 157.
American (wild) licorice *(Glycyrrhiza lepidota)*, from Curtis (1787-present; #2150).

Glycyrrhiza

Family: Leguminosae (Fabaceae) (pea family)

Genus Notes

Glycyrrhiza has about 20 species of temperate and subtropical perennial herbs of Eurasia, Australia, and the Americas. As noted by Uphof (1968) and Facciola (1990), several species are useful, in addition to *G. glabra* described below. Roots of Chinese licorice, *G. uralensis* Fisch., are employed as a sweetener for foods and tobacco, and have been used in the treatment of ulcers and Addison's disease (Simon et al. 1984). The sweet fleshy roots of American (wild) licorice, *G. lepidota* (Nutt.) Pursh, have been roasted by American Indians, and are said to taste like sweet potatoes. The roots have also been used by wild food enthusiasts for flavoring and tea, and the young shoots eaten raw. This species was sufficiently attractive to some American Indians that they sometimes cultivated it. American licorice is used commercially like licorice in confectionary and flavoring (Roecklein and Leung 1987). Some other wild species of North America and China are also consumed locally on a limited basis. Note that *G. glabra*, described in detail here, may cause medical problems, so that the same may be true for other species of the genus.

Some species quite unrelated to *Glycyrrhiza* have licorice in their common names, for example the "wild licorice" species *Galium circaezans* Michx. and *Abrus precatorius* L. Seeds of the latter, a tropical species commonly called precatory-pea and jequirity-bean, are very attractive and so are often used in seed jewelry (such as necklaces). However, they are extremely toxic and have been responsible for the death of people, especially children (importation of the seeds is banned in Canada).

Glycyrrhiza Glabra L.

Scientific (Latin) Synonyms

G. glandulifera Waldst. & Kit., *G. violacea* Boiss.

English Names

Licorice
Also: black sugar, common licorice, liquorice, licorice plant, licorice root, sweet licorice, sweet wood, sweetweed [Names such as "Italian licorice," "Persian licorice," and "Spanish licorice," are sometimes encountered in the licorice trade, and are occasionally given in books as alternative common names for licorice. "Russian licorice," as noted below, refers to a distinctive variety of the species.]

French Names

Family: Légumineuses, famille du pois
Réglisse (f)
Also: bois douce, bois sucré, régalisse, réglisse glabre, réglisse officinale, réglisse ordinaire, racine douce

Warning

Excessive licorice consumption is known to be associated with cardiovascular toxicity, hypertension and edema. Metabolic effects may occur in individuals consuming only modest amounts (Simon et al. 1984). Licorice should be avoided by persons with cardiac problems, hypertension, kidney complaints, or who are overweight or having difficult pregnancies (Morton 1977).

Description, Taxonomy, and History

Glycyrrhiza glabra is native to the Mediterranean region and central and southwestern Asia, including Greece, Turkey, Spain, Iraq, Caucasian and Transcaspian Russia, and northern China. It is often found growing near streams, in sandy soils, and in dry scrubland, and is sometimes quite weedy. This subshrub generally grows 50-80 cm, occasionally as high as 2 m. The leaves have 2-9 pairs of leaflets that are dotted beneath with tiny glands; exudate from the glands may cause the leaves to be sticky. The small flowers are bluish or violet, and are borne on spikes 10-15 cm long.

The underground system of licorice consists of rhizomes and roots. A vertical tap-root (often with several main branches) may penetrate the soil for several metres (Palevitch, personal communication). As well, rhizomes (which are underground stems, not roots) branch off from the main root just below the soil surface, and grow horizontally for a considerable distance. In their second year, these runners produce new plants. Both the rhizomes and attached roots are sweet-flavored, and are the parts of the plant for which licorice has been grown in its native area at least since classical Greek times.

A distinctive wild licorice in Russia, Russian licorice [var. *glandulifera* Waldst. & Kit. = subsp. *glandulifera* (Waldst. & Kit.) Ponert] produces a rhizome which develops enormous adventitious roots (i.e., roots branching off the rhizome), up to 10 cm thick. This variety is cultivated in Russia, and the roots, not the rhizomes, are mainly marketed. Other cultivated variants of licorice have been recognized ("Spanish" and "Persian") but are not as distinctive as

Fig. 158.
Licorice *(Glycyrrhiza glabra)*, from Thomé (1903-1905).

Russian licorice. According to Henry et al. (1991), the Persian (Iranian) form is not found in Iran, but mainly in Iraq. So-called Spanish licorice is indeed cultivated in Spain, but also in other parts of Europe as well as western Asia (Henry et al. 1991).

Licorice has a history of use dating back 4000 years, as a sweet flavoring agent, and as a medicinal. The earliest record of its medicinal use appears to be the Code Hammurabi engraved about 2100 B.C. (Gibson 1978). Licorice was known to the ancient Egyptians, Assyrians, Chinese, Indians, Greeks and Romans. It was first cultivated in England in 1562 (Davis and Morris 1991). In Elizabethan times it was grown in the neighborhood of Pontefract Castle in Yorkshire, and the region is still the center of a British licorice industry, notable for Pontefract (or Pomfret) cakes (Sokolov 1979). Licorice was brought to the New World by early English settlers, and Native Americans took it up as a medicinal plant (Davis and Morris 199l). From time to time in this book examples are given of the "Doctrine of Signatures," whereby people have deduced the usefulness of a plant by its evident characteristics. In this case, American Indians seem to have inferred that the sweetness of licorice reflects the plant's medicinal function, and used it to treat diseases associated with high sugar levels, particularly diabetes (Davis and Morris 1991).

Uses

Licorice is grown for yield of commercial licorice, used in medicine, industry, and as a flavoring. Licorice is rarely used in domestic cookery, but is employed in commercial cooking. Commercial licorice is marketed in several forms, including peeled or unpeeled sticks, solid extract, and juice. Powdered licorice root or root extract is used as a natural sweetener in alcoholic and nonalcoholic beverages, confections, candy, chewing gum, ice cream, meat and dairy products. It is also used in pharmaceuticals, including cough and cold preparations and laxatives. Licorice used to be added to the English liquor stout, to make it darker and thicker (Zverina 1976). Licorice extract serves as a flavoring agent in soy sauce in China and Japan. Anise oil (from *Pimpinella anisum*, treated in this book), which has a licorice aroma, is often mixed with licorice for use in candies, pastries, and baked goods. Indeed, most "licorice" candy is flavored predominantly with anise oil or anethole, and has little or no licorice (Duke 1985).

Licorice cures tobacco, and so has been used for about a century in cigars, pipe tobacco, cigarettes, chewing tobacco, and even snuff. Very large amounts (sometimes more than 18,000 kg/year) of licorice root and extract have been imported to North America from Iraq, Turkey, Russia, Syria, Italy, Spain, and East Africa (Davis and Morris 1991), and from Israel (Palevitch, personal communication), for the purpose of conditioning and flavoring tobacco. About 90% of licorice imported into the U.S. goes into tobacco products (Chandler 1985*b*). The use of licorice in American brands of chewing tobacco has been related to hypertension, sodium retention and other medical ailments (see problems associated with consumption of licorice discussed in Medicine).

Note the warning regarding consumption of licorice at the head of the treatment of this herb. In fairness, it should also be noted that "licorice is generally recognized as safe for human consumption as a natural flavoring and plant extract" (Simon et al. 1984). In Canada, licorice root consumed as a crude herb is "considered safe when consumed as food" (Blackburn 1993).

In addition to its culinary uses, licorice extract has been employed as a foaming agent in fire extinguishers (Simon et al. 1984). The ability to produce foam of some licorice extract residues has also proven useful in an emulsifier, used to create foam in drinks and alcoholic beverages (Davis and Morris 1991). Licorice extracts have also proven to be an excellent growth medium for mushrooms. Licorice is grown as an ornamental plant. As noted in some detail below, it continues to be used as a medicinal plant.

Recipe Sources

Licorice tea (Marcin 1983).

Importance

Licorice is harvested in southern Europe and southwestern Asia, principally in Russia, Spain, France, Italy, Greece, Egypt, Iran, Iraq, Turkey, Syria, and China. It has been grown experimentally in the U.S. (Morton 1977) and Uzbekistan (Desmarest, personal communication).

Cultivation Notes

Soil

Rich, moisture-retentive soil is recommended. The soil should be deep, stone-free and well-cultivated to accommodate the growing roots. Licorice has been collected from soils ranging in pH from 5.5 to 8.2 (Simon et al. 1984), while 7.3-7.8 has been recommended (Duke and Hurst 1975).

Climate

Licorice plants grown naturally in deep, moist soil, such as on river banks subject to flooding, but where the late summer is hot and dry (Morton 1977). Therefore, under

cultivation irrigation may be necessary after planting. The plant prefers warm regions with long photoperiods. It will survive winters of at least -15°C, but does not generally produce good quality licorice in cold regions. Growth occurs between 3 and 28°C, and is rather slow during the first 2 years. Grieve (1931) suggested that climates suitable for growing oranges are also favorable for growing licorice. In the U.S. the sandy and sandy loam river valleys of the southwestern states and in Texas seem well adapted to licorice growing, although this has not been attempted on a commercial scale (Sievers 1948).

Propagation and Cultivation

Commercial plantings are usually reproduced from vegetative cuttings of rhizomes, suckers, or crowns. Mature crowns develop usable roots in the season of planting, while plants grown from suckers may require 2 or 3 years. Plants can also be reproduced by seeds. These are hard-seeded, and need to be scarified (the seed surface scratched or abraded to allow water to enter) before planting (Wang et al. 1993). The seeds should be planted at a depth of 6 mm or less, with seedling emergence usually in 14-21 days (Wang et al. 1993). In France, 3-year-old cultures yield of the order of 26 t/ha (Desmarest, personal communication).

Harvest and Storage

Rhizomes for the commercial market are developed in 3 to 5 years. They are harvested in the autumn, after the foliage has dried. Decorticated (debarked) rhizomes can be cut into sticks up to 20 cm long and 2 cm thick, which are yellowish in colon After grinding and boiling, a liquid is produced which solidifies into a black material. Average licorice yields are 9-11 t/ha (Morton 1977).

Example Cultivars

Pontefract, Poznan, Russian [the three preceding described by Facciola (1990)]

Additional Notes

Chemistry

Compounds in licorice include glycyrrhizin, a saponin, asparagine, sugars, resin, bitter principles, and a volatile oil (Simon et al. 1984). Glycyrrhizin, the ammoniated form of glycyrrhizin acid, is the chief constituent, and varies in amount from 5 to 20% (Morton 1977). Licorice also contains about 20% starch, 4% glucose, and about 2-7% sucrose (Morton 1977). Commercial glycyrrhizin intensifies other flavors (Simon et al. 1984). For example, it can replace 25% of cocoa in cocoa products (Duke 1985).

Fig. 159.
Licorice *(Glycyrrhiza glabra)*, from Köhler (1883-1898).

Medicine

Folk remedies with licorice were used against asthma, bronchitis, coughs, fevers, ulcers, and cancers (Simon et al. 1984). The ancient Chinese thought that licorice gave them strength and endurance, while the ancient Hindus believed that it increased sexual vigor (Davis and Morris 1991). Davis and Morris (1991) extensively review folk and modem medicinal uses of licorice, noting how some traditional uses seem to have been partly justified based on present knowledge. It has been said that chewing on licorice roots instead of candy has been helpful to those wishing to stop smoking without gaining weight (Marcin 1983). Babies have been give a hard, non-fibrous piece of washed root to aid them in cutting teeth (Marcin 1983).

Licorice is known to have several pharmacological effects (Simon et al. 1984). It is estrogenic (simulating sex hormones) and spasm-relieving. The saponin in licorice bark affects blood cells. Glycyrrhetinic acid from licorice is employed in anti-inflammatory agents used against gastric ulcers and in the treatment of Addison's disease. It can cause sodium retention leading to hypertension (Davis and Morris 1991; Schambelan 1994). Licorice contains

salicylic acid and 0.15% o-acetylsalicylic acid, constituting enough "aspirin" to perhaps be effective as a pharmaceutical agent (Duke 1985). Licorice is currently used as a flavoring agent to sweeten the bitter taste of many drugs, as a filler for pills, and in ointments for treating skin diseases, and in some European countries as a primary antipeptic ulcer drug (Davis and Morris 1991). Glycyrrhizin served as a model for the production of carbenoxolone, a synthetic remedy against gastric ulcers, but unfortunately one with adverse side effects (Palevitch, personal communication). For purposes of treating gastric ulcers, the adverse side effects of licorice are essentially eliminated by removing the glycyrrhizinic acid from the herb, apparently showing that there is another anti-ulcer factor in licorice besides glycyrrhizinic acid (Palevitch, personal communication). The usefulness in ointments for skin disorders is related to the fact that glucocorticoid action is potentiated by glycyrrhizin or glycyrrhetinic acid; that is, the healing action of some medicines is made more effective. Clinical trials have shown that preparations from licorice are useful in treating various herpes infections and peptic ulcers, and potentially for some cancers (Chandler 1985*b*).

According to Duke (1985), excessive licorice ingestion can produce severe hypertension and cardiac problems [according to Desmarest (personal communication), there is good evidence of hypertension and edema, but not of cardiovascular toxicity]. Cases have been reported of extreme weakness in individuals who for years daily consumed licorice candy bars or chewed licorice-flavored tobacco (Duke 1985).

Nutrition

Licorice is not known to add significant nutrients to the human diet.

Curiosities

• *Glycyrrhiza* is appropriately named from the Greek *glycys*, sweet, and *rhiza*, root, so named by the classical Greeks. The English word licorice and the French word réglisse are corruptions of *Glycyrrhiza*, tracing through the latin *liquiritia* (Sokolov 1979).

• Tons of licorice were stored in the 3000-year-old tomb of King Tut, apparently to prepare a sweet drink called *mai sus*, still consumed in Egypt, for the king's afterlife (Inglett 1982; Davis and Morris 1991).

• During the reign of Edward I, a tax was levied in 1305 on licorice and other articles in order to repair London Bridge (Gibson 1978).

• Pieces of raw licorice used to be widely sold in Europe as a kind of natural, sweet chewing gum (Grieve 1931). Licorice continues to be used as chewsticks in some countries, and is employed in chewing gum (Morton 1977).

• Glycyrrhizin, the main constituent of licorice, is more than 50 times sweeter than cane sugar (Simon et al. 1984).

• Singers often chew licorice root in the belief that it will strengthen the throat (Duke 1985).

• Glycyrrhizin in licorice increases extracellular fluid and plasma volume, while inducing sodium retention and reducing loss of potassium. Consequently, thirst is reduced. Therefore, it has been rationed to desert troops expected to survive on low water intake (Morton 1977).

• Common sugar (sucrose) promotes tooth decay, because micro-organisms in the mouth convert the sucrose into a sticky substance that enables harmful bacteria to adhere to the teeth. Glycyrrhizin has been found to suppress an enzyme involved in the production of the sticky substance, while having no effect on beneficial oral bacteria

Fig. 160.
Licorice *(Glycyrrhiza glabra)*, from Harter (1988).

[Innovation, April 1987, page 8 (Israeli publication); Industry Week, June 1, 1987; information supplied by D. Palevitch].

Problems and Potential

Licorice is an established herb grown for extract, that has traditionally been grown commercially in Europe and imported into North America. Crops could be grown in the U.S., but previous experimentation has not led to an indigenous licorice agriculture.

Selected References

Morton (1977); Simon et al. (1984); Chandler (1985*b*); Davis and Morris (1991).

Hibiscus

Family: Malvaceae (mallow family)

Genus Notes

Hibiscus has perhaps more than 400 species of annual and perennial herbs, vines, shrubs and trees of warm-temperate, subtropical, and tropical regions (Edmonds 1991). Many species are grown as ornamentals, and several for food, fiber, and medicinal products. *Hibiscus cannabinus* L., kenaf, is widely grown for fiber. It is considered to be a promising new crop for the U.S., and has been experimentally (and unsuccessfully) grown in Canada (Small 1994a). Kenaf is closely related to *H. sabdariffa* treated below. Both species belong to *Hibiscus* section *Furcaria*, a group with more than 100 known species (Wilson 1994). The tropical African *H. acetosella* Welw. is grown as an ornamental in Florida and elsewhere, and is often confused with *H. sabdariffa*. Unlike the latter, its calyx is not fleshy, and just the young leaves are eaten for their acid flavor -usually cooked with rice or vegetables (Morton 1987; note that all references to Morton 1987 refer to J.F. Morton, not J.K. Morton). The fruit pods of *Albemoschus esculentus* L. (often called *H. esculentus* L.) constitute the vegetable known as okra [discussed in detail in Munro and Small (1997)].

Hibiscus Sabdariffa L.

English Names

Roselle
Also: East Indian sorrel, Florida cranberry, Guinea sorrel, hibiscus, Indian sorrel, Jamaica dogwood, Jamaica sorrel, Jamaica tea, Java jute, jelly okra, lemon bush, mesta (applied to the fiber type; the seed oil may be called mesta oil), Natal sorrel, Queensland jelly plant, red sorrel, red tea, rosella, rosella hemp (also refers to the fiber from the plant), roselle, rouselle, rozelle, rozelle hemp plant, sorrel (better reserved for *Rumex* species, discussed in this book), sour-sour, Sudanese tea, thorny mallow, various leaved hibiscus
[In Switzerland, the edible calyx is called *karkadé* (Watt and Breyer-Brandwijk 1962). The calyx is also known as *karkadé* or *carkadé* in North Africa and the Near East, as well as in the pharmaceutical and food flavoring trades of Europe (Morton 1975*b*). The calyces have also been called karkade flowers in the commercial trade (Crane 1949). The fiber from the species has been called India rosella hemp, rosella fiber, rosella hemp, rozelle hemp and Pusa hemp (Crane 1949).]

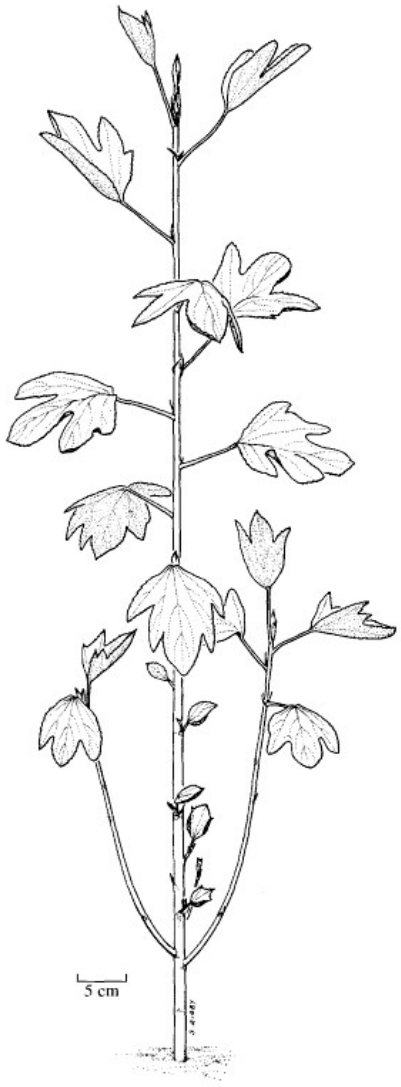


Fig. 161.
Roselle *(Hibiscus sabdariffa)*, vegetative plant, prepared by S. Rigby. (Based on greenhouse plant grown from seed from Richters.)

French Names

Family: Malvacées, famille de la mauve
Roselle (f)
[In French, roselle also is the name of the red-winged thrush.]
Also: bissap, groseille, groseille de Guinée, groseille du pays, hibiscus (acide), karkadé (more information below), ketmie (acide), ketmierose, oseille indienne, oseille rouge, oseille (rouge) de Guinée

Note

In preparing culinary products with roselle, it should be kept in mind that the juice is quite acidic, so that aluminum, copper, and iron containers are best avoided (cf. information for sorrel in this book).

Description, Taxonomy, and History

Roselle is an erect shrub, native to subSaharan Africa (Wilson, personal communication). Although normally grown as an annual, it is a perennial [Bailey and Bailey (1976) refer to it as "annual or perennial."] The species is often said in the literature to be native to Asia [Morton (1987) states that it is native from India to Malaysia], but this does not appear correct (Wilson, personal communication). Forms that are grown for their fiber are tall, less branched, and sometimes over 3.5 m in height (rarely up to 5 m), while culinary varieties are much-branched, bushy, and generally 1-2 m tall (Wester 1920). Stems are green or red, depending on seed source. Roselle has a strong

Fig. 162.
Roselle *(Hibiscus sabdariffa)*, flowering branch, prepared by M. Jomphe.

taproot. The young plants have leaves that are unlobed, but as the plant grows the later-developed leaves are shallowly to deeply palmately 3- or 5-parted (sometimes 7-parted). The large flowers have pale yellow petals (sometimes suffused with pink or red) and a dark red eye. The exposed petals often last only a day (Cooper 1993). The flowers are usually borne singly in the leaf axils. The sepals at the base of the large flowers and fruits vary from dark purple to bright red (sometimes white) at maturity, and they are quite fleshy. The calyx increases from 1 to 2 cm before the flower is fertilized to about 5.5 cm (rarely longer) in length at maturity. Some forms of roselle contain a red pigment that gives a brilliant red color to culinary products made from the plant, other forms are completely green. Edible types of roselle are usually succulent, have well-developed lateral branches, and lack a hairy covering, while types grown for fiber are less succulent, have few lateral branches, and are often hairy or prickly (Wilson and Menzel 1964).

At maturity, when the calyces are edible, the succulent calyx encloses a seed pod. At the base of the 5-lobed calyx is an "epicalyx" with eight to 12 bracts. The epicalyx looks much like the entire calyx of the flowers or fruits of many other plants. To harvest the edible portion, the base of the calyx should be cut off and the seed pod removed.

Roselle may have been domesticated in western Sudan before 4000 B.C. (Wilson and Menzel 1964). It was not recorded in Europe until 1576 (Lambourne 1913). It seems to have been carried from Africa to the New World by slaves for use as a food plant. Roselle was called Jamaican sorrel in 1707 in Jamaica, where the regular use of the calyces as food seems to have first been practiced (Lambourne 1913). The use of the plant as "greens" was known in Java as early as 1658 (Wester 1912; Lambourne 1913). Taken to the New World, roselle was cultivated in Mexico, parts of Central America, the West Indies, and in the late 19th century in southern Florida, Texas, and California. It is now grown for culinary purposes in much of the tropical world. The use of *H. sabdariffa* for fiber seems to have developed in regions other than Africa (Wilson and Menzel 1964). Most breeding of roselle has been for its yield of fiber (Duke and duCellier 1993).

Uses

Roselle is a multipurpose food plant (Wilson and Menzel 1964), commonly found in tropical gardens. Its seeds are eaten roasted or ground into meal. Although somewhat bitter, the meal is high in protein (Morton 1987). The seeds have also been used as an aphrodisiac coffee substitute (Duke 1985). The pleasantly acidic leaves and

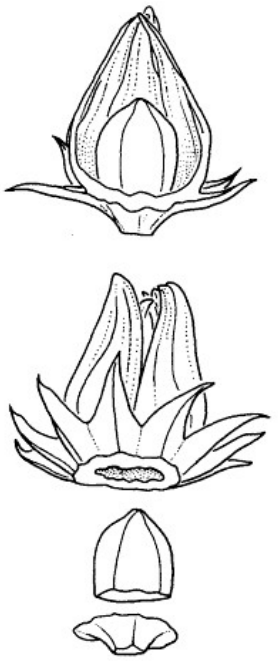


Fig. 163.
Views of fruit and enclosed calyx
[prepared by S. Rigby, after Wester (1912)].
At top, two of the five calyx lobes
have been removed to show the seed pod.
Below, the bottom of the calyx
has been cut off, and the seed pod
pulled out, leaving the remaining
edible portion. Note the "epicalyx"
(bottom lobed portion)
at the base of the calyx.

young shoots are consumed raw or cooked, either as a sour-flavored vegetable or as a condiment. Cooked roselle goes well with other vegetables, meat and fish (Morton 1987). The juice (from leaves, stems, or calyxes) is squeezed out and used in fresh or fermented drinks, and in flavoring extracts and syrup (Pandey 1990). Fresh calyces are used for wine, jelly, syrup, gelatin, beverages, pudding, and cakes, and dried calyces are used for tea, jelly, marmalade, ices, ice cream, sherbets, butter, pies, sauces, tarts, and other desserts (Duke 1985). The fleshy calyces are also eaten in chutneys, preserves, fruit salads, and in other confections much like cranberries. In southern Florida, where roselle is called Florida cranberry, the fleshy calyces are used in preparing sauce or jelly (Stephens 1978). The calyces contain over 3% pectin, and it is generally not necessary to add pectin to make a firm jelly (Morton 1975*b*). In Mexico, a red beverage made from roselle is known as Jamaica (Duke 1985). In India, the calyces are employed in making soups, puddings, cakes, and for coloring syrups and liqueurs. In the West Indies roselle is used to color and flavor rum (Duke 1985).

Roselle is grown in tropical regions for its fiber, obtained from the phloem ("inner bark"). The fiber strands are up to 1.5 m long, and are useful for cordage and in manufacturing burlap (Duke 1985). Roselle is sometimes also grown for seed oil, which is edible. Different parts of roselle are used medicinally.

Recipe Sources

Wester (1912) and Lambourne (1913) give recipes for roselle jam, jelly, sauce, syrup, and wine. Wester (1920) provides recipes entitled Baked pudding, Cake, Frosting, Cottage pudding, Pudding sauce, Gingerbread, Jelly (from calyces), Jelly (from leaves), Jelly cake, Pie, Pottage, Punch, Roly-poly, Roselleade, Sauce, Sherbet, Shortcake, Syrup, and Wine. Several recipes are in Orosa (1932). Wolfe (1972) provides a recipe entitled Sorrel drink and Barash (1993) has a recipe for Roselle ice cream. Morton (1987) provides many suggestions for preparation and serving.

Importance

Roselle is primarily a fiber plant of the tropics. It is grown in the drier parts of west and central Africa (particularly Nigeria) and in tropical America, but the major areas of production are in India and several other Southeast Asian countries (Dempsey 1975; Morton 1987). It also finds use as a garden food plant in tropical and subtropical areas. Large amounts were grown for jam in Australia about the end of the 19th century (Lambourne 1913). As a food plant, it grows well in Florida (Stephens 1978), and in California (Whallon 1954), and has been cultivated for food purposes as a garden curiosity as far north as Michigan (Whallon 1954). It has also been grown for food in Australia (Wester 1911). Cooper (1993) records the following comments regarding current roselle production in other countries. Roselle is grown for the calyces in the Sudan, China, Thailand, and Mexico, and exported from the first three countries. In the Sudan it is collected by goat herding nomadic tribes, and because of poor processing conditions the product is frequently inferior. Nevertheless, Sudanese material is attractively bright red, very acidic, and extremely popular in Germany where most of the crop is exported. The Chinese material is more sour than fruity, and there is wide

variation in the quality of export batches. In Thailand there is good quality control. In Mexico most of the crop is consumed within the country, and is sold as raw dried calyces and as extracts and powder drink mixes, which are very popular. Export prices for the 1992-93 season for Sudanese, Chinese, and Thai roselle was of the order of $1,700.00 (U.S.)/t, while Mexican material was about twice as expensive. Duke and duCellier (1993) record an estimate of about 800t (apparently of imports) for the U.S. market in 1986.

Cultivation Notes

Soil

Roselle appears to tolerate various soils, but they need to be permeable, not very compact, and not subject to flooding (Crane 1949). Roselle has been found to grow well in uniform loam and sand over clay, and seems to tolerate a broad range of soil pH, with reported ranges of 5.5-8.5 (Hackett and Carolane 1982), and 4.3-8.0 (Duke 1978). Soils should generally be medium-textured and well-drained. Stable manure and commercial fertilizers increase growth (Duke and duCellier 1993). However, excessive manuring with nitrogen causes the plants to grow large at the expense of producing fruits (Lambourne 1913). To hasten maturity of the fruits, avoid extremely rich soils or application of nitrogenous manures (Crane 1949).

Climate

Roselle is adapted to tropical and subtropical conditions, growth occurring between 10 and 35°C, with optimal growth about 28°C. It requires full sunlight, and will not withstand frost. The plant is strongly photoperiodic - a short-day plant that is induced to flower when days shorten sufficiently. (Some edible varieties that have been grown in Florida seemed to be almost day-neutral, flowering quickly after planting; Wilson, personal communication.) In hot areas roselle requires abundant moisture, although it needs to be grown on well-drained land. In southern Michigan, plants seeded in June have come into bloom in September, with young fruits forming as killing frosts arrive (Whallon 1954). This means that outdoors in Canada and the northern U.S. it is possible to harvest young shoots and leaves for use as a condiment, but probably not significant crops of the fleshy sepals. Under greenhouse conditions the plants could be forced to flower to produce edible calyces during the winter.

Propagation and Cultivation

Roselle is usually started from seed but can be grown from cuttings. It requires about 6 months to produce a fiber crop. Details of how the crop is grown for fiber purposes are provided by Duke and duCellier (1993), and especially by Dempsey (1975). Roselle grown for the sepals is cultivated much like eggplant (Stephens 1978). In Florida where roselle is grown as a food crop, the sepals can be harvested in 4 months. Roselle is subject to injury by root-knot nematodes, and soils known to be infested should not be used for it (Duke and duCellier 1993). There is, however, considerable variation in tolerance to the nematodes (Wilson and Summers 1966).

Harvest and Storage

Calyces ripen about 3 weeks after the start of flowering, which could be 100-160 days after the plants are transplanted outdoors (Duke and duCellier 1993). The fruits ripen progressively from the bottom of the plant to the top. Like tea and coffee, harvesting is carded out by intensive hand labor, the calyxes picked singly at the appropriate stage. The fruits may be harvested when full-grown but still tender, when they can be easily snapped off by hand; later harvesting requires clippers (Morton 1987). The fruits are easier to break off in the morning than at the end of the day, according to Morton (1987). On average, each fruit yields about 7-10 g of sepals (Wester 1912). The capsules (with their seeds) attached to the sepals are easily separated, but do not need to be removed before cooking (Duke and duCellier 1993). However, Morton (1975*b*) notes that if the seed capsule is not removed, the resulting product may be "stringy" and contaminated with the small hairs from the capsule, which may be injurious. She recommends removing the seed capsule for culinary purposes. As much as 7 kg of sepals per plant (fresh weight) has been harvested in southern Florida (Stephens 1978), although in India 1.4 kg per plant is considered average (Pandey 1990). A calculated yield of about 10 kg/ha (based on just a few plants) is possible in Florida, and an experimental yield of about 7 t/ha has been realized in Florida (Lambourne 1913). In Hawaii, 19 t/ha has been achieved (Wester 1920). In Florida and other warm areas, a second blooming period and harvest are possible, although the second fruit crop is much smaller than the first. In China, calyces from the second crop have proven to be much smaller and weaker in flavor than the first harvest (Cooper 1993). The setting of additional fruits is stimulated by harvesting the first fruits that develop (Wester 1912). The fruits should be gathered before the sepals become woody, and while they are tender, crisp, and plump. The sepals can be dried and stored in air-tight containers (Pandey 1990). Dried calyces are sometimes sold in tropical markets (Crane 1949) and are exported (Morton 1975*b*). A chief cause of poor quality is moisture level during the drying process: excess moisture can cause mold, ruining the flavor (Cooper 1993).

Example Cultivars

Archer, Rico, Temprano, Victor (culinary cultivars described by Wester 1920). Temprano is also described by Crane (1949). Altissima is an example of a fiber cultivar, whose fruits are inedible (Wester 1920). Nonsoong-2 is an Asian fiber cultivar (Sermsri et al. 1987*a*); so is Ton-Kiew (Sermsri et al. 1987*b*). Crane (1949) describes some varieties that are useful both for fiber and for edible fruit.

Additional Notes

Chemistry

About 89% of the fresh calyx is water (Crane 1949). The dried calyx contains about 13% acidic components (Duke and duCellier 1993). Acidic components present include hibiscic acid (up to 28%; this is the lactone of a hydroxycitric acid), citric acid (12-17%), and oxalic, malic, and tartaric acids (Pandey 1990; Tyler 1993). About 0.004-0.005% ascorbic acid (vitamin C) is also present (Duke and duCellier 1993). The sepals also contain about 3% pectin (Pandey 1990). Anthocyanins and other pigments are responsible for the color. The major pigment is daphniphylline (Morton 1987). The seed oil contains palmitic acid (ca. 35%), oleic acid (ca. 34%), linoleic acid (ca. 15%), and other constituents (Ahmad et al. 1979). The tart taste of the plant, and perhaps also the mildly laxative and urination-stimulant effects, are due to the plant acids (Tyler 1993). Considerable water-soluble mucilaginous polysaccharides in the plant may also contribute to the postulated physiological effects of roselle (Tyler 1993).

The chemistry of the seed oil is discussed by Sarojini et al. (1985) and Jirovetz et al. (1992). The seed oil has some potential as a vegetable oil, and is notably rich in linoleic acid (Chin and Nushirwan 1992).

Medicine

Morton (1975*b*, 1987), Perry and Metzger (1980) and Duke (1985) review medicinal uses, some of which are mentioned in the following. In India, Africa, and Mexico all above-ground parts of the plant are used in native medicine. In Burma the seeds are used to treat debility and the leaves to soften skin. In Taiwan the seeds are employed as a laxative and tonic and to stimulate urination. In the Philippines, the bitter root is used as a tonic and appetite-stimulant. In Angola the leaves are used to soften skin and as a cough remedy. In central Africa a poultice of the leaves is applied to abscesses. The calyces have been considered to be an anti-scorbutic (to prevent scurvy) (Crane 1949), which is consistent with a high content of vitamin C (see below). Medicinal usefulness has recently been indicated for treatment of arteriosclerosis, and as an intestinal antiseptic (Perry and Metzger 1980), and for lowering blood pressure (Morton 1987).

There appears to be no toxicity associated with roselle calyces, and no reason not to consume it (Tyler 1993). Morton (1987) commented "toxicity is slight."

Nutrition

Duke (1977) characterized content of roselle as follows: leaf: high in calcium, fiber, niacin, and vitamin C, and very high in vitamin A; both fruit and seed: high in calcium, fiber, and vitamin C. Morton (1975b, 1987) noted the calyces are high in calcium, niacin, riboflavin, and iron. Hackett and Carolane (1982) regarded the fresh fruit

Fig. 164.
Roselle *(Hibiscus sabdariffa)*,
from a 1601 woodcut originally published by
Clusius and reproduced in Wester (1911).

as high in fat and oil, protein, and vitamin C. The fresh fruits contain about 6.7% protein (Duke 1985). El-Adawy and Khalil (1994) consider the seeds to be a potential high-protein source for nutritional purposes.

Curiosities

• The name *sabdariffa*, which is part of the scientific name *Hibiscus sabdariffa*, was the name by which the roselle was first known. The name is of Turkish origin, suggesting that the plant was transported to the West through the early Turkish empire (Wester 1912).

• The English name roselle appears to be a corruption of the French word oseille (sorrel, discussed in this book) (Crane 1949).

• In promoting the use of roselle in the early 20th century, making wine from it was considered one of its good points. With Prohibition of alcoholic beverages in the U.S., a different, but rather resourceful argument was used: "the prohibition wave has produced a greatly increased demand for soft drinks, and roselle sirup as a flavoring extract might well be considered for introduction to the public by the dispensers of soft drinks" (Wester 1920).

• An experiment showed that chickens become less inebriated from consuming alcohol after eating roselle extracts (Duke and duCellier 1993). It is therefore curious indeed that, in Guatemala, roselle "ade" is a favorite remedy for hangovers (Morton 1987).

Problems and Potential

Roselle can be grown for culinary purposes as a garden curiosity in the northern U.S. and Canada. It is basically a fiber and food plant adapted to tropical and subtropical circumstances, and is not a suitable food crop for the northern U.S. or Canada.

Selected References

Lambourne (1913); Wester (1920); Crane (1949); Whallon (1954); Wilson and Menzel (1964); Dempsey (1975); Morton (1975b); Morton (1987); Stephens (1978); Hackett and Carolane (1982); Cooper (1993); Duke and duCellier (1993).

Houttuynia

Family: Saururaceae (lizard's-tail family)

Genus Notes

Houttuynia has only one species.

Houttuynia cordata Thunb.

English Names

Vap ca
Also: dokudami (Taylor 1976), giâp cá (Kuebel and Tucker 1988), tsi (Roecklein and Leung 1987), masundari [in Assam (Saikia and Shadeque 1993)]. According to Pröbstle (1994) the official name in Japan is gyoseiso, but it is also

Fig. 165.
Vap ca *(Houttuynia cordata)*,
from Curtis (1787-present; #2731).

called dokudami zoku, shih-yao, chung-yao, and jyu-yaku; in Korea it is called osaengch'o; and in Thailand it is called pluu-kao.
[K.R. Kuebel (personal communication) advises that the name vap ca appears to be an invention of the Richters herb company (note Richters 1994). It is adopted here as the only anglicized version of the name available, although "giap ca" may be a preferable reflection of the original Vietnamese.]

French Names

Family: Saururacées, famille de la queue de lézard
Houttuynie (f)
Also: houttuynie en coeur

Description, Taxonomy, and History

Houttuynia cordata is a semi-aquatic perennial herb, 15-50 cm, occasionally to 100 cm tall. The leaves are heart-shaped, dark green with some dark red-violet coloring. The plant is common in temperate and tropical regions of eastern Asia, from the Himalayas through Nepal, China, and Java to Japan, often in damp shady places in mountainous districts (Li et al. 1973). After being introduced as an ornamental about 1960, the species became naturalized on the campus of the University of British Columbia at Vancouver, in marshy areas as well as shady wooded places, with flowering occurring in June and July (Taylor 1976). All parts of the plant are strongly aromatic, and in flower it has a fetid smell (Keys 1976). The species has a clump-forming rootstock, and may spread widely through its buried or partially buried rhizomes. The stems and leaves may be purplish-red. The showiest part of the plant is the inflorescence, which develops in early summer (Yashiroda 1968). This consists of 4-6 snowy white or green-white, cross-shaped floral bracts, subtending a stout spike of small, naked, crowded flowers. These have been said to superficially resemble white buttercups borne on 10-15 cm stems (Kuebel and Tucker 1988). A Japanese and a Chinese chemical race, each differently scented, have been described (see Chemistry). Both types are cultivated in Vietnam and by transplanted Vietnamese in Texas (Kuebel and Tucker 1988). A tricolored (red, green and white) variegated ornamental variety is available under several names (see Cultivars).

According to Pröbstle (1994), who examined vap ca in Chinese history, *H. cordata* was first described in the later Han period (25-220 A.D.) as a "slightly effective drug"

in the "Materia Medica of the Steep Mountain Slopes" (*Lu Chan Yan Ben Cao*). Later, the eminent physician Tao Hong-jing (425-536) added *H. cordata* to the *Shen nong ben cao*, the authoritative pharmacopoeia that was first prepared in the later Han period.

Pröbstle (1994) lists the following species, which resemble *H. cordata*, and have been deceptively substituted for it: *Gymnotheca chinense* Decne., *Gymnotheca involucrata* P'ei, *Veronica undulata* Wall., *Potamogeton perfoliatus* L.

Uses

The leaves are eaten in salads, soups, and fish stews. Some Vietnamese consider the herb a useful garnish for Hot vit lon - boiled fertilized duck eggs cooked 3 days before they hatch (Kuebel, personal communication). It is also popular in Vietnamese stews and sweet and sour dishes (Kuebel, personal communication). Roots and fruits are also considered edible (Facciola 1990). The taste is pungent (Keys 1976). Barclay (1993) found that *H. cordata* had a "very strong, soapy coriander taste and odor." Similarly, Adams (1996) reported that it had a strong cilantro taste. Li et al. (1973) state that "Notwithstanding the fact that it has a decayed fishy smell... it is sometimes eaten by the Chinese as a salad." Further embellishing their rather limited opinion of the culinary qualities of this herb, these authors also state that it "is good for feeding to pigs." However, according to Bauer (personal communication), the Chinese generally consider va ca to be a healthy food. Kuebel and Tucker (1988) note that some Vietnamese judge the aroma to be too strong and avoid the use of the herb. Kuebel (personal communication) relates that the first sample of this herb that he encountered was very disagreeable, with a harsh odor of raw meat, but that this odor was almost masked in a second sample by a sour citrus scent. Barclay (1993) advised that "like all the other coriander fragrance plants, the oils are evanescent and easily destroyed by cooking."

Houttuynia cordata is also grown as an ornamental. Its showy white bracts give the plant a superficial similarity to dogwood, and "it would be an ideal plant for the edge of a pond in an oriental garden or for any shady border or secluded comer" (Kuebel, personal communication). However, Shimizu (personal communication) suggests that the plant is so invasive that if it is planted by the edge of a pool it should be contained. Large containers will serve this purpose. In northern areas the plant is insufficiently hardy to survive, so that its potential invasiveness is not a problem.

Recipe Sources

None found. Consider using it as a substitute for cilantro (see *Coriander*).

Fig. 166.
Vap ca *(Houttuynia cordata)*,
from Lamarck and Poiret (1791-1823).

Importance

Houttuynia cordata is a minor Asian culinary and medicinal plant, recently introduced to the southern U.S., and available as a curiosity through some garden supply outlets. It is little known in North America and of almost no importance at this time.

Cultivation Notes

Soil

This species can be planted in marshy areas or at the margins of ponds in up to 10 cm of water. A pH tolerance range of 5.0-6.8 has been reported (Duke 1978).

Climate

Vap ca is hardy to at least -15°C (U.S.D.A. hardiness zone 5), so that it could be maintained outdoors at least as far north as the warmer parts of Canada. It will die back to the ground at first frost. Kuebel and Tucker (1988) recommend semi-shade. Barclay (1993) states "it grows well in semi-shaded, moist conditions or in full sun if sufficient water is supplied" and "the coloration of the Chameleon cultivar is most striking when grown in a sunny area." I have had no difficulty growing vap ca as a potted greenhouse plant, and specimens have survived well even when the soil became somewhat dry.

Propagation and Cultivation

Houttuynia cordata can be propagated by seeds and by division. Yashiroda (1968) notes that in Japan the plant can become an aggressive weed after it is planted. On drier soils it is less weedy.

Harvest and Storage

Since the culinary quality of yap ca is marginal, it probably is not advisable to attempt to dry the herbage, which could reduce the taste. Fresh material is likely necessary to appreciate the culinary virtues of the plant. Spring and summer-grown herbage tends to be more flavorful and less bitter than material collected in the autumn.

Example Cultivars

Chameleon (= Tricolor = Variegata; has attractive red, cream and green markings on the foliage), Plena

Additional Notes

Chemistry

A Japanese chemotype (chemical race), scented of oranges and cilantro, has been shown to have aerial parts rich in dodecanoic acid (ca. 40%), 2-undecanone (ca. 10%), and methyl decanoate (Tutupalli and Chaubal 1975). A Chinese chemotype, smelling of fresh meat and cilantro, has been shown to be rich in myrcene, 2-undecanone, limonene, and decanoyl acetaldehyde (Liu and Deng 1979). Jong and Jean (1993*a*) attribute the peculiar odor of Chinese material (from Taiwan) to decanoyl acetaldehyde. Barclay (1993) stated that the Chinese strain seems to be the kind available in the U.S. Additional components of the species are given in Duke and Ayensu (1985) and Jong and Jean (1993*a, b*). Recently, several aristolactams and dioxoaporphin derivatives have been found (Pröbstle and Bauer 1992), as well as a high amount of unsaturated fatty acids (oleic, linolic, and linolenic acid) (Bauer and Pröbstle, unpublished results), and unique benzene, pyridin and dihydropyridine derivatives (Pröbstle et al. 1994).

Medicine

In Vietnam the leaves are used to treat eye diseases, and for gynecological diseases (Nguyêñ-Xuân-Duñg and Dô-Tât-Loi 1991). In China the plant is used for chest pains, whooping cough, bronchitis, urinary and skin problems, malaria, snakebite, tumors, cancer, cough, dysentery, fever, gastritis, laryngitis, hemorrhoids, swelling and inflammation of abscesses, nephritis, and other ailments (National Academy 1975; Duke and Ayensu 1985; Foster 1989). In Japan the dried plant has been made into a crude folk remedy, applied to tumors and wounds, and sometimes put into baths (Yashiroda 1968). Li et al. (1973) state that "When eaten in excess it is said to cause shortness of breath, and is therefore considered to be slightly deleterious."

Houttuynia cordata extracts are anti-bacterial and have been used to treat humans (National Academy 1975). Decanoyl acetaldehyde has been shown to be antibacterial, although it is unstable and easily decomposes when the essential oil is distilled (Hayashi et al. 1995). The flavonoid quercitrin in *H. cordata* has inhibitory effects on several viruses, and the steam distillate from fresh plants of the species has virucidal effects against herpes simplex virus type 1, influenza virus, and human immunodeficiency virus type 1 (Hayashi et al. 1995). Extracts of *H. cordata* have shown inhibitory activity on prostaglandin synthesis (Bauer and Pröbstle, publication in preparation). Quercitrin in the plant has been found to be responsible for the diuretic (promoting urination) effect of the species (National Academy 1975).

Nutrition

Saikia and Shadeque (1993) analysed the content of calcium, phosphorus, magnesium and iron, and described yap ca as rich in these minerals. The unsaturated fatty acids (about 1%) may also be important for nutrition (Bauer, personal communication).

Fig. 167.
Vap ca *(Houttuynia cordata)*, photograph by M. Jomphe.

Curiosities

• The lizard's tail family (Saururaceae) is quite small (five genera with a total of only seven species). The odd family name is based on the scientific name of the genus *Saururus*, which is a combination of the Greek *sauros*, a lizard, and *oura*, a tail (Steam 1992*a*). The name is a reference to the dense spike-like flowering stalk of *Saururus*, said to resemble the scaly tail of a lizard.

• The generic name *Houttuynia* commemorates Martin Houttuyn (1720-94), a Dutch naturalist (Garcia 1986).

• In addition to the plant genus *Houttuynia*, there is an animal genus *Houttuynia* (plant names are independent of animal names). The latter is a genus of tapeworms, and includes a species found in ostriches (Gruss et al. 1988).

• Giâp in the vietnamese name *giâp cá* probably originates from the Cambodian word for this plant, and means a fishy smell; cá means fish (Kuebel, personal communication).

• There are several interesting Chinese names for yap ca, including: *yu xing cao* (fishy smelling herb), *zhu bi kong* (pig's nostrils, used in Sezchuan), *chou giao mai* (stinky wheat, used in Zhejiang), *gou re cai* (dog ear vegetable or dog's ear vegetable, used in southern China), *gou xing cao* (doggy smelling herb or herb that smells like a dog, used in Gansu) (Pröbstle 1994; Bauer, personal communication).

• *Houttuynia cordata* develops seeds parthenogenetically, i.e., without fertilization (Takahashi 1986). Very few flowering plants have completely or almost completely given up producing seeds by the normal sexual procedure. The most familiar example is dandelion, also discussed in this book.

Problems and Potential

Vap ca is capable of growing well in the warmer parts of temperate regions, and as such is not well suited to being grown as a commercial crop in Canada or the northern United States. It is an Asian crop, familiar to many of Asian cultural heritage, but on the whole poorly known in North America. It does not seem to be a sufficiently attractive culinary herb that familiarity with it would increase its popularity in North America appreciably. It has some limited potential as a novel, edible landscaping, particularly when container-grown.

Selected References

Kuebel and Tucker (1988); Pröbstle (1994).

Humulus

Family: Cannabaceae (hemp family)

Genus Notes

Humulus has three species of wind-pollinated, herbaceous vines, indigenous in north-temperate areas, including one annual and two perennials (Small 1978). Only the species described below has significant economic value. *Humulus japonicus* Sieb. & Zucc., a native annual of eastern Asia, is a naturalized weed of eastern North America. A variegated ornamental form of it has foliage streaked and splashed with white; it is sometimes cultivated, especially for porches and screens (Bailey and Bailey 1976).

Humulus lupulus L.

English Names

Hop
Also: common hop, English hop, European hop
["Hop" refers to a hop plant; "Hops" refers to the hops of commerce, i.e., the female cones. "Spanish hops" is a name sometimes used for dittany of Crete, *Origanum dictamnus*, discussed in this book.]

French Names

Family: Cannabacées, famille du chanvre
Houblon (m)
Also:, couleuvrée, houblon à (la) bière, houblon commun, houblon grimpant, houblon lupulin, houblon vulgaire, salsepareille indigène, salsepareille nationale, vigne du nord

Description, Taxonomy, and History

There are five varieties of wild hop, three native to North America, one to Europe, and one in Japan (Small 1978, 1994*b*, 1996*a*). In much of North America the European variety, var. *lupulus*, is found as an escaped plant from past use in brewing, or as a persisting ornamental around abandoned homesteads.

Hop is a high-climbing perennial vine, in cultivation exceeding 5.5 m (the average height of commercial trellises in North America), and sometimes extending more than 10 m. The vines climb by twining, and are assisted in holding onto surfaces by two-hooked hairs that resemble miniature grappling hooks. The annual, above-ground stem is killed by frost each year, re-growth occurring each season from perennial underground rhizomes and from buds on the rootstock (crown). The perennial crown becomes woody with age, with heavy, rough, dark brown bark. Rhizomes produced from the crown possess numerous buds, and are used for propagation. Some plants have male flowers, others have female flowers; occasionally some plants, especially in some populations, bear both kinds of flowers, but in diploid plants (i.e., those with the regular chromosome number of the species) these are usually functionally female (Neve 1991). In most natural populations of hop, female plants are about twice as numerous as males (Neve 1991). Because the female plants produce the commercially valuable hops (the cones or fruit-clusters), and also are of greater ornamental value than the males, the latter are generally discarded as soon as they can be recognized. However, males are usually planted deliberately in England because they increase yield and it is uneconomical to grow most English cultivars seedless (Neve, personal communication). Male flowers are not organized into "cones," but are in loose inflorescences (panicles). In hop plantations, males are usually regarded as a nuisance, since their pollen fertilizes the females, and prevents the formation of the valuable "seedless hops" that are predominantly preferred in commerce. Female flowers and hence cones consist of "bracts" and bracteoles," each bract usually matched by two bracteoles. The bracts are smaller and wider than the bracteoles and carry few, if any, resin glands. The bracteoles are longer, and are covered with small resin glands, particularly at the base; these contain the flavoring ingredients. The bracteoles also have a pocket at the base, where the seed is formed. Unless pollinated, seeds do not form. If seeds form, the pericarp (fruit wall surrounding the seed) develops glands, and these may contain up to one third of the important flavoring -acids (see Chemistry).

The hop plant is propagated primarily vegetatively rather than by seeds. More than one hundred cultivars have been named, each essentially a clone derived from a seedling (in theory, a genetically uniform line), many of which have been reproduced asexually for centuries. Many of these are of hybrid origin. Especially with older cultivars, different names were frequently given to the same clones in different production areas (Haunold, personal communication).

Wild hop has been used through recorded history for culinary, medicinal, and household purposes, although it is chiefly as a brewing ingredient that hop is well known. It has been argued that hopped beer was made in prehistoric times [see for example DeLyser and Kasper (1994)]. However, the early history of the cultivated hop is obscure. Fermented liquids such as beer were important beverages throughout the ancient world. Herbs and spices

Fig. 168.
Hop *(Humulus lupulus)*, from Köhler (1883-1898), showing a female branch with cones (bottom),
a branch with male flowers from a different plant (at top), and two lupulin glands (at right) considerably expanded.

were often added to improve flavor or keeping qualities, and it seems that ancient civilizations used hops for this purpose.

The first unequivocal evidence for cultivation of hop comes from 9th century Bavaria, and it appears that a tradition of hop usage in beer has been maintained there for perhaps a millennium. During the Middle Ages many monasteries were famous for their hopped beers. The brewing trade developed to a highly refined art, with beer being consumed for breakfast, lunch and supper. The cultivation of hop was not introduced into England until the close of the 15th century. The hop was brought to North America and grown in the early 17th century. By the middle of the 19th century, New England and New York produced the bulk of the hops of the New World. However, by the early 20th century, the Pacific Coast became the leading hop-producing area in North America. In the 1920's hop growing in New York was practically wiped out by downy mildew and by Prohibition. Similarly in Canada, commercial hop growing was phased out in the east by the end of the Second World War, and became established in British Columbia.

The wild European variety, var. *lupulus*, is the ancestor of most brewing cultivars used today. However, both in Japan and in North America, the local wild hops hybridized with the imported European hop, to produce unique Japanese and European cultivars (Small 1980, 1981). The hop is not native to the Southern Hemisphere, but has been introduced there for cultivation. Brewers have long recognized that North American cultivars have a higher content of the important brewing constituents, the alpha acids, and produce beer of stronger aroma. American hops usually have a less desirable odor and flavor than European hops, and relatively few hop cultivars have mostly American parentage (Haunold 1993). Nevertheless, bitter hops are still very important commercially, and nearly all owe a great deal to American parentage (Neve, personal communication).

Uses

Hops are a chief constituent of beers, which in the past have often been produced in kitchens, and not just in specialized breweries. Tea is also "brewed," as an infusion of the leaves and cones (Grieve 1931). Hops can be added to soups, stews, and other foods to produce bitterness, if desired.

The hop plant has some limited use as a cooked vegetable or for providing a component of mixed salads, to be eaten raw. Considerable information on this is provided in a companion volume to this book, that treats vegetables (Munro and Small 1997).

Fig. 169.
Hop *(Humulus lupulus)*, from Thomé (1903-1905),
showing a female branch with cones (above)
and a male branch with flowers (below).

Hop extracts and oil have been used to flavor tobacco, yeast, beverages other than beers, frozen dairy desserts, candy, gelatins, puddings, baked goods, various confections, chewing gums, and condiments (Duke 1985; Farrell 1985). Hop extract has also been used as an aromatic bitter principle in pharmaceutical preparations and in shampoos. Extracts are used in skin creams and lotions in Europe for their alleged skin-softening properties (Duke 1985).

Before yeast cakes became widely available in stores, yeast for bread-making was prepared by culturing wild yeast in a decoction of hops and water. Some of this was mixed with bread dough, adding flavor to the bread, and apparently preventing the yeast from spoiling by virtue of the antiseptic properties.

Hop stems contain considerable fiber, and have been used in making paper and twine. The stems were once used in basket and wickerwork (Stuart 1979). The inflorescences and leaves of hop yield a yellow dye. *Humulus lupulus* is a popular garden ornamental, and some cultivars have been selected for their decorative qualities.

Recipe Sources

[for beverage purposes; for vegetable purposes see Munro and Small (1997)]

Grieve (1933) presents recipes for Hop bitters [tea], Hop beer, and Hop ale. Crowhurst (1973) has recipes for Hop ale, Lager beer, and stout.

Other recipes are: Hop lemonade (Garland 1979); Hop tea (Marcin 1983); Hop beer (Phillips 1986).

Importance

Hops are a specialty or minor crop wherever they are grown. About two dozen countries raise substantial commercial crops of hops, including Canada and the U.S. World centers of hop production also include Germany, Russia, China, England, the former Czechoslovakia, and the former Yugoslavia. About 114 000 t are produced annually in the world, on more than 90 000 ha (Swahn 1991). The U.S. is the second largest producer in the word, after Germany, growing about 26 000 t annually (Hays 1992). In the U.S., hop is cultivated predominantly in Oregon, Washington and Idaho. It was also grown commercially in California, until 1989 (Haunold, personal communication). In Canada, hop is cultivated commercially in British Columbia.

Essential oil produced from hop is of minor value. Verlet (1993) estimated the annual world value of hop essential oil to be $400,000.00 (U.S.).

Cultivation Notes

Soil

While hop grows in a wide variety of soils, it performs best in rich, alluvial or deep sandy or gravelly loams. Well-drained soils considerably reduce winter killing by frost-heaving in cold areas. A pH of 5.5-7.0 is best according to Hackett and Carolane (1982), although 4.5-8.3 has been reported to be tolerated (Duke 1978). Neve (1991) states that hops do not thrive under acid soil conditions, and it is best not to allow the pH to fall below 6.5.

Climate

The hop is adapted to a wide range of temperate climates. In North America, dry inland valleys of the Pacific Coast have been found to provide very hospitable climates, but irrigation is essential. The hop plant survives considerable cold, and indeed needs a dormant period initiated by frost in order to resume growth. Good snow cover can reduce winter kill in very cold regions. Considerable moisture is required during the growing season, but well-drained soils are necessary. Light shade is tolerated. The hop has a long-day requirement to produce flowers, which limits its range to latitudes above 35° in the Northern Hemisphere (Neve, personal communication; of course the plant can also be grown in the Southern Hemisphere).

Propagation and Cultivation

While hops can be grown from seeds, they are generally propagated vegetatively by "root" (rhizome) cuttings. Hop plants will live for up to 50 years, although commercial growers sometimes replace 1-10% of the plants annually, and in practice growers often renew their plantings at intervals of 15-25 years. The most prominent feature of a hop yard is the huge trellis or supporting structure provided for the annual vines to climb upon. The trellis is usually constructed from heavy wire strung across wooden poles placed in a regular pattern to facilitate mechanical picking of the cones. Low-trellis systems have been developed that use conventional cultivars in the U.S. and dwarf types in England (Neve 1991).

The home gardener can simply use hop plants grown as ornamental vines as a source of hops for use as a condiment. Hop plants grown for ornament need to be provided with a trellis or other base upon which they can climb.

Harvest and Storage

Freshly harvested hops normally contain about 80% moisture, which is reduced to 10-11% by drying, necessary for storage (Verhagen 1988). When grown for commerce, hop vines are cut, and the cones removed. These are usually dried in forced-draft hot-air kilns and then packed for storage and delivery. In most commercial hop producing areas worldwide, picking is by machines, which have proven 10-20 times as efficient as hand labor. Yields of ca. 2 t/ha are typical (Hackett and Carolane 1982). In North America most hops are pressed into 91 kg (200 pound) packages, wrapped in burlap or woven plastic depending on the brewer's preference. At room temperature, oxidation leads to rapid losses of the brewing value of hops, so that cold (often frozen) storage needs to be given as soon as possible after harvest. Hops are normally refrigerated until used in brewing, usually between 6 and 20 months after harvest.

The home gardener interested in using hops for culinary purposes can pick the cones at maturity, in late summer or early fall. In eastern Canada, this may be in late August or early September (Anon. 1948).

Fig. 170.
Hop *(Humulus lupulus)*, from Sturm (1900-1907), showing a female branch with cones.

Example Cultivars

At least 100 ornamental and brewing cultivars are available. Literature cited in Munro and Small (1997) lists almost all known brewing cultivars.

Additional Notes

Chemistry

The commercial value of hops is due to the resins in the lupulin glands which give beer its bitterness, and essential oils which contribute to flavor. Most domesticated hops are of European origin, and the content of the chemicals of brewing interest are different from the relatively few cultivated hops derived in part from American parentage (Haunold 1993). The important brewing chemicals include alpha-acids (-acids) and the beta-acids (ß-acids), also referred to as humulones and lupulones, respectively. Both contribute bitterness to beer, but the -acids are much more intense than the ß-acids. The -acids are a mixture of chemical analogues, including humulone, cohumulone, and adhumulone; similarly the ß-acids are a mixture of lupulone, colupulone, and adlupulone (Neve 1991). Since the -acids are the chief source of bittering, the content needs to be known to determine the rate at which hops are added to the brew. Content of -acid varies from about 3.5% in traditional European types to as much as 15% in newer bitter varieties (Neve, personal communication). The European forms of hop have a relatively low content of "soft resins" (- and ß-acids collectively), a ratio of :ß approaching one, low cohumulone, moderately low essential oil content, and relatively low myrcene in the essential oil fraction (Haunold 1993). Native American hops are quite high in cohumulone and colupulone content, and have a pungent, unpleasant aroma (Haunold 1993).

Yields of 0.5 to 1.5% of oil are typically obtained from hops (Farrell 1985). Seeded hops have more oil than seedless (Neve 1991). The essential oils give odor and flavor to hops. Over 200 constituents are present (Neve 1991). The chief aromatic constituents are myrcene, humulene, and caryophyllene, with minor amounts of dipentene, linalool, farnesene and methyl nonyl ketone (Stevens 1967; Farrell 1985; Neve 1991). Tannins are also present. A volatile alcohol (2-methyl-3-butene-2-ol, or dimethylvinyl carbinol) comprises up to 0.15% of the dried leaves and has been found to have sedative activity; it is thought to account for at least some of the plant's alleged sedative properties (Tyler 1993*a*). The leaves also contain rutin (Perry and Metzger 1980).

Medicine

The high oil and resin content of hops contributed to a reputation, greatly exaggerated, for valuable medicinal properties, and hops have a long history of use in folk medicine, not only in the Old World, but also by North American Indians (Duke 1985). Illnesses treated included boils, bruises, cancer, cramps, cough, debility, delirium, diarrhea, fever, fits, hysteria, inflammation, insomnia, jaundice, nerves, neuralgia, rheumatism, and worms (Duke 1985). Hop resin is bacteriostatic (against gram-positive organisms) and this factor may lend some credibility to use of hop in former times for treatment of certain types of epidermal sores and irritations, and bacterial infections such as tuberculosis. Although bacteriostatic activity is not important in modern brewing conditions, it used to be so important that when resin contents were first determined chemically they were expressed in terms of P.V. (Preservative Value) (Neve, personal communication). The tranquillizing effect commonly alleged in folklore for hops may have a logical basis in the sedative alcohol discussed above in Chemistry. Tyler (1994), however, has concluded that active sedative principles in hops have not as yet been authoritatively identified. In China and Japan the dried

cones are presently used as a tonic, to treat stomach problems, as a sedative, and to increase urine flow (Perry and Metzger 1980).

Hop causes dermatitis in as many as one in 30 hop workers (Duke 1985). Separated leaf hairs may irritate eyes (Foster and Duke 1990), but more likely such irritation is due to resin glands carelessly wafted into the eyes at harvest or in processing operations (Haunold, personal communication). The hop plant is related to the hemp (marihuana) plant, tempting some to try to smoke the leaves. However, hops are devoid of the mood-altering chemicals found in marihuana (Small 1979).

Nutrition

Hop is not considered to supply significant nutrition to the human diet (Hackett and Carolane 1982).

Curiosities

(In addition to the following curiosities, many more are given in Munro and Small (1997), where hop is discussed as a vegetable.)

• The Arabian physician, Mesue, in the middle of the 9th century claimed that the use of hops would induce sleep (Farrell 1985). There is a long Eurasian tradition of using hops as a sedative, including putting the cones in pillows, and planting hop beside bedrooms (Munro and Small 1997). American Indians independently adopted the sedative use of hops (Moerman 1982).

• St. Hildegard (1098-1179, also known as Hildegard of Bingen and Hildegardis de Pinguia), was an abbess who established a convent and a Benedictine nunnery near the Rhine River. She was one of the most remarkable women the world has ever known (Lipscomb 1995), becoming an adviser to popes, kings, and various dignitaries. She wrote on nature and medicine, and was a mystical and spiritual visionary who interpreted Oriental, Judeo-Christian and Greek philosophy. St. Hildegard is often credited with being the first person to popularize the use of hops in brewing (Hardwick 1995).

• During the Middle Ages in Scandinavia, peasants were required to grow hops in their gardens (Swahn 1991).

• In England about 1500, after learning of how well hops preserved beer in continental Europe, British brewers started adding hops to ale (sweet beer made without hops), turning it into bitter beer. Henry VIII (1491-1547), responding to a petition to ban hop, described as "a wicked weed that would endanger the people," outlawed the use of hops by brewers. His son, Edward VI (1537-1553), rescinded the ban in 1552 (Castleman 1991).

• In the 19th century, hops were an ingredient in many patent. medicines. One of these was hop bitters, comprised of hops in 30% alcohol. Its advertising slogan was "Take Hop Bitters three times a day, and you will have no doctor bills to pay" (Castleman 1991).

• Charles Darwin (1809-1882), the great student of evolution, entertained himself while sick in bed in 1882 by studying a hop plant growing on his window-sill. He noted that the tip of the stem completed a revolution in 2 hours (Neve 1991).

• Among the many curious Hoosier Indiana) folk remedies recorded by Tyler (1985) is the following: for tuberculosis, take freely powdered hops in rye whisky - morning, noon, evening, and night. How effective this was might be judged by another cure for tuberculosis on the same page: "spread horse manure liberally all around the outside of the house where you live, and you will soon. get well." However, prior to antibiotics, hop essences (especially ß-acids) were commonly used to treat tuberculosis patients. In fact, ß-acids are very effective against gram-positive bacteria (Haunold, personal communication).

• According to Launert (1981), hop tea should be taken "3-4 times a day for nervous heart conditions and excessive sexual urge."

• It has often been suggested that hops are hallucinogenic, like the related marihuana (*Cannabis sativa* L.). This may be partly due to the peddling by British merchants in the 19th century of a substance they called hopeine, alleged to be a narcotic derived from the finest wild American hops. In fact, it was a mixture of an aromatic oil and morphine (Moerman 1982).

• Well-known for the brewing of a legal intoxicant, "hop" was transformed into a generic term covering illegal intoxicants. "Hop" is slang for any narcotic drug, especially opium. "Hophead" is slang for drug adddict. In the 1950's, jazz musicians smoking marihuana were commonly called hopheads (Castleman 1991).

Problems and Potential

An unusual feature of the hop as an agricultural commodity results from its complete economic dependence on the brewery industry. Because of the stability of this industry, whose output is highly predictable, there is no elasticity in consumable annual crop. Until recently, small deviations from market demand often caused disastrously low prices in the case of oversupply, or extremely high prices in the case of relatively small shortages. Hops are

an extremely light commodity in relation to value, and are easily transported long distances without loss of brewing qualities. Moreover, in recent years hop powders, resin extracts, and compressed hop pellets have increased storage stability and decreased transportation costs considerably. Accordingly, the supply has become quite stable from year to year, and bad harvest seasons do not provide the boost to prices that was once the case. The factors noted above have contributed to the centralization of hop farming, and the creation of a large international trade in hops. Hop farming is very specialized, requiring high capital investment, and it is very labor-intensive, and increasingly an "agribusiness" venture. In the U.S., nearly all hop farms are "family corporations."

Selected References

Small (1978, 1980, 1981); Hackett and Carolane (1982); Neve (1991); Small (1996*a*); Munro and Small (1997).

Fig. 171.
Hyssop *(Hyssopus officinalis)*, from Hallier (1880-1888).

Hyssopus

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

Hyssopus has about five species of perennial shrubs and subshrubs, found from southern Europe and the Mediterranean region to central Asia.

Hyssopus Officinalis L.

Scientific (Latin) Synonyms

H. aristatus Godr., *H. vulgaris* Bubani

English Names

Hyssop
Also: common hyssop, garden hyssop
[Hedge hyssop refers to species of *Gratiola*, water hyssop includes species of *Bacopa*, and the genus *Agastache* has several species with hyssop in their names, including anise hyssop discussed in detail in this book. Roman hyssop is *Satureja thymbra*, discussed in the Genus Notes for *Satureja.* Persian hyssop is *Thymus capitatus*, discussed in the Genus Notes for *Thymus.*]

French Names

Family: Labiées, famille de la menthe
Hysope (f)
Also: herbe sacrée (note below association with religion; however, as explained in Curiosities, this is probably not the biblical hyssop), hiope, hys(s)ope (officinale)

Description, Taxonomy, and History

Hyssopus officinalis is a subshrub (a semi-woody perennial), 20-70 cm tall (to as much as a meter in favorable circumstances). The leaves have been described as "nearly evergreen" (Morton 1976) and "semievergreen" (Crockett and Tanner 1977). There are whorls of small, deep bluish-violet flowers in wild plants. In cultivars, white, rose, pink, and red flowers are also known. The plant is native to Morocco, Algeria, southern Europe, Turkey, the Caucasus of Georgia, Iran to southern Siberia, and the western Himalaya; it seems to be naturalized in western and central Europe (Mansfeld 1986). In its native area hyssop is found on dry banks and among rocks and ruins (le Strange 1977). It is introduced in North America, occurring sporadically on dry pastures and roadsides from southeastern Canada to North Carolina (Muenscher and Rice 1955). Several wild subspecies are recognized (Mansfeld 1986), and cultivated plants are sometimes separated as subsp. *officinalis.*

Hyssop was mentioned as a medicinal plant by ancient Greek physicians (see Medicine). The classical Romans used it as a base for a herbal wine (Barash 1993). Hyssop has been cultivated in central Europe since the Middle Ages as a medicinal plant and condiment. In the 13th century hyssop oil was used by religious orders to flavor soups and sauces (le Strange 1977). In former times the strongly, pleasantly aromatic herb was strewed on floors to control odors, and the volatile oil was considered a deterrent for fleas and lice (Page 1980). The culinary use of hyssop in history is limited, and has declined since the Middle Ages (Barash 1993). Like other herbs with quite pungent flavors, it has become less popular.

Uses

Flowering tops and leaves of hyssop are sometimes used to flavor teas, tonics, non-alcoholic beverages, vegetable dishes, soups, salads, sauces, pickles, meats, and candied products. Hyssop used to be favored as a flavoring for gamy meats (Crockett and Tanner 1977). Such usage has largely disappeared (Morton 1976). The plant has an agreeable camphor-mint aroma. The flavor has been described as penetrating but light, between rosemary and savory, neither strongly camphorous like the one or bitter like the other (Mességué and Peter 1982). The taste is strong, hot, pungent, bitterish and somewhat minty. However, its lack of appeal has resulted in hyssop generally not finding much use today for flavoring dishes. It should be used sparingly. The essential oil or hyssop extract is employed in liqueurs such as Benedictine and Chartreuse, non-alcoholic beverages, ice cream, candy, and baked goods (Furia and Bellanca 1975). The oil has also been used in herbal essences, herbal-scented perfumes, soaps, creams, and other cosmetics.

Hyssop is also grown for medicinal use, as discussed later, as an ornamental, for bee pasturage, and to prevent soil erosion. It makes a good ornamental as it grows well in rather poor soils, is easily propagated from seed, is fairly hardy, and withstands clipping. Hyssop is sometimes grown as a low hedge (Crockett and Tanner 1977). Rinzler (1990) furnishes instructions for obtaining and using a greenish dye from the leaves, for natural wool fabrics.

Fig. 172.
Hyssop *(Hyssopus officinalis)*,
from Thomé (1903-1905).

Recipe Sources

Leyel (1938) has recipes entitled Hyssop flip and Queen Elizabeth's cordial electuary of hyssop. Crowhurst (1973) presents recipes for Hyssop honey and Hyssop sauce. Michael (1980) gives recipes for Meat balls with hyssop, Hyssop syrup, Fresh apricot ran with hyssop, Hyssop dessert, and Hyssop tea. Holt (1991) presents recipes for Roast duck with a sauce of morello cherries and hyssop, and Raspberry and hyssop shrub [a shrub is a fruit-based cordial, like the sherbet of the Middle East]. Barash (1993) has two recipes with hyssop flowers: Avocado and papaya salad with hyssop vinaigrette and Hyssop stuffed pork.

Other recipes are: Hyssop tea (Grieve 1931; Marcin 1983); Botanic beer (Stuart 1979); Cauliflower and hyssop (Larkcom 1984); Hyssop tissane (Leggatt 1987); Peach tart with hyssop (Holt 1989).

Importance

Hyssop is grown commercially for oil in southern France, Italy, Yugoslavia, Bulgaria, Hungary, Germany, the former Czechoslovakia, the Crimea, and Kashmir in India (Mansfeld 1986). Verlet (1993) estimated the annual world value of hyssop essential oil to be $230,000.00 (U.S.). Lawrence (1993*a*) estimated annual world production of herb at 1800 kg worth about $32 million (American). Culinary use of hyssop is limited. The major use in North America is as an ornamental.

Cultivation Notes

Soil

Hyssop grows well in dry, rocky, limestone soils. Light, well-drained soils are recommended. Crockett and Tanner (1977) state that hyssop will thrive in any well-drained soil. A somewhat acidic pH tolerance range of 5.0-7.5 has been reported (De Baggio 1987), although alkaline soils have been recommended (Muenscher and Rice 1955; Sváb 1992). Older plants need to be provided with nitrogen-containing fertilizers for good productivity (Sváb 1992). Commercial fertilization information is given in Sváb (1992).

Climate

Hyssop grows naturally in warm areas, but will survive in protected locations as far north as southern Canada. Marcin (1983) stated that it will survive winter temperatures as low as -37°C. Galambosi (personal communication) has observed excellent survival of hyssop exposed to winter temperatures of -43°C. Plants should be cultivated in a sunny location, but will grow in partial shade (Muenscher and Rice 1955).

Propagation and Cultivation

Hyssop is grown mostly from seeds. Commercially, hyssop seedlings are first established, then transplanted into the field. The plant can also be reproduced by dividing it, and by taking cuttings. To encourage new growth, the

stems should be cut back to the ground in the fall or spring of each year (Crockett and Tanner 1977). Hyssop should be discarded or divided and re-established every 3 or 4 years, as the plants become woody, producing less foliage. Suggestions for the commercial cultivation of hyssop are given in Sváb (1992).

Harvest and Storage

In cultivation, hyssop may have a life span of 7-9 years (Sváb 1992). Commercial harvest typically occurs 2 years after planting, immediately after flowering; harvest is possible after 1 year (the plants flower the first year), but with about half the yield of 2-year-old plants. Yields (fresh weight) of hyssop are generally 2.0-3.0 t/ha in the first year, and 6.0-10.0 t/ha in subsequent years, with an essential oil yield of 8-15 kg/ha (Sváb 1992). Galambosi et al. (1993) observed that there was considerable variation in herb yield in Finland among plants from different sources. They found that total fresh herb yield was 0.5-3.2 kg/m^2, and dry leaf yield was 67-326 g/m^2.

For out-of-season use, the home gardener can harvest tender upper stems and flowering shoots, dry them, strip away material from the larger stems, pulverize the remainder, and keep it in tightly closed jars (Muenscher and Rice 1955).

Example Cultivars

Alba (Albus), Grandiflora, Purpurascens (= Rubra?), Rosea, Sissinghurst

Additional Notes

Chemistry

The essential oil of hyssop contains pinocamphone, isopinocamphone, -pinene, ß-pinene, camphene, -terpinene, pinocampheol, cineole, linalool, terpineol, and other constituents (Simon et al. 1984). Rinzler (1990) states that half of the oil is made up of pinene, which

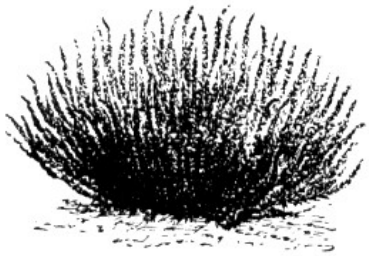


Fig. 173.
Hyssop *(Hyssopus officinalis)*,
from Vilmorin-Andrieux et C^{ie} (1883).

contributes the smell and taste of turpentine. Lawrence (1992) reviewed the results of a study of 36 different strains, and found variation in the major components, isopinocamphone pinocamphone, pinocarvone, and 1,8-cineole. Lawrence also found an exceptional clone with 61.7% ß-phellandrene, a very unusual principal component of essential oil in the Labiatae. Tsankova et al. (1993) found 1,8-cineole, isopinocamphone and ß-pinene were the major constitents of wild *H. officinalis* in Bulgaria, whereas commercially cultivated plants predominantly contained isopinocamphone, pinocamphone and ß-pinene, but lacked 1,8-cineole. Kerrola et al. (1994*a*) studied several chemically divergent accessions, which also differed notably in odor. They found that pinocamphone, isopinocamphone, and pinocarvone were the main volatile compounds observed, and the relative proportions of these ketones served to distinguish the accessions, despite notable annual variation during the three consecutive years of cultivation.

Medicine

The Greek Hippocrates (460?-377? B.C.), known as the Father of Medicine, prescribed hyssop for pleurisy and bronchitis (le Strange 1977). The Greek physician and writer Galen (ca. 130-ca. 200) burned it with brimstone, recommending the fumes to relieve inflammations of the throat (le Strange 1977). In folk medicine a poultice of hyssop leaves has been used to remove discoloration around bruised eyes. Leaves have also been used to treat asthma, rheumatism, sore throat, wounds, ulcers, and tumors (Simon et al. 1984). Hyssop has also been employed as a tonic, stimulant, and in various other ways.

In modern medicine hyssop is considered a reasonably effective treatment for mild irritations of the respiratory tract that accompany the common cold (Tyler 1993). Experimental extracts have shown promise against *herpes simplex* (Foster and Duke 1990). Hyssop is generally regarded as safe, without concern expressed in the scientific literature about its consumption (Tyler 1993).

Nutrition

Hyssop has not been shown to supply nutrients significantly.

Curiosities

• "Hyssop" is a term well known in scripture. For example, in Psalm LI,7: "Purge me with Hyssop, and I shall be clean;" in Leviticus, XIV, hyssop is mentioned as a purifying plant used by the priests to cleanse lepers; and at the Passover, Moses commanded the Israelites to take a bunch of hyssop and dip it in the blood of the

lamb to sprinkle the lintel and doorposts, after which none were to pass out until morning. However, the hyssop in question is thought not to be *Hyssopus officinalis*. The name hyssop, originating from the Greek form of the Hebrew *ezov*, appears to have been a collective term for several food plants in the Holy Land (Fleisher and Fleisher 1988*a*). It seems to have principally designated *Origanum syriaca* L. (Fleisher and Fleisher 1988*a*; see the discussion of *O. syriaca* in this book for additional information).

• In Sicily hyssop was said to keep off the evil eye and evil magic (Fox 1933).

• European women supposedly pressed hyssop leaves in their prayer books in the belief that the strong aroma would keep them awake during services (Barash 1993).

• In the Victorian language of flowers, hyssop signified cleanliness (Barash 1993).

• Hyssop is believed to be the best companion plant for grape vines, both plants in theory benefitting by growing close together (Erichsen-Brown 1975).

Problems and Potential

This old-fashioned herb has limited use, primarily as a medicinal and flavoring plant of commerce and as a garden ornamental. Its use in the home garden for culinary purposes is insignificant and is certain to remain so.

Selected References

Grieve (1931); Simon et al. (1984); Sváb (1992); Svoboda et al. (1993).

Juniperus

Family: Cupressaceae (cypress family)

[Sometimes placed in Pinaceae.]

Genus Notes

Juniperus has about 60 species of evergreen trees or shrubs, widely dispersed in the Northern Hemisphere, with one in eastern Africa. There are 13 species in North America north of Mexico (Adams 1993). Juniper berries of various species have been used medicinally since antiquity. The berries of several species are consumed as food by birds. Consumption of berries or oil of species other than *J. communis* by humans should not be attempted, as some may be toxic; the medicinal use of small amounts of oil of some species of juniper has resulted in death on occasion (Chandler 1986). Many of the species are grown as ornamentals and some are harvested for lumber. Uphof (1968) summarizes the economic value of 16 species. Use of *Juniperus* species for food is rare.

Fig. 174.
Eastern red cedar *(Juniperus virginiana)*,
from Sargent (1890).

The dull red wood of *J. virginiana* L., eastern red cedar, a species indigenous to eastern North America, has long been valued as a moth-repellant for lining wardrobe closets and chests. The wood is not very strong, but is useful for carving, and to make furniture, baskets and pencils (Roecklein and Leung 1987). The leaves are used for incense (Roecklein and Leung 1987). The oil has been used in medicines, perfumes, insect repellents, insecticides, shoe polish, and in microscopy as a clearing agent and immersion oil (Chandler 1986; Roecklein and Leung 1987). The oil has also been used to treat gonorrhea and induce abortions, but deaths have resulted (Chandler 1986; note additional comments on cedarwood oil, below). This species was named bâton rouge by French settlers in Canada, meaning "red stick," and after they encountered the same tree in Louisiana, they applied the name to the present capital city of that state, Baton Rouge (Hosie 1979). In the southern U.S., the trees may exceed 18 m in height (Roecklein and Leung 1987). *Juniperus virginiana* is one of the main species of *Juniperus* used to produce "cedar-wood oil," along with *J. ashei* Buch. (R.P. Adams 1987). Cedarwood oil is the eleventh most important essential oil in commerce in the world, with a value of $9.8 million (U.S.) in a recent survey (Lawrence 1993*a*). Verlet (1993) estimated the annual world value of cedarwood essential oil to be $11 million (U.S.). The U.S. imported 288 451 kg of cedarwood oil worth $1,775,500 in 1991; 365 855 kg worth $1,276,100 in 1992; and 338 179 kg worth $1,693,600 in 1993 (Dull 1994*a*). Chinese cedarwood oil is from *Chamaecyparis funebris* (Endl.) Franco, and a recent survey indicated it has an annual world commerce value of about $3.2 million (Lawrence 1993*a*).

Juniperus Communis L.

English Names

Common juniper
Also: juniper, melmot berry, mountain juniper
[Marcin (1983) also gives the colorful names horse-saver and bastard-killer.]

French Names

Family: Cupressacées, famille du thuya
Genévrier commun (m)

Fig. 175.
Tree form of common juniper *(Juniperus communis)*, from Hatter (1988).[The name is sometimes spelled gènevrier commun in France (Fournier 1947-48).] Also: genève, genevrier, genévrier, genèvrier, genévrier de montagne, genévrier ordinaire, genibre, genibré, genièvre, genièvre commune, péteron, péterot, pétron, pétrot, piket

Warning

Consumption of juniper berries should be limited. Juniper should not be consumed if pregnant or suffering from kidney disease (see Medicine).

Description, Taxonomy, and History

Juniperus communis, the most widespread of juniper species, is indigenous to North America and Eurasia. Common juniper typically grows in rocky, infertile soils, in fields, meadows, pastures, open woods and other settings, almost from sea level to alpine sites. The species has needlelike leaves, about 1 cm long, arranged in three's. Common juniper is a very variable species found in several forms, including a small tree up to 10 m (rarely to 15 m) of pyramidal or columnar form; an erect shrub, and a prostrate, mat-forming shrub. Tree forms are much commoner in Eurasia than in North America. Five varieties merit recognition, three of these in North America (Adams 1993). Most native common junipers of North America belong to subspecies *depressa* (Pursh) Franco (Adams 1993).

Small cones, some male, others female, develop in early summer at the base of a few of the needle-like leaves. Male cones are yellow while female cones are hard, pungent, and bluish-green with a whitish, waxy coating. Female cones become fleshy berries, requiring 2 years to ripen (sometimes 3), and turning gradually from green to blue-black. According to Brouk (1975), the fleshy berry-like structure surrounding the seeds of juniper is an *aril.* [Esau (1960) defined an aril as a fleshy outgrowth arising at the base of the unfertilized seed and enveloping the seed.] Strictly, a "berry" is a fleshy or pulpy fruit derived from the ovary of a single flower, and the term is inappropriate for the junipers since the fleshy structure containing seeds is derived from 3 to 6 fleshy cone scales, each 1-ovuled; however, the term berry is universally accepted (Weiss 1988). Both unripe green and ripe blue-black berries will be found on the plant. The green-blue bloom on the surface of the fresh berries tends to disappear after drying. For the most part, plants produce male cones or female cones, rarely both. Since female cones (berries) are the culinary part of the plant, the female plants are of principal interest here.

Juniper has been used for folk medicinal purposes at least for hundreds of years in both the Old and New Worlds (see Medicine). Its use as a beverage is also centuries old; a fermented brew made with the fruits was produced in France, and French traders may have introduced the recipe to Indigenous People of the Northwest Territories, Canada (Kuhnlein and Turner 1991). Boughs, with or without the fruit, were employed to make a beverage tea by various native groups in Canada, from British Columbia to the Maritimes (Kuhnlein and Turner 1991). The first use for what came to be termed gin has been credited to the Dutch medical professsor Franciscus Sylvius (1614-72) (Blumenthal 1992*a*). Although not commonly eaten today, juniper was also widely used as a condiment in mountainous areas of Europe where the plants grow naturally (Stobart 1977).

Uses

Juniper fruits are often fermented to produce alcoholic beverages such as beer and brandy. In France they are fermented with barley to make *genevrette*, a kind of beer (Turner and Szczawinski 1978). Essential oil is also extracted from juniper fruits, and is used largely as a component in flavoring for gin, liqueurs and such cordials as sloe gin. (The sloe is *Prunus spinosa* L., a Eurasian tree which produces cherry-like fruits about 1-1.5 cm wide, used to flavor gin and liqueurs, as well as soft drinks, ice cream, candy, and baked goods.) Gin has been one of the most popular alcoholic beverages of the Western world for well over 300 years.

Fig. 176.
Common juniper *(Juniperus communis)*, from Köhler (1883-1898).

Juniper fruits, fresh or dried, are sometimes used directly as food, generally crushed before use. "Although juniper berries have a limited application in cookery, they are indispensable" (Mességué and Peter 1982). Ground roasted berries are sometimes used as a substitute for coffee (Chandler 1986) and as an alternative for pepper (Morton 1976). The dried berries can be ground in a peppermill. The aroma of juniper is bitter-sweet, very reminiscent of gin, pine, and turpentine. The taste is sweet, pungent, slightly burning, with a bitter aftertaste. Berries are made into a conserve in Sweden (Turner and Szczawinski 1978). The aromatic, resinous flavor goes well in marinades and with wild game, beef, pork, pickled fish, stuffings, pâtés, sauerkraut, gravies and potatoes (Garland 1979; Duke 1985; Norman 1990). The flavor also combines well with garlic and other aromatic herbs such as marjoram and rosemary. As the flavor is strong, juniper berries should be used very sparingly. Rinzler (1990) equates the flavor of 1 teaspoon of juniper berries to ½ cup gin.

Juniper leaves have also been eaten with food, notably with grilled fish (Garland 1979). Burning juniper wood can be used to flavor and cure smoked meat and fish. Juniper wood is often added to fuel for smoking ham and bacon (Launert 1981).

Extracts and oils are used in soft drinks and other non-alcoholic beverages, frozen dairy desserts, candy, chewing gum, baked goods, gelatins, puddings, meat products, and condiments (Furia and Bellanca 1975; Morton 1976; Duke 1985). The oil is also employed for fragrance in soaps, detergents, creams, lotions, shampoos and perfumes (Duke 1985).

Juniper berries have been used as a source of dyes in the past. Brown and purple dyes can be obtained from the berries and roots. Juniper bark was once used as cordage (Roecklein and Leung 1987). In hot climates incised trees yield gum and varnish (Duke 1985). Junipers are popular ornamentals, and are widely planted in parks and around homes. Deer and moose graze juniper, and sheep eat the fruit (Duke 1985).

Recipe Sources

Leyel (1938) has recipes for Conserve of juniper and Rob of juniper. ["A rob is the juice of a fruit made so thick by the heat either of the sun or the fire that it is capable of being kept safe from putrefaction".] Brackett and Lash (1975) have recipes for: Juniper and mushroom sauce for roast chicken, duck or two game hens; Sauerkraut with juniper berries and wild carrot seed; Juniper ratafia; and Juniper marinade for wild game or beef. Turner and Szczawinski (1978) present recipes for Juniper-bough tea, Juniper-berry tea, Juniper coffee, and Juniper mocha. Rose (1979) gives recipes entitled Indian stew with lamb and Ollie's onions. Bremness (1988) has recipes for: Lamb's kidneys sautéed with juniper, Pork chops marinated with juniper and garlic, Cabbage and juniper, and Mulled pears with juniper. Holt (1989) gives recipes for: Game pâté with juniper berries; Wild duck with juniper berries, and Apple and herb [juniper] jelly. Norman (1990) presents recipes for Potatoes with bacon and juniper and Onion and juniper bread.

Other recipes are: Juniper berry butter sauce (Bryan and Castle 1974); Game pâté with juniper berries (Boxer and Back 1980); Pork spare rib with juniper berry stuffing (Michael 1980); Juniper lamb stew (Hughes 1982); Juniper-berry tea (Marcin 1983); Juniper marinade (Schofield 1989); Fillet of beef with juniper berries and *crique ardechoise* (potato pancake) (Holt 1991).

Importance

Juniper berries are widely harvested from wild trees in northern areas for local use, especially in southern Europe. Commercial crops have been grown in Canada and the

Fig. 177.
Common juniper *(Juniperus communis)*,
from Hallier (1880-1888).

U.S., but the major producing countries are Austria, France, Hungary, Italy, Germany, Poland, Spain, and the former countries Czechoslovakia, the USSR, and Yugoslavia (Chandler 1986). Most berries grown for commerce come from eastern Europe (Norman 1990). Juniper berries are rarely used as a culinary ingredient in the kitchens of English-speaking countries. Verlet (1993) estimated the annual world value of juniper berry essential oil to be $1,200,000.00 (U.S.).

Cultivation Notes

Soil

Junipers grow naturally on dry, rocky soil. A pH range of 4.5-7.5 has been reported to be tolerated (Duke 1978). Variety *megistocarpa* Fernald & H. St. John grows on sand dunes, serpentine, and limestone barrens in Newfoundland, Nova Scotia, and Quebec (Adams 1993).

Climate

There is considerable variation in the tolerance of common juniper to climate, the plant surviving northwards into the Arctic. Common juniper occurs in most of Canada, much of Alaska, and in the colder areas of the United States. An open, sunny position is best.

Propagation and Cultivation

Seeds take a considerable period to germinate, and plants are more easily established from cuttings. Junipers are often used as foundation plantings near homes, and will tolerate a range of conditions and soils.

Harvest and Storage

Because the plants are covered with small, prickly leaves, gloves should be worn during harvesting. The berries are picked when they are completely ripe, and are dried in the sun or in a well-aerated, shady location, and stored in an air-tight container. They are best used within a year of harvest (Page 1980).

Example Cultivars

Numerous ornamental cultivars are available (see, for example, Bailey and Bailey 1976; Huxley et al. 1992). It should be noted that berries of some garden cultivars have been selected for ornamental appearance, and may not be suitable for culinary purposes (Page 1980).

Additional Notes

Chemistry

Juniper berries usually contain 0.2-3.4%, usually 1-2%, volatile oil, depending on geography, altitude, ripeness and other factors. The volatile oil is made up mostly of

Fig. 178.
Common juniper *(Juniperus communis)*,
from Syme et al. (1863-1886).

monoterpenes (ca. 58%), mainly -pinene, myrcene, and sabinene (Duke 1985). The chemistry of juniperberry oil is reviewed by Lawrence (1987d). As much as 33% of the berries is made up of sugars, and about 10% is resin (Chandler 1986).

Medicine

In classical herbal medicine in Europe, juniper berries, wood, and oil have been used to treat numerous complaints, including arteriosclerosis, arthritis, bronchitis, colic, cancer, dysentery, gonorrhea and other venereal diseases, gout, hysteria, rheumatism, snakebite, tuberculosis, worms, heart, liver, and kidney disease, polyps, swellings, tumors, and warts (Grieve 1931; Duke 1985). American Indians used juniper to treat a variety of ailments (Duke 1986). The Laplanders and Scandinavians used juniper berry tea as a tonic (Turner and Szczawinski 1978). After discussing many of the traditional folk uses of juniper, Chandler (1986) concluded "as a consequence of serious potential side effects, its use as a folk medicine should be discouraged."

Juniper extracts have tannins, which are astringent, and may provide a rationale for some folk medicinal uses, such as for the treatment of diarrhea, skin sores, and hemorrhoids (Chandler 1986).

Juniper contains a diuretic principle (an agent promoting urination), 4-terpineol or terpinen-4-ol, that has been used medicinally. About 50 commercial preparations, mostly "teas" meant to be used as diuretics, are marketed in Canada (Chandler 1985*a*). Because juniper has a history of relieving "woman's problems," its use has been promoted as a herbal therapy for pre-menstrual syndrome (Chandler 1985*a*). However, the diuretic component may produce kidney irritation (Duke 1985), and sufferers of kidney complaints are warned never to take juniper oil in any form (Page 1980). Juniper is no longer recommended for kidney disorders (Duke 1985).

Juniper and juniper extracts should not be consumed by expectant mothers because they increase intestinal movements and uterine contractions, and indeed in rare cases can cause abortion (Duke 1985). Juniper causes contact dermatitis in some people (Chandler 1986).

Juniper is "generally regarded as a safe plant," and "consumption of a few berries should be harmless in most cases" (Chandler 1986). Despite its long-established use as a culinary plant, juniper berry consumption should be limited. "If the berries are eaten freely symptoms of poisoning follow with possible serious results" (Quelch 1946).

Nutrition

Juniper beverages have been used occasionally as an antiscorbutic, i.e. to counteract vitamin C deficiency (Chandler 1986). However, juniper is used in very limited quantities for culinary purposes, and so is not a source of nutrients.

Curiosities

• The Old testament records that the prophet Elijah took refuge under a juniper tree to avoid persecution by King Ahab (Bryan and Castle 1974).

• The juniper tree is revered in Catholic countries because of the legend that a juniper bush hid the infant Jesus and the Virgin Mary from Herod's army while they were fleeing into Egypt (Leyel 1938; also see Curiosities for rosemary, which is also reputed to have assisted the Holy Family in its flight).

• Gin gets its name from the plant responsible for its characteristic flavor. The word gin traces to the Latin *juniperus* through the Old French word for the plant, *genèvre* (Page 1980). The name juniper is derived from a Celtic word, *jehupus*, meaning bitter (Toussaint-Samat 1992).

Fig. 179.
Common juniper *(Juniperus communis)*,
from Hatter (1988).

• Castleman (1991) attributes the invention of gin to the Dutch in the 17th century, and the origin of the phrase "in Dutch" to the English, who after drinking too much gin described themselves as in Dutch (i.e. in trouble). "Dutch courage" (bravery due to intoxicants) is another of the international slurs that seems traceable to gin.

• In the Middle ages in Europe it was believed that a juniper planted by the front door kept witches out -unless they correctly guessed the number of its needles (Castleman 1991).

• In Europe, juniper branches were often burned as a fumigant during plagues, for example in French hospitals during the smallpox epidemic of 1870 (Garland 1979).

• In North America, juniper was used by Indian peoples as a fumigant, deodorizer, disinfectant, and protective agent against bad spirits, ghosts, and diseases (Turner and Szczawinski 1978). It was included in the wash water to cleanse bedding and personal effects of those who had just died.

• One kg of juniper berries is typically used to flavor over 400 L of gin (Stuart 1979).

Problems and Potential

Well established commercial crops in Europe make it difficult to grow juniper competitively for commercial extracts in North America. Wild plants are also easily harvested for commercial purposes, and so juniper can not be considered to be a promising potential cultivated crop in North America.

Common juniper is not really suited for culinary plantings in home gardens, since the plant is widespread in much of North America and a supply of berries can be easily harvested from wild plants or ornamental plantings.

Selected References

Turner and Szczawinski (1978); Chandler (1986); Adams (1993).

Fig. 180.
Bay laurel *(Laurus nobilis)*, from Köhler (1883-1898).

Laurus

Family: Lauraceae (laurel family)

Genus Notes

Laurus comprises two species of evergreen trees or shrubs native to southern Europe, the Canary Islands, and the Azores.

Laurus nobilis L.

English Names

Bay laurel
Also: Grecian laurel, laurel (tree), Mediterranean laurel, noble laurel, poet's laurel, Roman laurel, sweet laurel, tree laurel, true laurel, (sweet) bay (tree), victor's laurel
[The plant is called "bay laurel," and the commercial product is called "bay leaf" (plural "bay leaves"). "Bay" can be used either for the plant or the condiment.]

French Names

Family: Lauracées, famille du laurier
Laurier commun (m)
Also: laurier à jambon, laurier d' Apollon, laurier franc, laurier noble, laurier ordinaire, laurier des poètes, laurier sauce (laurier-sauce)
[The French common name for the commercial product is "feuilles de laurier."]

Bay laurel should not be confused with plants With similar sounding names, such as bayberry (*Myrica pensylvanica* Lois.), a native of eastern North America that provides bayberry oil used in perfumes and candlemaking; California bayberry (*Myrica californica* Chum.), a native of the Pacific states of the U.S.; California bay (*Umbellularia californica* Nutt.), a native of western North America, also in the Lauraceae, which produces more potent-tasting aromatic leaves than bay laurel, used for the same culinary purposes (Creasy 1982) [the odor released can cause headaches, dizziness, and nausea in susceptible individuals; as a result, the plant has acquired the name "headache tree" (McClintock 1993)]; *Kalmia latifolia* L., mountain laurel, a poisonous, eastern North American bog-loving plant sometimes grown as an ornamental [several other species of *Kalmia* are also called laurel; according to Rinzler (1990), the constituent andromedotoxin in *Kalmia* is so potent it can poison honey made by bees visiting its flowers]; West Indian bay tree (*Pimenta racemosa* J.W. Moore, a relative of allspice, *Pimenta dioica* (L.) Merrill), a native of the Caribbean region, whose oil is used in perfumery and to make bay-rum; and cherry (or English) laurel (*Prunus laurocerasus* L.), a native tree of southeastern Europe and Asia minor (Rosengarten 1969; Stobart 1977; Huxley et al. 1992). Cherry laurel has sometimes been mistaken for bay laurel with disastrous results (Grieve 1931); cherry laurel produces prussic acid, a virulent poison (see discussion of hydrocyanic plants in lemon grass Curiosities). Portuguese (or Portugal) laurel (*Prunus lusitanica* L.) is another hydrocyanic plant that has caused poisoning by virtue of being mistaken for bay laurel (McClintock 1993).

Note

Bay leaves used to flavor dishes should always be removed before food is served, The fibrous quality remains despite long cooking, and the sharp-edged leaves can cause internal injuries. The leaves can lodge in the throats of children, causing suffocation. Store away from children and pets.

Description, Taxonomy, and History

Bay laurel is a pyramidal, evergreen, broadleaf shrub or tree that may exceed 20 m in height. Its leaves are stiff and spicy. Bay laurel is native to western Asia Minor and perhaps parts of the European Mediterranean (Rosengarten 1969). The plants occur naturally in sheltered sunny mountain valleys on rich soils. Yellowish or greenish-white flowers, about 3 mm across, are produced in the spring. The flowers are generally either male or female, occasionally hermaphroditic, all on the same plant. The berries are green when young, turning dark purple or black as they ripen towards the autumn, when about 15 mm in diameter. Bay laurel was distributed throughout the Mediterranean by man over 2000 years ago, and it was familiar to ancient Greek and Roman civilizations (Stobart 1977). It is now cultivated in many subtropical regions of the world, including those around the Mediterranean, the Caribbean, Central America, and the warmer parts of North America.

Uses

The leaves of bay laurel are fragrant and sweet-scented with a lemon and clove overtone. Fresh bay leaves are rather bitter. The bitterness is lost after a few days of drying. The very old, dried bay leaves that most people use are regarded by purists as a poor substitute for fresh or recently dried leaves (Stobart 1977). As the flavor of fresh leaves is stronger than that of dried leaves, half a fresh leaf should

Fig. 181.
Bay laurel *(Laurus nobilis)*, from Thomé (1903-1905).

be used where a whole dried leaf is required (Mességué and Peter 1982). The taste intensifies through cooking, and indeed bay is one of the few herbs that should be added early in cooking. Commercial bay leaves are sold whole or ground (Prakash 1990).

The leaves are important in the cooking of many Mediterranean countries. Bay is the primary taste of traditional "bouquet garni" used in many French dishes. One leaf is sufficient to flavor family-sized portions of stews or soups; the dried bay leaf produces a concentrated flavor and should be added cautiously. The leaves are added (either whole or ground) to stuffings, soups, stews, chowders, tomato sauces, gravies, pickling spices, vinegars, puddings, salads, and vegetables, as well as meat, game, fish, and poultry dishes. Ground bay is an important ingredient of liver pâté. The dried leaves can be brewed into a herbal tea. Bay leaves are sometimes boiled in milk used to flavor creams and custards. Bryan and Castle (1974) suggest adding bay to a martini or a glass of 7-Up. The dried fruits are also used for flavoring. The berries are pressed and distilled to give a thick green oil used in a liqueur called "fioravanti" (Prakash 1990). In China the leaves are used to package rice (Morton 1976). The leaves are sometimes packed around licorice and placed in boxes of dried figs to discourage weevils (Stobart 1977). The leaves are also placed in canisters of flour or cereal products to discourage insects (Kublick 1990).

Ground bay leaves are added to commercial products such as delicatessen-style prepared meats like corned beef, chicken loaf, mortadella (Italian bologna), pressed sausage, and luncheon meats. Ground leaves are also added to barbecue sauces, preserves, and pastries (Farrell 1985). Cracked bay leaves are a common ingredient in commercial whole pickling spice (Prakash 1990).

The essential oil of the leaves is used commercially in preparation of pickling spice, in the flavoring of vinegar (Rosengarten 1969), and in condiments (Morton 1976). The oil is also employed as a scent for soaps, perfumery, candles, nonalcoholic beverages, baked goods, confectionery, meats, sausages, and canned soups. The berries are cold-pressed in the manufacture of laurel oil for use in medicines (Farrell 1985). [Bay laurel oil should not be confused with the oil of West Indian bay (*Pimenta racemosa*, mentioned in Genus notes).] The fat from the fruits has also served in making soap and candles, and in veterinary medicine (Furia and Bellanca 1975; Duke 1985).

In frost-free areas, bay laurel is grown as an ornamental and as a screen and hedge, for which its tolerance to clipping makes it quite suitable. In Europe, large, well-developed potted specimens serve as "gate guards" in establishments such as restaurants and banks, with several large nurseries, mainly in Belgium, specializing in rather elaborately trained forms (Raviv, personal communication). Bay laurel is a very hardy pot plant which can withstand drought, light frost, and low light intensity (Raviv et al. 1983). Bay wood resembles walnut, and can be used for cabinetry (Duke 1985).

Recipe Sources

Belsinger and Dille (1984) present 14 recipes, notable of which are Bay hot cross buns, Pecan tomato sauce with bay, and Brisket of beef with bay mustard sauce. Bremness (1988) gives recipes for Game soup with bay and Escalope of veal with bay. Holt (1991) has recipes for Bay tree brochettes of cod with yellow pepper and black olives and Saffron orzo [rice pasta] with fresh bay leaves and lemon. Other recipes are: Sweet pickles with bay (Hériteau 1975); Bay tea (Marcin (1983).

Importance

Bay leaves are among the most important herbs in the international spice trade. Most of the bay leaves entering international trade are from wild rather than cultivated plants (Greenhalgh 1979). Turkey is the largest exporter of bay leaves followed by Greece. Bay laurel is cultivated commercially in these countries as well as Portugal, Spain, France, Italy, the former Yugoslavia, Morocco, China, and Central America. There is limited production in California. Although U.S. bay is the most visually attractive, its flavor is regarded as poor. The domestic product represents less than 1% of all bay leaves sold in the U.S. (Greenhalgh 1979). In 1988, the U.S. imported 666 t of bay leaves valued at $934,000.00, mostly from Turkey (Anon. 1989*b*). The average annual value of imports for bay laurel and thyme (U.S. trade statistics combine these) was $3.9 million over the period 1990-94 (Buzzanell et al. 1995). Once again, Turkey was the main supplier of bay (Buzzanell et al. 1995). There is some international trade in fresh branches for ornamental purposes, since these have excellent vase life and serve well as green decorations in bouquets (Raviv, personal communication).

Essential oil produced from bay is of minor value. Verlet (1993) estimated the annual world value of bay essential oil to be $720,000.00 (U.S.), and that of "laurel leaf" essential oil to be $360,000.00 (the value of "pimento bay" (*Pimenta racemosa*) was given at $330,000.00).

Bay is also grown horticulturally on a commercial scale as a garden ornamental, notably in Holland and Belgium.

Fig. 182.
Bay laurel *(Laurus nobilis)*,
from Bailey (1900),
showing trained specimens in pots.

Cultivation Notes

Soil

Bay laurel prefers a fertile, moisture-retentive but well-drained soil (Prakash 1990). Reported pH tolerance ranges are 4.5-8.2 (De Baggio 1987) and 4.5-8.3 (Duke 1979). In regions subject to freezing temperatures, bay laurel is grown in a tub filled with equal parts of sand, loam, and peat. This allows the plant to be taken indoors during cold periods. Good drainage in the tub is essential.

Climate

Bay laurel prefers a sheltered, sunny location. It tolerates some shade (especially in hot regions) but grows well in full sun. It can withstand -5°C although this will generally cause defoliation (Huxley et al. 1992). If protected from cold drying winds and placed in a sheltered location that warms readily, bay laurel has been known to withstand occasional lows to -15°C (Huxley et al. 1992). In areas of North America experiencing freezing temperatures, bay laurel should be grown in a tub that is brought indoors during the winter. During periods of active growth, the soil in the tub should never be allowed to dry out. In winter, a sunny window with room temperature from 5 to 16°C is best. A tepid watering weekly and a slow-release fertilizer applied about November is all that is required for maintenance. Over-watering in winter is likely to kill the plant. When the tub is summered outdoors, filtered sunlight should be provided at least initially, under trees for example.

Propagation and Cultivation

Bay laurel can be propagated from either fresh or partially stratified seeds (i.e., seeds given several weeks of cold treatment). The seeds will not germinate if they dry out in storage. Seeds may be difficult to obtain in North America, but if available can be planted at a depth of 6 mm or less (Wang et al. 1993). In northern North America, propagation is chiefly by cuttings of ripened wood, rarely from seed. In warm climates, lower branches can be layered (covered with soil until they take root, and then separated as new plants). Semi-hardwood cuttings can be used, these taking 6-9 months to root (Rosengarten 1969). Commercial roofing is carried out under intermittent mist in well-drained media, usually consisting of ingredients such as spahgnum peat or perlite. Slow-release fertilizers may be incorporated in the rooting medium. Rooting can be improved and accelerated by bottom heat and plant hormone treatment (Raviv and Putievsky 1987). For the amateur, purchasing a small plant from a nursery may save disappointment (Kublick 1990). Bay laurel makes an appealing, slow-growing house plant.

Martin (1986) provides tips for growing bay laurel in tubs. To produce an attractive plant, remove side shoots and suckers; support the stem of the young plant with a small stake to ensure that the trunk grows straight; prune the top to a rounded shape; and rotate the pot every few days so that sunlight reaches all sides evenly. Repot when the root system becomes pot-bound.

Harvest and Storage

Commercial bay leaves are harvested by hand early in the day. To retain the natural green color, the leaves are dried in thin layers in trays kept in a moderately warm, sheltered location. To prevent curling, thin boards are placed over the leaves during desiccation. Drying generally takes 10-15 days (Prakash 1990). The leaves are not dried in the sun as they lose their green color and much of their essential oil. Those wishing to prepare dried leaves from their houseplants should allow a similar period of drying. Crockett and Tanner (1977) provide the following instructions for home drying. Hang sprigs in a warm, dark room, at no more than 21°C. When the leaves are partly dry but not brittle, spread them on a fiat surface, covering them with a clean cloth, over which a board is placed for about 10 days. Store the flattened leaves in an airtight container.

Example Cultivars

Aurea, Angustifolia, Crispa (= Undulata) are described by Huxley et al. (1992).

Bay laurel is generally marketed as seeds or plants in North American garden catalogs, without reference to named cultivars.

Additional Notes

Chemistry

The essential oil of bay leaves is obtained by steam distillation. The oil is a colorless liquid with a strong aromatic, camphorous odor and a cooling taste (Prakash 1990). The leaves yield 1 to 3% oil on a fresh weight basis (Simon et al. 1984). Maximum concentration of the oil seems to be developed by mid summer (Simon et al. 1984). The main constituent is cineol, up to about 70% (Raviv et al. 1983). The highest relative percentage of 1,8 cineol is reached in the spring, and the lowest in the summer (Putievsky et al. 1984). Other chemicals include eugenol, *l*-linalool, methyl eugenol, geraniol, geranyl and eugenyl esters, *l*- -terpineol, -pinene, and ß-phellandrene (Farrell 1985). The berries have 25-30% fat (glyceryl laurate), and about 1% volatile oil with similar composition to the leaves (Stuart 1979).

Fig. 183.
Bay laurel *(Laurus nobilis)*, from Nicholson (1885-1889).

Medicine

The ancient Greeks believed that bay laurel leaves were useful for treating infections of the bladder, wasp and bee stings, and general inflammation (Farrell 1985). Bay leaves crushed with other ingredients were used to treat pain from migraine headaches. Bay trees were always present in monastic gardens, as it was believed that they were antiseptic (Martin 1986). During the Middle Ages the berries of bay laurel were thought to stimulate womens' periods and were used in heavy doses to promote abortion (Rosengarten 1969). Both the leaves and berries were said to possess stimulant and narcotic properties and were formerly used to treat hysteria and flatulent colic. The berries were also used to treat diarrhea and dropsy (edema or swelling). Externally, the oil obtained from the berries was sometimes applied to sprains, which is occasionally still done in veterinary medicine (Prakash 1990). Bay laurel has been widely regarded in China as a folk cancer remedy (Duke and Ayensu 1985). In the Far East, oil from the bark and leaves is applied to scabies (Perry and Metzger 1980). Bay leaves and berries are still used in Chinese medicine (Duke and Ayensu 1985), but are rarely used in Western medicine today.

Methyl eugenol, which makes up 4% of bay laurel oil, is narcotic and sedative in mice, and the essential oil has bactericidal and fungicidal properties (Duke and Ayensu 1985). The narcotic quality is interesting in that this was one of the reputed properties in folk medicine.

Caution should be exercised when using bay leaves in cooking. It is best to remove them before serving foods because of the possibility of throat or intestine injury from swallowing the sharp-edged leaves (Kublick 1990). Because they can obstruct a child's throat, they are capable of cutting off the air supply and causing suffocation (Rinzler 1990). Because they are so tough, they may remain intact in the digestive system, obstruct the intestines, and require surgical removal (Rinzler 1990).

Quelch (1946) wrote that "the dark purple berries which appear in the autumn are poisonous, causing irritation of the stomach with violent sickness." However, this assessment does not seem to be repeated in other references and, as noted earlier, oil from the berries is expressed for food purposes, and the berries themselves are sometimes used as flavoring.

Laurel oil in toothpastes, even in hat bands, has caused dermatitis (Duke 1985). Bay leaves have caused inflammatory lip and mouth disease in susceptible individuals (Duke 1985).

Nutrition

Bay leaves contain 4.2% protein, ß-carotene, thiamine, riboflavin, niacin, and ascorbic acid (Duke 1985). Duke (1977) characterized the content of calcium, fiber, iron, riboflavin, and pro-vitamin A (ß-carotene) as high, and content of vitamin C (ascorbic acid) as very high. According to Rinzler (1990), "since bay leaves are usually removed from a cooked dish before it is served, they do not contribute any appreciable amount of nutrients to your diet."

Curiosities

• The botanical name *Laurus nobilis* emphasizes the admiration with which bay was held: *Laurus* from the Latin to praise, and *nobilis* meaning renowned or famous (Smart 1979).

• Distinguished scholars and young physicians were given berries of bay laurel ("baca lauri") and were called "baccalaureates," a term now denoting a bachelor's degree (Farrell 1985). The link of bay laurel with academic honors is also found in such phrases as "poet laureate" (Kublick 1990) and "resting on one's laurels" (Castleman 1991).

• In Greek mythology the sun god Apollo was said to have pursued the reluctant nymph Daphne until the other gods turned her into a laurel tree. When Apollo learned what had become of her, he declared the tree to be sacred and wore a wreath of bay laurel leaves as a sign of his devotion (Kublick 1990). The tree is still known in Greece as the Daphne tree (Rosengarten 1969).

• Because Apollo was the God of Light, in old Europe bay laurel was used to help celebrate the winter solstice; it was considered symbolic of the lengthening days of spring and evidence that the long winter would soon be over (Madsen 1990).

• The Oracle of Delphi held a bay leaf in her mouth to protect her from prophecies of evil (Kublick 1990).

• The emperors of ancient Rome were crowned with bay laurel leaves and the victors of chariot races received laurel wreaths as symbols of victory (Farrell 1985). In the first Olympic games held in 776 B.C., the champions wore garlands of bay laurel (Rosengarten 1969).

• In ancient Roman times it was believed that bay laurel provided effective protection from thunder and lightning. The Emperor Tiberius (42 B.C.-A.D. 37) accepted the superstition and apparently placed a laurel wreath on his head and hid under a bed during storms (Rosengarten 1969).

• The smell of the leaves was thought to protect against infection. The Emperor Nero (A.D. 37-68) fled to Laurentium (a historical site known for its bay laurel trees, west of Rome on the Mediterranean Sea) during an attack of the plague in order to breath the purified air from bay leaves (Rosengarten 1969).

• The protective reputation of bay laurel trees was still apparent in 1649 when the British herbalist Nicholas Culpepper (1616-54) stated that a man standing beside a bay laurel tree could not be harmed by witch, devil, thunder, or lightning (Kublick 1990).

• It was fashionable at dinners during the Middle Ages to boil bay leaves with orange peels for use in finger bowls (Farrell 1985).

• The bay laurel tree was generally regarded as protection from bad luck in Italy and there was a superstition that when a bay laurel died, a great disaster would follow. Indeed, in 1629 a pestilence broke out immediately after bay laurels in the Italian city of Padua sickened and died, thus prolonging the belief (Rosengarten 1969).

• Bay laurel withstands a few degrees of frost for a few days, and then succumbs. This seems to have promoted the legend that in a hard winter, when the bay trees die, death will follow (Martin 1986). Shakespeare wrote in Richard II:

'Tis thought the king is dead.

He will not stay

The bay trees in our country all withered.

• As noted earlier, the Caribbean *Pimenta dioica* is used to make bay-rum. In the early days of the Pure Food Law in the U.S., a regulation was adopted ordering that

the leaves of the bay laurel be described as laurel leaves, not simply as bay leaves, to avoid confusion with the bay-rum species (Parry 1945).

• Experimental evidence has indicated that bay leaves can triple insulin activity, and may therefore be useful in the treatment of Type II (adult onset) diabetes (Ziegler 1989). In this study, 34 species of spices were tested, with cinnamon, cloves, and turmeric proving as effective as bay.

Problems and Potential

There are no prospects of commercial production of bay laurel in the cooler parts of North America as the species is adapted to warmer climates. The plant is likely to remain a potted curiosity in Canada and the northern U.S.

Selected References

Rosengarten (1969); Farrell (1985); Martin (1986); Prakash (1990).

Lavandula

Family: Labiatae (Lamiaceae) (mint family)

Genus Notes

Lavandula has 20-30 species of aromatic shrubs and perennial herbs, found from the Atlantic Islands and Mediterranean region to northern tropical Africa, western Asia, Arabia, and India. In warm climates some species (including English lavender) are almost evergreen. About half of the species are commonly grown as ornamentals, and several are used as sources of essential oil. The species are extremely attractive to bees, and several are grown as honey plants. "The genus *Lavandula* is typically Mediterranean for several reasons: its grey-green or olive-green foliage; its fragrance, which blends so well with other Mediterranean plants such as rosemary, sage, myrtle, and lemons; its love of sunshine; and its ability to thrive in alkaline (calcareous) arid soils among rocks and stones" (Pizzetti and Cocker 1975).

English lavender (*L. angustifolia*) is described in detail below. *Lavandula latifolia* Medicus, known as spike and sweet lavender, is much like English lavender but the leaves are more pubescent and less green [Richters (1997) herb catalogue interprets "sweet lavender" as the hybrid of *L. angustifolia* and *L. dentata* L.] Spike lavender is commonly grown as an ornamental, and essential oil from its flowers are sometimes used to flavor salads and jellies (Facciola 1990). This species produces a grade of oil inferior to that from English lavender; this oil tends to be used in the manufacture of lacquers, varnishes and cheaper grades of perfume. Hybrids of English lavender and spike lavender (*L. angustifolia* × *Lavandula latifolia* = *L. intermedia* Emeric. ex Loisel. = *L. hybrida* Reverchon) occur naturally in the Mediterranean region (Tucker 1981), but have also been widely produced in cultivation. Known as lavandin, these hybrids are very vigorous and easy to

Fig. 184.
(left) Spike lavender *(Lavandula latifolia)*, prepared by B, Brookes. (Based on Wilkomm 645 at Agriculture and Agri-Food Canada herbarium, Ottawa.)
Fig. 185. (right) Spanish (fringed) lavender *(Lavandula dentata)*, from Curtis (1787-present; #400).

Fig. 186.
English lavender *(Lavandula angustifolia)*, from Köhler (1883-1898).

grow, and because they are very productive of essential oil of reasonable quality they are widely grown for this purpose (Guenther 1954).

Lavandula stoechas L., Spanish lavender, Italian lavender, or French lavender, is cultivated extensively as an ornamental and for extraction of low-grade essential oil. It is often confused with *L. dentata*, also widely known as French lavender (although like *L. stoechas* it occurs wild predominantly in Spain), and is also cultivated both as an ornamental and for essential oil. *Lavandula dentata* is sometimes called fringed lavender because of its fernlike foliage with deeply indented edges. Compounding the confusion over correct names, *L. dentata* is often erroneously termed *L. delphinensis*, but as noted below *L. delphinensis* Jord. ex Billot is a synonym of *L. angustifolia*. Garden guides to herbs sometimes confuse lavender species because of the above nomenclatural difficulties. Finally it may be noted that "Spanish lavender" is also a common name for *Pelargonium cucullatum*, discussed in this book as a fragrant geranium used for culinary purposes.

Lavandula Angustifolia Miller

Scientific (Latin) Synonyms

L. atropurpurea hort, *L. delphinensis* Jord. ex Billot, *L. officinalis* Chaix, *L. pyrenaica* DC., *L. spica* L., *L. vera* DC.

English Names

English lavender
Also: common lavender, Dutch lavender [note cultivars with Dutch in their names; Richters (1997) herb catalogue interprets Dutch lavender as the hybrid of English and spike lavender, i.e., lavandin], fragrant lavender, garden lavender, lavender, true lavender [Desert lavender is *Hyptis emoryi* Torr., a cultivated ornamental that originated in the southwestern U.S. and Mexico; sea lavender (or lavender thrift) includes many of the ornamental species of *Limonium*. Lavender cotton is the strong-scented ornamental shrub *Santolina chamaecyparissus* L. originating from the Mediterranean region. Lavender thyme is *Thymus thracicus* Velen. "Lavender Gem" is a citrus fruit, the product of a grapefruit-tangelo cross, available only in specialty stores; this should not be confused with Imperial Gem, a cultivar of English lavender (Brown 1995).]

French Names

Lavande (f)
Also: lavande commune, lavande officinale, lavande vraie

Warnings

As ornamental flowers are often sprayed with pesticides, fungicides and herbicides, be sure that flowers picked for culinary purposes have not been exposed to chemicals. Lavender plants grown by paths and roadways may be subject to lead deposition from cars and urine from dogs. "Lavender oil may be poisonous. No more than two undiluted drops should be taken internally" (Barash 1993; also see information in Medicine).

Description, Taxonomy, and History

English lavender is a much-branched, pubescent shrub growing 0.3-2 m in height. It is native to the Mediterranean region. This species has not been collected outside of cultivation in Canada, and rarely occurs as an escape in the warmer regions of the U.S. The bluish-green leaves are narrow, often whitish when young, giving a silvery or silvery-grey caste to the plant. The tiny flowers are typically mauve or grey-blue, growing in whorls of 6-10 flowers along spiky inflorescences. Cultivars have been selected which have purple, pink, and white flowers. Flowering occurs in mid-summer to early fall. English lavender is an intensely and very pleasantly perfumed plant. Subspecies *angustifolia* includes most of the wild and cultivated forms. Wi1d groups that have been recognized include variety *delphinensis* Rouy & Foucaud of Switzerland, France and Italy, and subspecies *pyrenaica* (DC.) Guinea (= *L. pyrenaica* DC.) of the Pyrenees and northern Spain.

Lavenders were well known to the ancient Greek and Romans (precisely which species is debatable, although some authors such as De Wolf (1955) specify *L. stoechas*). The Romans and Carthaginians put lavender in their bath water for the fragrance and apparent therapeutic properties (Phillips and Foy 1990). Lavenders were cultivated in Elizabethan England, 1568 commonly cited as the earliest known date [Louewenfeld and Back 1974; Hemphill and Hemphill (1984); see Sanecki (1992) for information on the historical cultivation of lavender in England]. Lavender was a very popular strewing and cosmetic herb since at least the twelfth century (Stuart 1979). It was believed to have disinfectant qualities and was liberally used to mask household smells and reduce disease. Lavender was also thought to be antiseptic, for example being used to treat snake bite. The herb was widely used medicinally, and when the patient died, it was frequently used for embalming (see Curiosities for information on ancient Egyptian use). Since classical times, the smell of lavender has been considered to be therapeutic for many nervous diseases, and today it is perhaps the premier herb employed in aromatherapy. Although lavender is not currently

considered to be of any commercial significance as a culinary herb, several centuries ago such sweet-scented flowers were commonly and extensively employed in the kitchen (Hemphill and Hemphill 1984). Lavender was brought to North America by the Pilgrim Fathers (Grieve 1931). In the present century, the lavenders have been extensively bred as ornamentals and for yield of essential oil, especially in Europe. Some oil varieties have been selected to have a tall terminal inflorescence that facilitates hand and mechanized harvesting (Simon et al. 1984).

Uses

Lavender is a source of a commercial fragrant oil which has many uses. The oil is employed in perfumes, lotions, cosmetics, soaps, colognes, shaving creams, toilet water, and other toilet products, as well as for culinary purposes. "Lavender water" is a perfume consisting primarily of an alcoholic solution of lavender oil. English lavender oil is of the highest quality, but "lavender oil" is often adulterated with spike oil (i.e. from spike lavender) or oil from other inferior species which can be produced more cheaply. Because they are not only very productive of oil but produce a reasonably high quality of oil, hybrids of the English and spike lavenders (i.e. lavandin) produce most of the "lavender oil" marketed today.

Lavender is a widely grown ornamental, especially useful as a sweet-smelling border plant along pathways and in rockeries. "If I had to choose just one herb for fragrance from all my garden favorites, it would be English lavender" (Stebbins 1974). In warm climates, tall-growing forms can be used as hedges. Dwarf cultivars make excellent potted patio plants. Lavenders are also grown near highways for stabilization of soil and beautification (Simon et al. 1984).

Lavender is used in crafts, sachets and potpourris. The fragrant leaves and blossoms have been employed for centuries in dried sachets, scented soaps, perfumes and aromatic tobaccos (Crockett and Tanner 1977). The dried flower spikes continue to give off their pleasant odor for many years. Lavender has been used since ancient times to scent clothing and linens. While the aroma is very attractive to humans, it appears to dissuade many insects (Simon et al. 1984), and so has been used in clothes chests as a moth-repellent, and simply hung in a room to drive away flies and mosquitoes. On the other hand, the nectar in the lavenders is extremely attractive to bees and butterflies, and often lavender is planted deliberately to attract these desirable insects. Lavender honey has an outstanding reputation, and is widely sold as a gourmet item.

The flowers are the chief part of the plants employed as a culinary herb. According to Creasy (1990), "English lavender has a sweet lemon-floral taste superior for cooking; other [lavender] species taste medicinal." The leaves, petals and flowering tips are added to dressings, honey, jellies, salads, soft drinks, soups, stews, wine, and vinegar (Morton 1976; Facciola 1990). Lavender blossoms should be used sparingly in desserts such as ice creams, custards, puddings, and fruit (Belsinger 1991). "Lavender can be very intense so use it sparingly; too much can give a soapy flavor" (Barash 1993). Muenscher (1978) recommends "as with all recipes, it is well to start with only a little until you learn how much you like." Lavender seems to go particularly well with berries. Lavender vinegar for salads can be prepared by infusing whole lavender flowering stalks in white vinegar for several weeks (Hemphill and Hemphill 1984). A famous dried herb blend, Herbes de Provence, contains lavender blossoms, as well as thyme, savory, basil, and fennel, and complements all types of meat and fish, as well as sauces and pizza (Belsinger 1991). The flowers (fresh or dried) are brewed to make tea. In former times, lavender flowers were candied (Morton 1976). According to Belsinger (1991), cultivars of English lavender with darker flower buds are more attractive and flavorful for use in the kitchen. Essential oil extracted from the species is used commercially as a food flavorant added to beverages, ice cream, candy, baked goods, chewing gum, gelatins, and puddings (Morton 1976; Duke 1985). English lavender is generally recognized as safe for human consumption as a natural flavoring, and lavender extracts and essential oils are also generally recognized as safe (Simon et al. 1984).

Recipe Sources

Crowhurst (1973) has recipes for Lavender-apple jelly and Lavender wine. Muenscher (1978) presents recipes entitled Lavender tea, Lavender gelatin, Lavender salad, Lavender dessert, Lavender cookies, Lavender jelly, and Lavender conserve. Bremness (1988) has several recipes for Floral bouquet vinegars. Belsinger (1991) has a recipe for Raspberries with lavender cream. Barash (1993) has recipes for Lavender blueberry soup, Lavender apple chutney, Red snapper with lavender and nasturtium beurre blanc, Lavender tuna, Lavender cookies, Orange and lavender sorbet, and Lavender ice cream.

Importance

Lavender is chiefly important as an essential oil crop. Lavender oil has been produced primarily in Bulgaria, England, France, the former USSR, the former Yugoslavia,

Australia, South Africa, Tanzania, Italy, and Spain, with world production in some years of about 1000 t (about ¾ of which is obtained from lavandin, i.e., the hybrids of spike lavender and English lavender) (Lawrence 1985d). Lawrence (1992) estimated annual world production of English lavender oil at 462 t; lavandin oil (English spike) at 768 t; and spike lavender oil at 64 t. Simon (1990) reported that 75 t of lavender oil (representing English, spike, and lavandin species of *Lavandula*), worth U.S. $1,300,000.00, was imported into the U.S. in 1988, primarily from France, Spain and Bulgaria. More recent statistics for lavender oil imported into the U.S. are: 1992: 484,628 kg worth $6,914,000.00; 1993:417,518 kg worth $6,253,500.00; and 1994:339,621 kg worth $4,982,800.00 (Dull 1995). Recent statistics for lavender oil processed in the U.S. and exported are: 1992:76,481 kg worth $1,431,700.00; 1993:59,983 kg worth $1.358,300.00; and 1994:73,944 kg worth $1,712,600.00 (Dull 1995).

Fig. 187.
English lavender *(Lavandula angustifolia)*,
from Hallier (1880-1888).

Lavender is also a very popular ornamental. Additionally, it is commercially significant for crafts, fragrant sachets, and medicine. Its value as a culinary herb is very limited, although lavender honey and tea are marketed.

Cultivation-Notes

Soil

Wild species of *Lavandula* frequently occur in rocky situations, especially on calcareous soils (Huxley et al. 1992). A pH tolerance range of 5.8-8.3 has been reported by Duke (1978), while DeBaggio (1987) has a range of 6.4-8.2. Barker (1989) reported that English lavender does not grow at a pH of less than 6.0. Although tolerant of various types of soil, the lavenders prefer well-drained substrates, and waterlogging is detrimental during the winter (Huxley et al. 1992). Dry, sandy, well-drained alkaline soil is best, and acidic soils should be neutralized, for example with ground limestone. Infertile soil seems to improve the fragrance (Crockett and Tanner 1977).

Climate

In the wild, species of *Lavandula* occur in exposed, sunny, usually parched, hot situations (Huxley et al. 1992). Lavender should not be planted in a shady, damp location, as it will not develop sturdily or flower well (Hemphill and Hemphill 1984). English lavender should be provided with full sun. Depending on authority, English lavender is generally listed as tolerating United States Department of Agriculture climate zones 3 to 5 during the winter (Knapke and Still 1996). Spike lavender (*L. latifolia*) is comparatively tender, and will not grow as a perennial farther north than zones 8 or 9, while lavandin (*L. angustifolia* *L. latifolia*) is slightly less hardy than English lavender (Knapke and Still 1996). Improving the drainage of *Lavandula* species by amending the soil or growing them in inclined or raised beds enhances winter survival (Knapke and Still 1996). Although hardy in climate zones 5 and 6, English lavender should be covered with mulch in the winter in these areas to protect them from the cold (Crockett and Tanner 1977). In the northern regions of its climate range, English lavender will not attain the considerable size and floral profusion that it does in its Mediterranean homeland; dwarf cultivars such as Munstead and Hidcote winter well in northern regions when covered with straw or evergreen boughs (Lima 1986).

Propagation and Cultivation

Lavenders are propagated by seeds or division, and especially by autumn and spring cuttings. Some cultivars, such as Lavender Lady and Munstead, can be grown

efficiently from seeds, germinated at about 21°C, with emergence in 15-25 days (Cox and Craker 1993; Wang et al. 1993). Chavagnot (1978) found that moist prechilling, at 3-5°C for 1 to several weeks, considerably increased speed of germination. Wang et al. (1993) recommend a planting depth of no deeper than 6 mm. Because the seeds of many cultivars may take 6 weeks to germinate, and the seedlings grow very slowly, stem cuttings are preferable (Crockett and Tanner 1977). Plants produced from seeds are often variable and may not reproduce the distinctive characteristics of the cultivar, while cuttings have the advantage of propagating desired traits well. Growth is slow, and it usually takes several years for lavender crops to develop fully. English lavender tends to become unkempt after several years, and should be trimmed for an attractive shape, or replaced with young plants. Cutting away old woody growth every year in the spring is advisable (Crockett and Tanner 1977). Nipping the flower spikes off before they bloom during the first year makes the bushes more compact (Crockett and Tanner 1977). Established commercial plantings may last as long as 30 years (Simon et al. 1984), although ornamental forms usually require replacing at least at ten years of age (Huxley et al. 1992), and if not trimmed annually are probably best discarded by the age of five. Some cultivars of lavender are prone to fungus diseases. Plants showing symptoms of disease should of course not be used for propagation, and it would be prudent not to replant lavender for several years in a location where disease has developed. The cultivar Lady flowers consistently the first year, and has been mislabelled as "annual" because of this (e.g. Thompson and Morgan 1997), although true annuals die after flowering.

Harvest and Storage

Leaves can be picked at any time for culinary purposes, but flowering material is much more desirable. In the home garden, Hemphill and Hemphill (1984) recommend the following procedure for picking and drying: collect material before the last flowers on each stalk are fully open; harvest the stalks on a dry day before the sun's heat has evaporated much of the essential oils; tie the stalks in bundles and hang them in a warm, shady, airy place to dry until crisp (this may take several weeks); when dry, strip the flowers from the stems and store in airtight containers. Crockett and Tanner (1977) recommend against harvesting flowers during the first year, and prefer to cut the stems earlier (just as buds start to open) than in the above procedure. As an alternative to hanging bundled stalks, the stalks may be dried flat in trays. Fresh flowers can also be frozen rather than dried.

Commercially, lavender oil is obtained from flowers harvested at full bloom (Simon et al. 1984). Sanecki (1992) provides the following colorful description of the process in England:

"Harvesting of lavender takes place in mid- and late summer in England, varying perhaps a week or two according to the weather. As with all herbs, the cutting time is critical, not only because the small flowers will drop if left too long but because the maximum of essential oil must be harvested. The oil accumulates in tiny sacs at the base of each flower and the amount depends upon warmth and sunshine while the flowers are blooming.... No longer do sunburned women reap the harvest with sickle-like lavender knives because since the mid-1960's a machine combs in the flower spikes to drop them evenly from the plant, creating great swathes across the fields, and conveys them aloft to sacks. So, direct from field to distillery they go with a minimum of delay. There they are tumbled out in piles, forked into one of the large copper stills, trampled and distilled. The precious oil of lavender soon oozes through, just an hour or two after the spikes were cut."

Example Cultivars

Alba, Rosea, Atropurpurea, Compacta, Dutch, Dutch White, Fragrance, Grey Lady, Hidcote, Hidcote Giant, Hidcote Pink, Imperial Gem, Jean Davis [= Rosea according to Facciola (1990)], Lady, Loddon Pink, Miss Catherine, Munstead (Compact Nana), Nana, Nana Alba (Alba Nana), Rosea, Royal Purple, Seal, Sharon Roberts, Twickle Purple (Twickel Purple), Waltham [Most of these ornamental cultivars are described in Bailey and Bailey (1976), Facciola (1990), and Huxley et al. (1992). In Europe there are numerous commercial cultivars selected for harvest of essential oil.]

Additional Notes

Chemistry

Lavender has 0.5-1.5% volatile oil [1-3% according to Bisset (1994)], tannins, coumarins (including coumarin, umbelliferone and herniarin), flavonoids (such as luteolin), and (in the leaves) about 0.7% ursolic acid (Duke 1985). The essential oil has linalyl acetate (8-18% in English lavender, 30-60% in French lavender), linalool, 1,8-cineole, camphor, -pinene, geraniol and its esters, lavandulol, nerol, cineole, caryophyllene, limonene, ß-ocimene, furfural, ethyl amyl ketone, thujone, and pinocamphone (Simon et al. 1984; Duke 1985). Linalool has the distinct smell of lavender. The sweetly floral English lavender has little camphor compared to other lavenders, which accordingly have a medicinal or detergent-like smell.

Medicine

In the past, lavender have been used as a folk remedy for numerous conditions, including acne, cancer, colic, faintness, flatulence, giddiness, migraine, nausea, neuralgia, nervous headache, nervous palpitations, poor appetite, pimples, rheumatism, sores, spasms, sprains, toothache, vomiting and worms (Duke 1985). Lavender salts have been employed for centuries as a stimulant to prevent fainting (Crockett and Tanner 1977); lavender oil vapor is traditionally inhaled to prevent vertigo and fainting. Lavender is still used in folk medicine: internally as a mild sedative and cough suppressant, and in gastric disturbances caused by flatulence; and externally to counteract rheumatic pain, and as an antiseptic lotion for cuts (Stuart 1979).

In modem medicine, lavender drugs are occasionally used (mostly in Europe) as a mild sedative to treat excitement, nervous exhaustion; disturbances of sleep, and functional and intestinal disorders related to nervousness and difficulties in sleeping (Bisset 1994). Lavender is marketed commercially in a number of patent medicines and calmative teas (again mostly in Europe, although some medicines in the U.S. and Canada are formulated with lavender) (Bisset 1994).

Aromatherapy as been defined as follows: "the therapeutic use of fragrances or volatile substances to cure and to mitigate or to prevent diseases, infections and

Fig. 188.
English lavender *(Lavandula angustifolia)*,
from Harter (1988).

indispositions only by means of inhalation" (Buchbauer and Jirovetz 1994). Lavender is extensively used today in aromatherapy (Teranishi et al. 1993; Buckle 1996). Lavender has long had a reputation for calming the nerves and relaxing tensions, typically administered as a bath at night with a few drops of lavender oil, or as a sedative tea (Hemphill and Hemphill 1984). Like hop (see *Humulus lupulus* Curiosities), it has been recommended in "sleep pillows" to induce tranquil slumber (Hemphill and Hemphill 1984). A number of reports on the internet claim that the scent of lavender is aphrodisiac. The extent to which aromatherapy offers a direct therapeutic pharmacological interaction of fragrance molecules with body tissues, rather than simply inducing a pleasant feeling, remains to be determined (Buchbauer et al. 1993). It is probable, however, that by simply relaxing people and relieving stress, aromatherapy is highly beneficial.

"In large doses lavender oil is a narcotic poison that can cause death by convulsion. The oil can cause dermatitis" (Duke 1985). Aromatherapy may not be without risk; Pages et al. (1992) found an abortifacient effect (in mice) based on oil of *Salvia lavandulifolia* Vahl.

Nutrition

Lavender is consumed in extremely small amounts and therefore does not contribute appreciably to nutrition.

Curiosities

• The genus name *Lavandula* originates from the Latin *lavo*, I wash, in reference to the frequent use of lavender water, made from oil of lavender, and used as a fragrant wash (Huxley et al. 1992).

• The color lavender of course is named for the flower, but like many colors it is difficult to define exactly. Webster's (1981) Third New International Dictionary defines lavender as "a variable color averaging a pale purple that is bluer and deeper than wisteria, floss flower blue, or mauvette and bluer, darker, and slightly stronger than phlox pink." Other colors defined in Webster's: lavender blue: "a light to brilliant purplish blue;" lavender grey: "a light bluish grey that is darker and slightly redder than sky grey or chicory;" lavender mist: "a pale purple that is paler than average lavender, bluer and duller than wisteria, and bluer, stronger, and slightly lighter than flossflower blue."

• Ancient Egyptians created mummification casts that would last indefinitely by soaking linen in oil of lavender containing asphalt, wrapping the bodies with these, and drying them in the sun until the casts were hard (Duke 1985).

• "It was formerly believed that the asp, a dangerous kind of viper, made lavender its habitual place of abode, so that the plant had to be approached with great caution" (Grieve 1931).

• Lavender was a principal ingredient of "Hungary water," invented for Queen Elizabeth of Hungary who became paralysed in 1235. Hungary water was considered a panacea for many diseases (for detailed information, see *Rosmarinus* Curiosities).

• In the Victorian language of flowers, lavender signifies distrust (Barash 1993).

• In North Africa, lavender is used to protect the Kabyle women from being mistreated by their husbands (Barash 1993).

Problems and Potential

Lavender cultivation as a commercial essential oil crop is well established in Europe, making the development of an industry in the warmer regions of North America a difficult venture. Lavender is commonly grown as an ornamental in the warmer regions of North America, providing a stable but small market for garden supply firms. In Canada and the cooler areas of North America there is little prospect of developing lavender as a commercial crop of much value.

Selected References

Grieve (1931); Bisset (1994); Simon et al. (1984); Duke (1985); Knapke and Still (1996).

Lepidium

Family: Cruciferae (Brassicaceae) (mustard family)

Genus Notes

Lepidium has about 150 annual, biennial, and perennial herbs of worldwide distribution. In addition to *L. sativum*, discussed in detail below, several other species are economically significant. *Lepidium densiflorum* Schrad., common pepper-grass, is a native of Europe and North America. It was used in Europe as a substitute for water-cress (*Nasturtium officinale*, also discussed in this book), but was not domesticated. Its use as an edible wild plant is discussed by Szczawinski and Turner (1978). *Lepidium virginicum* L., known as poor-man's pepper, wild cress, wild pepper-grass and Virginia cress, a native of North America, is a weed in parts of Canada and the U.S. Like the above species, it is undomesticated. The leaves and unripe pods are used as a condiment and the foliage is eaten fresh in salads and cooked as a potherb (Facciola 1990). The ripe seed pods are often fed to caged canaries (Morton 1981). *Lepidium meyenii* Walp., maca, is a minor root crop of the Peruvian Andes, employed for food and medicinal purposes. It is cultivated in central Peru for its enlarged, turnip-like root which is used fresh or dried (Yamaguchi 1983; Mansfeld 1986). Several other species of *Lepidium* that are employed for food purposes are mentioned in Uphof (1968) and Facciola (1990).

Lepidium Sativum L.

English Names

Garden cress
Also: common garden cress, land cress (also applied to upland cress, as noted below), pepper cress, peppergrass (often used as a general name for species in the genus), pepperwort, upland cress (as explained below, better reserved for another species)
[Garden catalogues sometimes list garden cress as curled cress, pepper cress, and pepper grass.]

French Names

Family: Crucifères, famille de la moutarde
Cresson a1énois (m)
Also: cresson alenois, cresson à la noix, cresson cultivé (could be applied to the other two cresses discussed in this book), cresson de(s) jardin(s) (also applied to *Barbarea verna*, the true upland cress), cresson domestique

Fig. 189.
Garden cress *(Lepidium sativum)*,
from Vilmorin-Andrieux et C^{ie} (1883),
showing the cultivar Extra-curled Dwarf.

(could be applied to the other two cresses discussed in this book), nasitor, passerage, passerage cultivée, passerage des jardins
[Wijk (1911) lists additional old-fashioned French names.]

Description, Taxonomy, and History

Garden cress is a fast-growing, annual herb with more or less lobed or dissected leaves. It produces a single, erect flowering stem, 20-80 cm (usually about 30) in height. The flowers are white and fragrant. Wild plants native to Egypt and western Asia, including Iran, are placed in subsp. *spinescens* (DC.) Thell. (Mansfeld 1986). The cultivated kind, subsp. *sativum*, is grown in temperate regions worldwide. Some forms have crisped, cured leaves (subsp. *sativum* var. *crispum* (Medik.) DC. of some authors (Mansfeld 1986)), and these are sometimes termed upland cress. "Upland cress" also refers to various species of *Barbarea*, and is best reserved for *Barbarea verna* (Mill.) Aschers., which is also discussed in this book.

Garden cress occurs wild in North America and is found along roadsides and in waste places and cultivated ground. In Canada, it has been recorded in all provinces with the possible exception of Newfoundland, as well as in the territories (Mulligan 1961; Scoggan 1978-79). It is uncertain whether the Canadian records all represent the cultivated

form that has escaped, or sometimes genuinely wild plants. In the U.S. it is most common in the northeast (Fernald 1970).

Garden cress was selected as early as 400 B.C. in Persia and spread to India, Syria, Egypt, and ancient Greece. It was first cultivated as a salad herb in England in 1548 (Szczawinski and Turner 1978). Today it is widely grown in Europe (Simmonds 1976; Halpin 1978).

Fig. 190.
Garden cress *(Lepidium sativum)*,
from Syme et al. (1863-1886).

Uses

The taste of the leaves of garden cress is reminiscent of the pungent flavor of watercress (*Nasturtium*, discussed in this book). The leaves are eaten fresh in salads, soups, sandwiches, omelets, and other foods. The sprouts are also consumed, often in combination with mustard as a cut-and-come-again seedling crop called mustard and cress (Facciola 1990) The roots of the seedlings are sometimes discarded before eating the sprouts. The whole seed pods can be used fresh or dried, as a seasoning with a peppery flavor (Halpin 1978). The roots are sometimes eaten as a condiment (Facciola 1990). In Europe, the leaves are processed for use in dried soup packages (Buishand et al. 1986). In Ethiopia the seeds are grown for their edible oil (Facciola 1990).

Garden cress is extensively used as a test subject in plant physiological studies, as an indicator organism to examine toxicity levels of environmental pollutants, and in experimental studies assessing diverse pathogens.

Recipe Sources

In addition to the recipes below specifically for garden cress, the recipes for watercress (*Nasturtium officinale*) are also suitable.

Peppergrass (garden cress) Tartar sauce (Szczawinski and Turner 1978); Peppergrass (garden cress) omelette (Szczawinski and Turner 1978); Green cress soup (Hemphill and Hemphill 1984).

Fig. 191.
Garden cress *(Lepidium sativum)*,
from Vilmorin-Andrieux et C^{ie} (1883),
showing the cultivar Curled (= Normandy).

Importance

Garden cress is commercially produced in Europe, including Britain, France, the Netherlands, and Scandinavia. It is usually sold for use as sprouts in sandwiches, like alfalfa sprouts (Buishand et al. 1986). In 1988 the Netherlands exported 1410 t of garden cress to other countries, with 1324 t to what was then West Germany (Hinton 1991). No reports seem available for commercial use of garden cress in North America. It is likely restricted to home usage, and may be available in local market gardens, or raised as a specialty item for restaurants.

Cultivation Notes

Soil

Garden cress grows best on moisture-retentive but well-drained, rich soil or well-rotted compost. It is also grown on various substrates in greenhouses, and in the British Isles is often germinated on moist cotton in homes, to produce edible seedlings (Halpin 1978). The pH range of tolerance is 4.9-8.0 (Duke 1979).

Climate

Garden cress is a cool-season plant, adapted to temperatures under 20°C. In hot weather its flavor becomes quite peppery. Garden cress grows best in full sun or partial shade. In greenhouses it can be grown under benches away from direct sunlight, to avoid heat (Halpin 1978). The seeds germinate at 18-21°C (Splittstoesser 1990).

Propagation and Cultivation

Propagation is by seeds, which are sown thickly and are lightly or not at all covered. Seedlings can be grown in flats, trays, or pots. Plants are thinned (the removed plants are edible) and watered as needed. Garden cress is best grown in reduced sunlight (although Huxley et al. (1992) advocate growing in full sunlight). Successive plantings are recommended for a series of harvests outdoors throughout the growing season. The species is well-adapted to greenhouse or indoor culture. In the winter, potted garden cress does best in a cool, sunny window.

If sprouts are desired, the plants are sown thickly in flats or jars (Halpin 1978). The seedlings can be produced at 10°C for 10-14 days in the dark (Huxley et al. 1992). If mustard sprouts are desired as an accompaniment, these should be sown 3-4 days later, as they germinate more quickly. The two kinds of seedlings can be harvested together using scissors.

Fig. 192.
Garden cress *(Lepidium sativum)*,
from Hallier (1880-1888).

Harvest and Storage

Garden cress leaves should be picked before the plants flower, as the leaves of blooming plants are tough and acrid. The entire plant can be used, or most leaves can be removed, allowing regrowth for a second harvest (Halpin 1978). Garden cress sprouts are harvested when the youngest leaves turn green, usually 10 days after sowing

(Splittstoesser 1990). In Europe, the seedlings are sold growing in small boxes. These keep for about 2 weeks at 0-1°C with high humidity (Buishand et al. 1986).

Example Cultivars

Armada, Broad-leaved (Mega, Broad Leaved French), Curled, Extra Curled, Fine Curled, Greek, Groka, Moss Curled, Reform (all listed in Facciola 1990). "Golden cress" is a dwarf form with scalloped, yellow-green foliage (Morton 1976).

Bettencourt and Konopka (1990) list institutions in various countries conserving garden cress germplasm.

Additional Notes

Chemistry

Like many other members of the mustard family, the pungent taste of garden cress is partly due to the presence of glucosinolates.

Medicine

Garden cress seeds are frequently used medicinally in Asia (Morton 1976).

Nutrition

Garden cress is rich in vitamin C, iron and calcium, and especially rich in vitamin A, with almost twice as much of this vitamin as watercress (*Nasturtium officinale*) (Halpin 1978).

Curiosities

• *Lepidium* species have small seeds with large amounts of mucilage, which becomes quite sticky when wet. Accordingly, the seeds often stick to the wool of sheep. Because wool is a worldwide commodity, and *Lepidium* occurs on many continents, the seeds are

Fig. 193.
Garden cress *(Lepidium sativum)*,
from Vilmorin-Andrieux et C^{ie} (1883),
showing the cultivar Broad-leaved.

often transported intercontinentally. Indeed, exotic *Lepidium* species often are found near wool-combing mills (Rollins 1993).

• A search for RNA (ribonucleic acid) from cress seeds from Thebes (ancient city located at modem Quena, on the Nile of southern Egypt), dated approximately 1400 years B.C., showed that fragments of RNA were still present in the old seeds (Rollo 1985).

Problems and Potential

Garden cress is a very minor crop, used occasionally in home gardens. It has potential for commercial marketing as a salad plant, and for sprouts on a year-round basis by growing the plant indoors. In North America, watercress (*Nasturtium officinale*) is more competitive as a salad and condiment plant.

Selected References

Halpin (1978); Buishand et al. (1986).

Levisticum

Family: Umbelliferae (Apiaceae) (carrot family)

Genus Notes

Levisticum has only one species, discussed below.

Levisticum Officinale W.D.J. Koch

English Names

Lovage
Also: common lovage, Cornish lovage, English lovage, Italian lovage, love parsley, maggi plant, old English 1ovage, sea parsley
[Scotch lovage (Scot lovage, Scots lovage) is *Ligusticum scoticum* L., a perennial herb native to the North Temperate region that is occasionally cultivated. True to its name, it

Fig. 194.
Scotch lovage *(Ligusticum scoticum)*,
from Syme et al. (1863-1886).

is used in Scotland as a cooked potherb. Its young shoots and leafstalks are blanched for use as a celery substitute, and added to salads, soups and stews. The young shoots and roots are sometimes candied like angelica. Black lovage is *Smyrnium olusatrum*, discussed in this book. The above two cultivated plants are in the carrot family. Several other species of the carrot family also have "1ovage" as part of their names. In Europe, a popular flavoring sauce called "Maggi," available in liquid or dry-cube form, is mainly flavored by lovage (Lima 1986). Accordingly, lovage is sometimes called "maggi plant."]

French Names

Family: Ombellifères, famille de la carotte
Livèche (f)
Also: ache de(s) montagne(s), levistique officinale, lévistique officinale, livèche officinale, livêche (officinale), céleri bâtard

Description, Taxonomy, and History

Lovage is a robust perennial herb growing as tall as 2 m and eventually expanding to a clump several metres in diameter. In appearance, it is reminiscent of angelica, also discussed in this book. Lovage has green-yellow flowers, hollow stems that are often purplish at the base, a thick brown root, glossy leaves, and a strong scent combining celery and parsley. The species is native to the eastern Mediterranean and Afghanistan and has escaped from cultivation in much of Europe and parts of North America. Cultivated and wild forms are indistinguishable. In North America, lovage grows outside of cultivation as far north as Saskatchewan, the southern parts of Ontario and Quebec, and Nova Scotia (Scoggan 1978-79). It is naturalized in much of the eastern U.S.

Lovage was used by the ancient Greeks and Romans (Stobart 1977), and was likely introduced to Britain and northern Europe by the latter. It has been grown in gardens in Europe since the 8th century as a condiment and medicinal plant (Mansfeld 1986). Lovage is believed to have been brought to America by the Pilgrims, as a digestive aid (and not for its alleged aphrodisiac properties!) (Gilbertie 1988).

Uses

The leaves, roots, and stems have a pleasant flavor that is reminiscent of celery and parsley with a spicy tang. Many consider lovage the best of culinary herbs while others

Fig. 195.
Lovage *(Levisticum officinale)*, from Köhler (1883-1898).

find it too strong in flavor. It should be used sparingly at first until one gets used to the taste. Rubbing a salad bowl with lovage leaves is enough to impart a celery flavor to a salad. The leaves and shoots are used as savory herbs. The leaves are added to many soups, particularly those containing peas, beans, and lentils. Hemphill and Hemphill (1984) suggest chopping the leaves finely, as they are a little coarse. Lovage can season chili, beef and other stews, chicken pie, tuna casserole and other seafood dishes. Cooking does not dissipate the flavor. Finely chopped leaves are an interesting addition to stir-fried vegetables and to bland dishes such as summer squash. Raw leaves can be added to green or potato salads. Lovage leaves are particularly suited to potatoes. They are blended with sour cream, combined with marjoram in potato soup, finely chopped on top of buttered potatoes, or combined with dill and parsley to make a white sauce that is poured over boiled potatoes. A sweet-scented tea is made from the dried leaves (Kublick 1990). Lovage wine was once popular (Muenscher 1978).

Lovage leafstalks can be blanched and eaten like celery or candied (Morton 1976). The hollow stems can be candied like angelica (*Angelica archangelica*, discussed in this book) although the result is not as sweet as candied angelica (Stobart 1977).

The caraway-like seeds are added whole or ground up to candy, cakes, and meats. They are also sometimes pickled like capers. The seeds add a distinctive flavor to savory biscuits.

The dried root was once ground as a condiment for its nutty flavor. The roots can be eaten but are strongly flavored. The bitter outer skin should be peeled before use. The grated fresh root is cooked as a vegetable or eaten raw in salads. Grated root is also steeped to make a hearty tea that is more like broth (Kublick 1990). The roots are sometimes chopped and preserved in honey (Facciola 1990).

An essential oil (called oil of lovage) is extracted from the plant and used in various forms as an aromatic addition to condiments, icings, syrups, certain liqueurs, heavy spicy perfumes, and tobacco products (Morton 1976; Mansfeld 1986). Lovage was once used as a freshener for linen closets (Kublick 1990).

Recipe Sources

Leyel (1938) gives recipes for Candied lovage, and Lovage cordial. Boxer and Back (1980) have recipes for Celery consommé with lovage and Braised Guinea fowl with lovage. Leggatt (1987) presents recipes for: Pot curd cheese with chervil, lovage and marigold petals, and Cheese and onion hot pot with marigolds, chervil and lovage. Bremness (1988) has the following lovage recipes: Stuffed lovage and grape leaves, Lovage and lentil roulade, and Lovage seed bread. Gilbertie (1988) gives recipes for Strasbourg hens with lovage stuffing, and Lovage frittata. Richardson (1991) presents recipes for: Lovage vinegar, Lovage omellete or scrambled eggs, Lovage vegetable soup, Lovage cheese soufflé, and Scandinavian meatballs with 1ovage.

Other recipes are: Meat loaf de luxe with lovage (Simmons 1969); Lovage soup (Garland 1979; Adams 1987; Bremness 1988); Lovage spears (Adams 1987); Cheese and lovage loaf (Holt 1989); Lovage cream soup (Kublick 1990); Pork tenderloin with ham and lovage (Holt 1991).

Importance

Lovage is of minor importance, both as a herb and as a source of essential oil. World production in 1984 was 500 kg of root oil and 300 kg of seed oil (Toulemonde and Noleau 1988). Verlet (1993) estimated the annual world value of lovage essential oil to be $1,200,000.00 (U.S.). The majority of cultivated 1ovage is grown in central Europe (Stuart 1979), largely for essential oil. In North America it is most familiar to those of central and eastern European origin.

Cultivation Notes

Soil

Lovage tolerates most soils except heavy clay (Stuart 1979). It performs best in deep, fertile, moisture-retaining but well-drained soils. An annual application of well-rotted manure is beneficial (Garland 1979). Reported pH tolerance ranges are 5.0-7.6 (De Baggio 1987) and 5.0-7.8 (Duke 1978). Crockett and Tanner (1977) recommend a pH of 6.0-7.0.

Climate

This hardy perennial is well adapted to the climate of much of Canada and the northern U.S. Lovage will tolerate winter temperatures of at least-15°C (Huxley et al. 1992). It prefers full sunlight but can tolerate shade. Lovage should be watered during dry periods.

Propagation and Cultivation

Lovage grows easily from fresh seeds sown in late summer or fall. Seed viability is short-lived, and seeds should be preserved under refrigeration (Wang et al. 1993). The seeds require a freeze and thaw cycle to break dormancy. They should be planted at a depth of 6 mm, with seedlings

Fig. 196.
Lovage *(Levisticum officinale)*, prepared by S. Rigby. (Based on greenhouse plant from Richters.)

usually emerging in 10-28 days (Wang et al. 1993). If seeds are unavailable, divisions can be taken from the outside of mature plants for replanting, utilizing a piece of root with a bud or "eye." Lovage requires a full summer from seed to develop into a plant of reasonable size. The plant will expand in size each subsequent year (Lima 1986). Called "the biggest of all kitchen herbs" (Gilbertie 1988), it is advisable to plant it on the north side of the garden, so that smaller plants will not be shaded. It is best to cut off the fruiting stalk before the seeds mature and fall to the ground, or else a thick growth of seedlings will take over the area the next growing season. Some stems can be cut back to ground level at various times during the season in order to stimulate new growth, for a regular supply of young, tender leaves. When propagated vegetatively, this perennial plant should be kept vigorous by dividing and replanting the fleshy rootstocks every 3 or 4 years. Seeds and living plants are available from North American garden catalogs.

Harvest and Storage

A few mature plants are sufficient for most families. The leaves can be picked fresh at any time. Leaves can be dried in a warm, dry, airy, shaded location and stored in airtight containers for later use. The fruiting stalks can be cut as they are turning brown, and hung upside down over a cloth to catch the ripe seeds (Garland 1979).

When cultivated for essential oil, the first harvest is taken from 2- or 3-year-old plants, and subsequent harvests every third year (Simon et al. 1984).

Example Cultivars

Named cultivars are generally unavailable.

Additional Notes

Chemistry

An essential oil is extracted from the roots and aboveground parts of 1ovage. The recovery of essential oil is 0.8-1.1% from seeds, 0.6-1.0% of the roots, and 0.05-0.15%

from leaves (Toulemonde and Noleau 1988). A large number of compounds have been found in the oil, mainly monoterpene hydrocarbons and phthalides, which are lactone derivatives. The essential oil comprises mainly umbelliferone and butyl phthalidine. Several coumarins are found in lovage oil, including umbelliferone mentioned above (Simon et al. 1984). Other compounds listed by Simon et al. (1984) include *n*-butylidene phthalide, *n*-butyl-phthalide, sedanonic anhydride, *d*- -terpineol, carvacrol, eugenol, and volatile acids. Resin, starch, sugars, tannins, and gum are also present (Stuart 1979).

There are differences in fragrance among the essential oils from different plant parts, and the extracted oils may be used differently (Simon et al. 1984). Blank and Schieberle (1993) reported that a key odorous component of lovage herb is sotolone (3-hydroxy-4,5-dimethyl-2(5H)-furanone). Root volatile oil is useful in perfumery, soaps, creams, and for flavoring tobacco products. Seed oil is used to flavor confectionery and liqueurs.

Medicine

The classical Greeks chewed lovage seeds to aid digestion and relieve flatulence (Stuart 1979). Lovage has been grown since medieval times in monastic gardens as a medicinal herb. In addition to the traditional use for digestion and for reducing flatulence, it was also employed as a deodorant. An infusion of the dried leaves was used for sore throats and fever and as an antiseptic mouthwash and gargle. A strong infusion was added to make a cleansing, aromatic, deodorizing bath (Garland 1979).

Lovage has been shown to be a diuretic (stimulating urine production), and is commonly a component of diuretic tea mixtures in Europe (Tyler 1993). It has been used recently to regulate menstruation (Simon et al. 1984). It might also have some value in relieving flatulence or gas. Like many other of the carrot family herbs discussed in this book, it tends to produce light-activated dermatitis, but this does not seem to be a serious problem (Tyler 1993).

Nutrition

Significant vitamin C is present in lovage (Stuart 1979).

Curiosities

• The generic name *Levisticum* is a corruption of the earlier Greek name, *Ligusticum*, after Liguria, Italy, where the plant once grew abundantly (Stuart 1979).

• Lovage owes its common name (as well as the name love parsley) to its use in love potions (Gilbertie 1988). It was once thought that wearing sachets of lovage and orris root (*Iris germanica* L. var. *florentina* (L.) Dykes) would ensure a strong attraction from one's secret love (Kublick 1990).

• Lovage flowers are attractive to tiny parasitic wasps (such as species of *Trichogramma*), whose young prey on garden pests such as cutworms and tent caterpillars, providing beneficial biological control (Lima 1986).

• Among the many curious Hoosier (Indiana) folk remedies recorded by Tyler (1985) is the following: for tonsillitis, cut up lovage root, fry it in lard, and apply a poultice to the throat.

Problems and Potential

Lovage is a little-known plant in Canada and the north-em U.S. However, it is well-adapted to the climate of northern North America, and has some potential as a crop for growers near large city markets.

Selected References

Garland (1979); Lima (1986); Kublick (1990).

Fig. 197.
Rau om *(Limnophila aromatica)*, prepared by S. Rigby. (Based on greenhouse plant from Richters.)

Limnophila

Family: Scrophulariaceae (figwort family)

Genus Notes

Limnophila has about 40 species of aromatic, marsh and aquatic, annual or perennial herbs native to warmer regions of Africa, and from Asia to Australia. Several of the species are used in indoor aquaria, some are eaten as potherbs in Asia, and a few are used medicinally (Tanaka 1976; Duke and Ayensu 1985).

Limnophila Aromatica (Lam.) Merr.

Scientific (Latin) Synonyms

Ambulia aromatica Lam., *L. chinensis* (Osb.) Merr. subsp. *aromatica* (Lam.)Yamazaki (Yamazaki 1978)

English Names

Rau om (a name used in southern Vietnam)
[Do not confuse rau om with rau ram, *Polygonum odoratum*, also included in this book.]
Also: swamp leaf, rau ngo (Thai name reported in Adams 1996).
[Keukeuhan (Sundra); beremi, shiso-kusa (Malay); additional southeastern Asian names are in Burkill (1935), Philcox (1970), and Kuebel and Tucker (1988).]

French Names

Family: Scrophulariacées, famille de la linaire
Rau om (appropriate gender unclear)
[Rau om is currently used in New Caledonia as a French name (H.S. MacKee, personal communication). F. Jacquemoud suggested the attractive name limnophile aromatique (f) (personal communication).]
Also: ambulie aromatique (Lamarck 1783; but no longer used).

Description, Taxonomy, and History

Limnophila aromatica is a small, tender, perennial, trailing, semi-aquatic herb 20-100 cm tall (usually less than 50 cm). The species is found in Japan, China, Taiwan, Malaysia, Indonesia, India, East Pakistan, Micronesia, and Australia (Philcox 1970; Tanaka 1976). In Java, it occurs in swampy places, with the lower part of the plant always submersed (Ochse et al. 1980). Many-flowered terminal inflorescences up to 15 cm long are produced, with blue flowers 10-14 mm long. True to its scientific name, it is quite aromatic, the odor described as similar to turpentine (Burkill 1935) or, more attractively, "uniquely floral" (Kuebel and Tucker 1988). Adams (1996) reported the scent to be warm and spicy like a mixture of cinnamon and cloves, and reminiscent of green *Perilla* (also discussed in this book). In Oriental groceries it is easily recognized by having whorls of three leaves along the stems.

Uses

The whole plant of *L. aromatica* is eaten raw or steamed in Asia (Tanaka 1976). The leafy stems are consumed as a side-dish with rice. The flavor is cinnamon-like, with citrus overtones. The distinct aroma and flavor are considered very desirable in several sweet and sour Vietnamese dishes, and in Thai cooking. In Malaysia the plant has been eaten like spinach, either raw or cooked (Burkill 1935). In addition to its culinary usage, the plant is a suitable candidate for ornamental use in a hanging basket (Adams 1996).

Fig. 198.
Rau om *(Limnophila aromatica)*
flowering branch, prepared by S. Rigby.
(Based on greenhouse plant from Richters.)

Recipes Sources

None found.

Importance

Rau om is an occasional culinary herb in parts of Asia. It is sometimes encountered in North American ethnic markets.

Cultivation Notes

Soil

Rau om is an emergent aquatic that prefers mud and a film of standing water. The plant should be cultivated so that the roots remain consistently moist. However, plants that I have cultivated in the greenhouse did well even when the soil occasionally became somewhat dry.

Climate

This tender perennial is essentially tropical and subtropical. It can be raised under glass in northern areas, and the pots transferred outdoors for the summer. The plant needs to be grown in a warm environment, and at least in northern locations prefers full sun.

Propagation and Cultivation

Rau om is perhaps most conveniently obtained by buying fresh stems, that have produced roots, in Oriental markets. "Although the plant is difficult to cultivate, the unique floral odor of the leaves is well worth the effort" (Kuebel and Tucker 1988). *Limnophila aromatica* can be grown either as an annual or a perennial (Philcox 1970).

Harvest and Storage

Shimizu (personal communication) suggests that the plant be harvested like basil, another tender, fleshy plant which is easily damaged.

Example Cultivars

No information found.

Additional Notes

Chemistry

The plants yield 0.13% essential oil, containing *d*-limonene and *d*-perillaldehyde (Duke and Ayensu 1985).

Medicine

In Asia, rau om is employed to treat many ailments (Burkill 1935; Perry and Metzger 1980; Duke and Ayensu 1985). In China, it is used for the treatment of intoxication and pain; in Indochina, to treat wounds; in Malaysia, chiefly as a poultice on sore legs, but also to promote appetite, and as an expectorant to clear mucus from the respiratory tract, and to treat fever; and in Indonesia, as an antiseptic or cleanser for worms. The plant is also used in Asia for menstrual problems, wounds, dysentery, fever, elephantiasis, and indigestion (see below).

Nutrition

No information found.

Curiosities

• The genus name *Limnophila* is derived from the Greek *limne*, marsh and *philos*, loving, a reference to the wet habitat (Huxley et al. 1992).

• In addition to the plant genus *Limnophila*, there is a genus of stone flies also called *Limnophila* (in the order Diptera, family Limoniidae). Plant names are independent of animal names, and there are other cases of the same name independently used for a plant and for an animal.

• The durian (*Durio zibethinus* Murr.) is a large tropical tree producing 2-kg fruits with a taste that has been described as a mixture of old cheese and onions, flavored with turpentine (Uphof 1968). In the Dutch East Indies, rau om, itself having a distinctly turpentine taste, is considered a good accompaniment, preventing the malodorous belching that often results when durian is eaten alone (Ochse et al. 1980).

Problems and Potential

Rau om is a tropical or subtropical plant, and so not suitable as an outdoor commercial crop in Canada and the northern U.S., and probably not even as a competitive glass house crop since it can be raised in warmer regions of the U.S.

Selected References

Philcox (1970); Ochse et al. (1980); Kuebel and Tucker (1988).

Lippia

Family: Verbenaceae (vervain family)

Genus Notes

Lippia has some 200 species of often aromatic herbs, shrubs, and small trees native to tropical Africa and the warmer parts of the Americas. Lemon verbena, *Lippia citriodora*, is treated in this book as *Aloysia triphylla*. In addition to the two species discussed at length below, several others are either harvested from the wild or cultivated as food or as medicinal plants. The more important of these include the following (Mansfeld 1986).

Lippia dulcis Trév. (= *Phyla scaberrima* (A. Juss.) Mold. of some authors) is called Mexican lippia, Aztec sweet-herb, Orozuz, and sweet lippia. It is a perennial native of Central America. In Central America and the Caribbean, the intensely sweet-flavored leaves are used to sweeten tea and other beverages, as a condiment, and in salads, while the licorice-flavored roots are chewed (Facciola 1990). The leaves are also used in Central America to treat bronchial ailments, particularly whooping cough (Huxley et al. 1990). Seeds are available through North American catalogs. **Warning**: Do not use this plant for culinary purposes, especially if pregnant. The very toxic constituent camphor is the main component of the volatile oil of *L. dulcis*. This may be the basis for the use of the plant as an abortifacient in Mexico, as camphor can cross the placenta and cause neonatal death (Kinghorn 1987). For additional information, see *Stevia*.

Lippia alba (Mill.) N.E. Br., anise verbena or licorice verbena), is native to temperate and tropical Central America and South America and is cultivated in Argentina for its essential oil. It is a slow growing, frost-sensitive shrub that can be grown as a house plant in Canada and the northern U.S. The fresh leaves have an intense anise aroma reminiscent of lemon grass (*Cymbopogon citratus*, discussed in this book). The herb is prized as a flavoring of soup, meats, fish, and tea (Morton 1976). Tucker (1994) notes that plants grown in North America seem to have originated from Panama and are scented of anise/tarragon, while plants from Argentina have been found to have the odor of peppermint. The plant can be obtained through a nursery stock firm in Canada.

Lippia micromera Schauer, Spanish thyme, is native to South America and has been used as a culinary herb in some Caribbean countries. Additional species sometimes harvested from the wild and used as oregano in Mexico and Central America include: *L. affinis* Schauer, *L. cardiostegia* Benth., *L. formosa* T.S. Bandeg., *L. fragrans* Turcz., *L. origanoides* HBK, *L. palmeri* Wats.,

Fig. 199.
Anise verbena *(Lippia alba)*,
prepared by M. Jomphe. (Based on
Ruiz 18362 at Agriculture and
Agri-Food Canada herbarium, Ottawa.)

and *L. umbellata* Cav. (Tucker and Maciarello 1994). These species are likely incorporated into oregano that is collected from the wild and exported.

Lippia Graveolens HBK

Scientific (Latin) Synonyms

L. berlandieri Schauer

English Names

Mexican oregano
Also: Mexican marjoram, Mexican wild sage, té de pais [In addition to *L. graveolens*, some other species are sometimes called Mexican oregano, and are used as culinary herbs in Mexico and sometimes in the southern U.S (Hutson 1987). These include the following species of the mint family: *Monarda fistulosa* var. *menthaefolia, M. austromontana* (see *Monarda* for additional information), and *Poliomintha longiflora* Gray. Known as Mexican bush oregano, this species can be wintered indoors as an edible ornamental (Adams 1996). Irving (1972) noted that

Fig. 200.
Mexican oregano *(Lippia graveolens)*, prepared by S. Rigby. (Based on greenhouse plant from Richters.)

P. longiflora produces carvacrol, the compound that gives oregano its distinctive odor and flavor, and large amounts are collected in northeastern Mexico, where the plant is native, and sold locally or shipped to the U.S. A chemical analysis of *P. longiflora* is given in Tucker and Maciarello (1987); this showed a content of 45% carvacrol. Another species of *Poliomintha, P. incana* (Torr.) Gray of northern Mexico and the southern U.S., is reported to be cultivated (Kearney and Peebles 1951). The Hopi Indians eat the herbage raw or boiled, and use the flowers to season food (Kearney and Peebles 1951).]

French Names

Family: Verbénacées, famille de la verveine
Marjolaine du Mexique (f)
[Name suggested by both H.S. MacKee and F. Jacquemoud (personal communications).]

Note

This popular culinary herb has been shown to have anti-fertility properties (see Medicine), although little concern has been expressed to date about its use as food.

Description, Taxonomy, and History

Mexican oregano is a white-flowered shrub that grows up to 2.5 m tall in its native habitat of southern North America and Central America. It is adapted to rocky slopes and arroyos, and arid conditions. Cultivated and wild plants are not distinguishable. Little information seems available on its history. Borrego-Escalante et al. (1992) indicated that in prehispanic Mexico, oregano was used for medicinal rather than culinary purposes. [These authors refer to "*Lippia berlandieri*;" *L. berlandieri* Torr. is a synonym of *L. graveolens*.]

Uses

Mexican oregano leaves have an intense oregano aroma that is preferred by many over European oreganoes (species of *Origanum*). The flavor of Mexican oregano has been described as somewhat sharper and more pungent than that of oregano (Simon et al. 1984). Mexican oregano is employed in Mexican-style foods, and in Italian-style foods in the western U.S. However, on the east coast of the U.S. the European oreganoes are usually used in Italian foods. Mexican oregano is added to flavor fish, sausages, tomato sauces, and other dishes requiring a strong oregano flavor. *Pozole* (pork and hominy) is a well known Mexican dish flavored with *L. graveolens* (Morton 1976). The dried leaves are also brewed to make a herbal tea (Greenhalgh 1979). Uribe-Hernández et al. (1992) noted that, as of the time their article, Mexican oregano

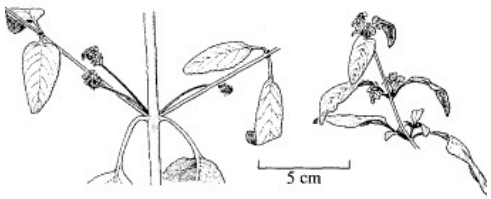


Fig. 201.
Mexican oregano *(Lippia graveolens)* flowering branches,
prepared by S. Rigby. (Based on greenhouse plant from Richters.)

was not used as a source of essential oil. However, Borrego-Escalante et al. (1992) suggested (without making it absolutely clear that they are referring to Mexican oregano, not oregano) that essential oils are extracted from the leaves and inflorescences for the cosmetic, food and pharmaceutical industries, and oregano oleoresin is used in liquor production.

Recipe Sources

Mexican oregano can be used in any recipes that call for oregano (see *Origanum* in this book). Borrego-Escalante et al. (1992) state that in Mexico it is used in pozole, menudo, soups, pickled chiles, and chorizo.

Importance

Lippia graveolens is often sold as true oregano in Mexico and the southern U.S. Mexico is the major producer of Mexican oregano. In 1988, the U.S. imported from Mexico 1 212 t of unprocessed oregano valued at $1,107,050 and 231 t of processed oregano valued at $340,820 (Anon. 1989*a*). This represented nearly half of the so-called "oregano" that was imported into the U.S. Uribe-Hernández et al. (1992) noted that about 50% of Mexican oregano harvested in Mexico, amounting to about 3 200 t, is exported, but that demand in the last 2 years had decreased drastically. Borrego-Escalante et al. (1992) indicated that in the 1980's Mexico produced an average of 3 000 t of oregano per year. Canada imports limited amounts of Mexican oregano from Mexico (Greenhalgh 1979).

Cultivation Notes

Soil

Well-drained, moderately fertile soils are best for plants grown outdoors. In its native habit Mexican oregano grows typically in dry, sandy soil. However, this perennial can only be grown year-round in northern North America as a potted houseplant or greenhouse plant, placed outside for

the summer if desired. In pots, a freely-draining, medium-fertility, loam-based potting mix is recommended (Huxley et al. 1992). A rich soil (or partial shade) make the plant grow leggy, increasing leaf size but decreasing piquancy (Hutson 1987).

Climate

Mexican oregano is basically unsuitable for commercial production in northern North America because it is adapted to frost-free climates, and is susceptible to freeze damage. It requires full sun and good ventilation. In their natural habit in northern Mexico, the plants are adapted to aridity (Borrego-Escalante et al. 1992). Indoor plants require moderate watering during growth. The plants should be overwintered with as little water as possible, and a minimum temperature of 10°C.

Propagation and Cultivation

Propagation is by seed or vegetative cuttings taken in the spring from basal or nodal softwood cuttings. Tip cuttings may be rooted in sand (Hutson 1992). The simplest way to obtain a plant is from a nursery. Borrego-Escalante et al. (1992) studied seed germination, and found that an average of 65% germination occurs in incubators at 25°C with 8 hours of light each day. They observed that brown seeds are harder to germinate than green seeds, possibly because of the presence of germination inhibitors, but that cold pretreatment stimulates germination of the brown seeds. Cuttings can be also taken of semi-hardwood shoots in early summer. These are rooted in a closed case with gentle bottom heat (Huxley et al. 1992).

According to Hutson (1992), too much water, too rich a soil, and fertilization tend to produce large leaves lacking in flavor.

The species can be placed outside over the summer but this tender annual must be brought indoors before any threat of frost. Properly pruned Mexican oregano in a bright window or greenhouse will grow into a small bush or miniature tree.

Harvest and Storage

The tender shoots and leaves can be harvested as needed and either used fresh or dried and stored in air-tight containers. Hutson (1992) recommends drying the harvested branches upside down, away from direct light. Pino et al. (1994) found that grinding Mexican oregano resulted in significant losses of nearly all chemical components except thymol and carvacrol, and that the ground spice has lower aroma intensity and freshness than unground oregano.

Example Cultivars

Cultivars are not available.

Additional Notes

Chemistry

Pino et al. (1989) identified 33 components of the essential oil of Mexican oregano. The oil usually contains mostly thymol (40-60%), and only a little carvacrol (3-21%) unlike some other sources of "oregano" (Lawrence 1984*c*). However in some populations carvacrol content exceeds that of thymol (Uribe-Hernández et al. 1992). Uribe-Hernández et al. (1992) identified two of 12 Mexican populations examined, with a thymol content of over 30% and an oil yield above 1.8%, that they considered held out the possibility of commercial exploitation. Tucker and Maciarello (1994) review various reports of chemical content of the essential oil of "Mexican oregano," but it should be kept in mind that which species are involved is often open to question.

Medicine

Mexican oregano has been used in traditional medicine in Central America for cases of respiratory problems (Grieve 1931), and against parasites, for malaria, and tooth pain (Borrego-Escalante et al. 1992). It is employed in Mexico in medicinal preparations as an antispasmodic (to prevent or relieve spasms or convulsions), diuretic (to promote the flow of urine), expectorant (to promote discharge of mucus from the respiratory tract), and stomach tonic (Borrego-Escalante et al. 1992). It has also been associated with antifertility activity in Mexico (Dominguez et al. 1989). The chemical that might contribute to the antifertility, lapachenole, is carcinogenic, and this "casts a shadow on the advantages of using this folk medicinal plant" (Dominguez et al. 1989). Compadre et al. (1987) note that *p*-cymene, which composed 28% of a sample they examined, is a relatively high concentration of this very toxic monoterpene.

Nutrition

No information found. Like other species that serve as "oregano," too little is consumed to add significant nutrition to the human diet.

Curiosities

• *Lippia* is named after Auguste (Augustin) Lippi (1678-1704), a Parisian botanist and physician who was killed in Abyssinia (Ethiopia) (Fournier 1947-48).

• Borrego-Escalante et al. (1992) speculated that production of Mexican oregano in Mexico increased after the nuclear explosion at Chernobyl, USSR in 1986,

because of reduced competition from oregano on the international market from Greece and Turkey, whose crops may have been affected by radioactive fallout.

Problems and Potential

Mexican oregano has little chance of outdoor commercial production in northern North America since it is adapted to long-season, warm climates, and can be produced more efficiently in countries such as Mexico. It is also likely to remain merely a curiosity of home gardens. It could be grown in northern greenhouses to supply fresh oregano to local specialty shops. A special problem for Mexican oregano is that its natural populations are being overharvested and exterminated in Mexico (Borrego-Escalante et al. 1992), and so valuable germplasm that may be useful for its future improvement is in danger of extermination.

Selected References

Greenhalgh (1979); Facciola (1990); Borrego-Escalante et al. (1992); Huxley et al. (1992).

Fig. 202.
Horehound *(Marrubium vulgare)*, from Köhler (1883-1898).

Marrubium

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

Marrubium has about 35 species of perennial herbs native to the Mediterranean region and Eurasia. A few of these are cultivated as garden ornamentals.

Marrubium Vulgare L.

English Names

Horehound
Also: common horehound, hound-bane, marrube, marrubium, marvel, white horehound
[Horehound is also rendered hore-hound and hoarhound. Other cultivated plants of the mint family that have "horehound" in their name include: black horehound, *Ballota nigra* L.; and water horehound, species of *Lycopus*.]

French Names

Family: Labiées, famille de la menthe
Marrube blanc (m)
Also: blanc rubi, bonhomme, bouenrib1é, grand bon-homme, grand-bonhomme, herbe aux crocs, herbe vierge, maltrasté, mapiochin, mariblé, marinclin, marrochemin, marrube, marrube commun, marrube des champs, marrube officinal, marrube vulgaire, mont blanc

Note

This species is pharmacologically active. Its use as a culinary herb should be limited.

Description, Taxonomy and History

Marrubium vulgare is native to central and western Asia, southern Europe, northern Africa, the Canary Islands, and the Azores. It prefers sandy soils and a maritime or mountain climate. Horehound is naturalized in England, Australia, and in North America. In its northern naturalized range in North America, horehound has been collected in most Canadian provinces, and even in Alaska. It is often found as a weed in dry sandy fields, dry slopes and waste places, and on roadsides. Hooklike appendages on the seeds fasten them to animals, spreading the seeds extensively, accounting for the plant's. This perennial grows 30-80 cm in height, develops yellowish white flowers 5-8 mm long from late spring until autumn, and produces a musky odor. The leaves are distinctly crinkled. The stem is white-wooly and the foliage densely covered with whitish felted hairs, hence the name white horehound.

Fig. 203.
Horehound *(Marrubium vulgare)*,
from Hallier (1880-1888).

Horehound has been used for medicinal purposes since antiquity. It was known to ancient Egyptians and Greeks as a medicinal plant (Stuart 1979).

Uses

For the home gardener, horehound marginally qualifies as a culinary herb, limited by its musky (some say musty) odor and bitter, pungent taste. Muenscher (1978) stated "horehound is one of the herbs where it is especially important to start with just a little until you have learned how much you will like... if you use too much you may never want to try it again." It is sometimes used in making candies and other confections. Horehound candy is bitter, but has a unique flavor. In Europe, the plant has been used to flavor salads, soup, fish and chicken (Evstatieva, personal communication). Muenscher (1978) recommended horehound as a seasoning for meat, stews,

sauces, cakes, and cookies, and suggested that it would also be suitable for stronger-tasting vegetables. The plant is also used to brew herbal teas, but generally for medicinal, not strictly culinary purposes, most often to treat coughs and colds by those who choose to treat themselves with herbals. Horehound has also been used to brew horehound ale. In large quantities the tea can be laxative and diuretic (promoting urine flow), and can induce diarrhea and nausea (Simon et al. 1984). Note the caution regarding consumption at the head of the presentation of this species. In fairness, it should be noted that "horehound is generally recognized as safe for human consumption as a natural flavoring and plant extract" (Simon et al. 1984).

Commercially, the foliage and stems of horehound are boiled. and used in the preparation of candied products, cough drops, and syrups. Extracts are used to flavor liqueurs, non-alcoholic beverages, ice cream, candy, and baked goods (Furia and Bellanca 1975).

The medicinal use of horehound is dealt with in the section on medicine. In the past, horehound was occasionally used as a snuff (Crockett and Tanner 1977). Horehound is grown as an ornamental, and as bee forage. A tasty honey is produced from the plant.

Recipe Sources

Grieve (1933) has recipes for Horehound beer (two recipes), Horehound drink, and Root beer; she also provides guidance in preparing candied horehound. Gibbons (1966) has recipes entitled Horehound drops and Horehound tea. Muenscher (1978) presents the following recipes: Horehound candy, Horehound tea, and Hominy and beef Muenscher.

Other recipes are: Horehound candy (Scoby and Myers 1975; Erichsen-Brown 1975; Mazza 1976); Horehound toffee (Garland 1979); Horehound tea (Marcin 1983); Horehound lozenge (Adams 1987).

Importance

Horehound used to be gathered from the wild for commercial pharmaceutical preparations, and wild plants are still sometimes harvested. For commercial uses, however, horehound is mostly grown in plantations in Europe. Horehound is a very old-fashioned medicinal herb, of very limited economic importance.

Cultivation Notes

Soil

Horehound is known for growing well in dry, poor soil. However, it responds quite well to fertilization (Tremblay, personal communication). It is suited to light, dry, calcareous soils with good drainage. If grown on heavy soil,

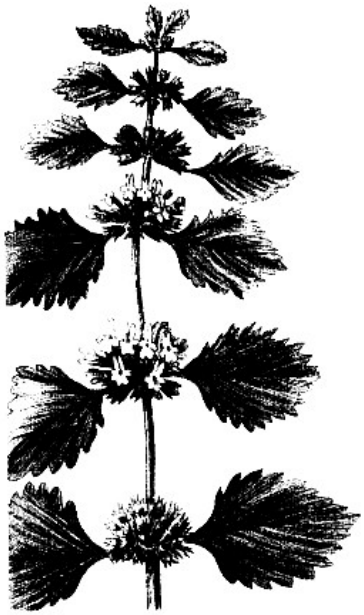


Fig. 204.
Horehound *(Marrubium vulgare)*,
from Lamarck and Poiret (1791-1823).

addition of compost is beneficial (Page 1980). Reported pH tolerance ranges are 4.5-8.3 (Simon et al. 1984), and 4.5-8.4 (De Baggio 1987).

Climate

Horehound prefers warm locations. It grows best in full sun and it withstands intense heat well. Bergeron et al. (1995) described it as xerophytic. Given its very wide distribution in the word today, horehound seems able to survive in some cold north temperate areas, although it may require protection in very cold situations. Tremblay (personal communication) has found that 50-70% of stands do not survive the winter in the Montreal area, and protection with insulating fabric did not improve survival. It may be that selections from cold areas are desirable for northern climates.

Propagation and Cultivation

Usually the plants are multiplied by root division, but they can also be increased by cuttings. According to Erichsen-Brown (1975), both divisions and cuttings are

difficult to make, and it is best to make these when new growth starts in the spring. Seeds are also used, but plants sown from seeds will usually take 2 years to produce flowers. In the Montreal area, Tremblay (personal communication) did not succeed in establishing open field stands directly from seeds, and he recommends that seedlings be established in a greenhouse for outdoor transplantation. Seeds should be planted about 6 mm deep, preferably in warm soil, with seedling emergence usually in 10-20 days [Wang et al. 1993; Tremblay (personal communication) recommends that seeds be sown 3-4 mm deep]. Seedling emergence may be extremely variable (Crockett and Tanner 1977). The seedlings may be thinned so that the plants are fairly closely spaced- 20-25 cm apart - to help keep the stems erect (Crockett and Tanner 1977). The main care that should be provided is weeding.

Harvest and Storage

For culinary purposes, cut flowering shoots should be harvested and dried when in early flower (Erichsen-Brown 1975). The tops of the plants are also collected for medicinal use. These are also cut off during early flowering, and dried in thin layers in the shade, or under low artificial heat. Cultivated commercial stands (in suitable climates) generally last 4 or 5 years, and can be cut two or three times each year. Yields of 2.2 t/ha of dry herb have been obtained (Sievers 1948). In the Montreal area, growers have averaged 2.6 t/ha dry herb, with experimental results of 3.2-5.4 t/ha (Tremblay, personal communication).

Example Cultivars

Green Pompon (listed in Richters 1995).

Additional Notes

Chemistry

The main constituent of horehound is the bitter principle premarrubiin (premarrubin), a bitter diterpenoid lactone found in concentrations from 0.3 to 1.0% (Tyler 1993). This transforms to marrubiin (marrubin) during isolation. Also present are tannins, resins, waxes, and a volatile oil with monoterpenes and a sesquiterpene (Simon et al. 1984).

Medicine

Horehound was used for respiratory problems in classical Rome and for the same purposes in Europe down to recent times (Castleman 1991). Horehound was once regarded as "the sovereign remedy for coughs" (Crockett and Tanner 1977). It has been used as a remedy against asthma, coughs, colds, bronchitis, sore throats, and skin irritations since antiquity. Horehound has also been used

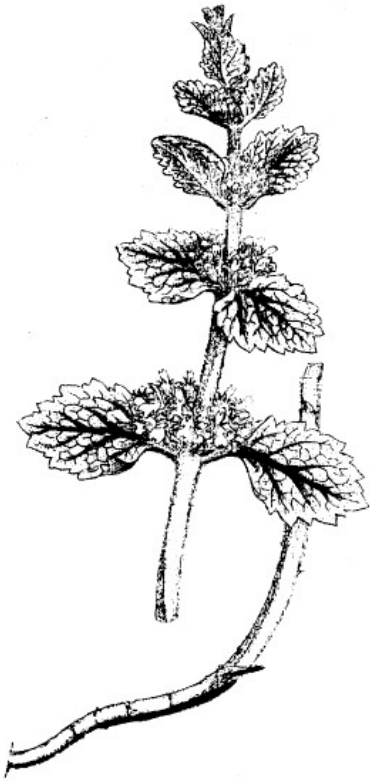


Fig. 205.
Horehound *(Marrubium vulgare)*,
from Syme et al. (1863-1886).

as a tonic, laxative, vermifuge, and ointment for wounds, and to treat menstrual pain (Grieve 1931; Stuart 1979; Simon et al. 1984). Folk herbalists have also used it to treat hepatitis and malaria (Castleman 1991).

Use of horehound in modern medicine is very limited (Starý and Jirásek 1973). However, horehound is pharmacologically active, reportedly stimulating appetite, acting as an expectorant in bronchitis, and possibly affecting heartbeat (Starý and Jirásek 1973). Tyler (1993)

has reviewed these medical claims. The expectorant property has been attributed to marrubiin or premarrubiin, and marrubiin in small doses has the reputation of normalizing heart irregularities. Marrubic acid which can be formed from marrubiin might be responsible for the purgative properties of horehound. In Germany, horehound is prescribed as an appetite stimulant and digestive aid. Horehound extracts are widely used in cough and cold remedies, and there has not been any concern for possible toxic effects. Horehound has been used as a replacement for quinine in cases of intolerance to this alkaloid (Furia and Bellanca 1975). However, the plant juice may cause dermatitis (Foster and Duke 1990). Horehound is laxative in large doses (Stuart 1979). Excessive consumption can also lead to nausea (Simon et al. 1984). In 1989 the Food and Drug Administration of the U.S. stated that horehound was ineffective and banned it in over-the-counter remedies (Castleman 1991).

Nutrition

Stuart (1979) has noted the presence of vitamin C in horehound. However, no nutritional advantages of horehound have been reported, and given its pharmacological activity, so little can be consumed that the plant cannot be used as a source of nutrition.

Curiosities

• One interpretation of the origin of the generic name *Marrubium* is that the classical Romans, who esteemed horehound for its medicinal properties, named it in allusion to the ancient Italian town of *Maria urbs* (Grieve 1931).

• Another interpretation of the origin of the generic name is that it derives from the Hebrew *marrob*, a bitter juice, and that it was one of the bitter herbs which the Jews were ordered to take for the Feast of Passover to commemorate the exodus of the Israelites from Egypt (Grieve 1931).

• The "hore" in horehound is rather suggestive. However, it is generally thought to derive from the Middle English *hor*, and Old English *har*, meaning white or frosty (cf. hoarfrost), and is simply a reference to the white pubescence covering the plant (Simon et al. 1984). "Hound" may refer to the use by the ancient Greeks of the plant as an antidote to bites from mad dogs (Tyler

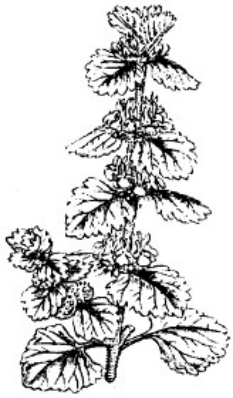


Fig. 206.
Horehound *(Marrubium vulgare)*
from Fitch (1924).

1993). Stuart (1979) stated that the common name is derived from the Old English *har hune*, meaning a downy plant. Lust (1974) thought the name refers to the ancient Egyptian god of the sky and light, Horus.

• In classical Rome it was thought that placing a horehound plant in milk in a house would eliminate all the flies (Fox 1933).

• Marrubiin has the jaw-breaking chemical name (6-[2-(3-furanyl) ethyl] decahydro-6-hydroxy-2a, 5a, 7-trimethy1-2H-napthol [1,8-bc] furan-2-one; 15, 16-epoxy-6ß, 9-dihydroxy-8ßH- -13(16), 14-dien-19-oic acid -lactone) (Bergeron et al. 1995).

Problems and Potential

Horehound is of marginal culinary and ornamental importance, economically notable only as a garden rarity offered by specialist herbal garden suppliers. Horehound is of extremely minor significance as a drug plant, and unless pharmacological uses are developed in the future, has very limited commercial economic potential.

Selected References

Grieve (1931); Simon et al. (1984); Tyler (1993).

Matricaria

Family: Compositae (Asteraceae) (sunflower family)

Genus Notes

Matricaria has about 35 species of annual, biennial, and perennial herbaceous plants native to Eurasia, South Africa, and western North America. Several of the species are grown as ornamentals. So-called Moroccan chamomile oil, used in perfumery, is extracted from the flowering tops of *Ormemis multicaulis* Braun-Blanquet & Maire, said to be related to *M. recutita*, described below (Arctander 1960).

Matricaria Recutita L.

Scientific (Latin) Synonyms

Chamomilla recutita (L.) Rauschert
[Commonly and mistakenly called *M. chamomilla*, although not fully identical to *M. chamomilla* L.]

English Names

German chamomile
Also: chamile, common chamomile, false chamomile (same name used for Roman chamomile), Hungarian chamomile, matricaria, sweet false chamomile, true chamomile (same name used for Roman chamomile), wild chamomile
["Chamomile" is generally pronounced with a long i.]

French Names

Family: Composées, famille de la marguerite
Camomille allemande (f)
Also: amarelle, amerolle, camomèle, camomille, camomille d'Allemagne, camomille commune, camomille hongroise, camomille sauvage, camomille vraie, matricaire camomille (an undesirable usage since, as noted above, *M. chamomilla* L. is a different species), oeil du soleil, petite camomille.

This species is often confused with *Chamaemelum nobile* L., Roman chamomile, also discussed in this book. Both species have feathery, fernlike foliage, and both have small daisylike blossoms that are yellow in the centre and have white petals. Both have an apple aroma, and both are used medicinally as a tea. Both have been called "true chamomile." While both have been used for centuries as medicinal plants, primarily due to azulenes in the essential oil (higher in German than Roman), the two species are quite dissimilar in their essential oil and chemical composition (Mann and Staba 1986). The table below gives some diagnostic differences.

Warning

Chamomile is a member of the same plant family as ragweed, and people allergic to ragweed or other members of the sunflower family need to be particularly cautious in consuming it (see Medicine).

Description, Taxonomy, and History

Matricaria recutita is a sweet-scented, yellow-flowered annual, sometimes growing to a height of almost a meter. It is native to Europe and western Asia, and has

Differences between German and Roman chamomile

Common name	German chamomile	Roman chamomile
Scientific name	*Matricaria recutita* L.	*Chamaemelum nobile* L.
Longevity	annual	perennial
Stems	stems erect, to 1 m tall; smooth	stems creeping, to 25 cm tall; slightly hairy
Leaves	Twice-divided into thin, linear segments	Twice- or thrice-divided into linear segments that are flatter and thicker than those of German chamomile
Flower arrangement	Flower heads on divided stems in a comb-like arrangement called a *corymb*	Flower heads single atop stems
Receptacle (found at base of flowers)[1]	hollow; disk medium-conical	solid; disk broadly conical

[1]Foster (1992/1993) recommends that five or ten flowers should be examined, as occasionally a German chamomile flower will be solid in the interior.

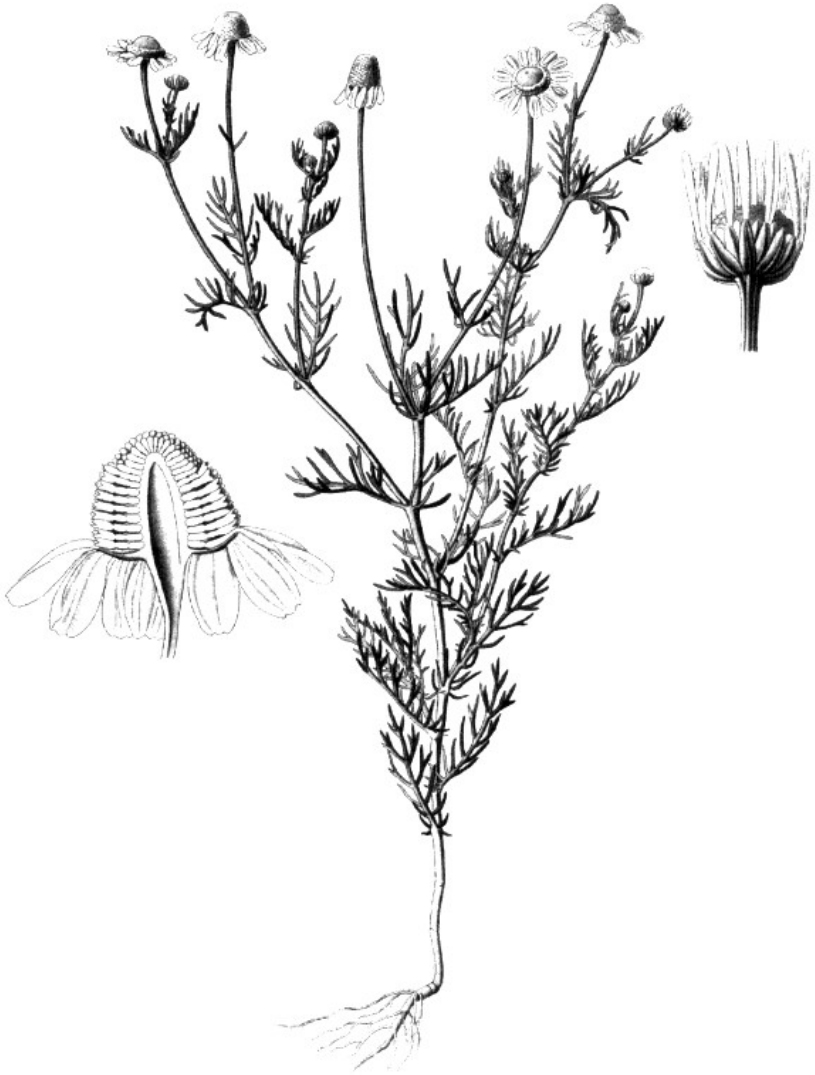


Fig. 207.
German chamomile *(Matricaria recutita)*, from Köhler (1883-1898).
Note long section of flower head at left, showing hollow receptacle.

Fig. 208.
German chamomile *(Matricaria recutita)*,
from Syme et al. (1863-1886).

become naturalized in almost all of Europe, central Asia, North America, and elsewhere. Dried flowering heads of German chamomile have been used medicinally since antiquity, dating back to ancient Egypt, Greece, and Rome. German chamomile has been alleged to be somewhat less aromatic than Roman chamomile (Grieve 1931), although this is questionable (Letchamo, personal communication).

Uses

German chamomile flowers are dried for use in herbal teas. According to Rinzler (1990) the flowers of German chamomile are not as strongly scented as those from Roman chamomile, but are sweeter and are preferred for tea.

The flower heads are collected for use in the pharmaceutical industry (as "chamomillae flos"). Both the herb and the extracted essential oil are used medicinally. The essential oil is used in alcoholic beverages (including such fine French-type liqueurs as Benedictine and D.O.M.), confections, desserts, gelatins, ice cream, candy, pudding, baked goods and chewing gum (Duke 1985; Facciola 1990). The essential oil is also used in perfumes, soaps, detergents, lotions, creams, cosmetics, shampoos, and hair dyes (Duke 1985; Mann and Staba 1986). Extracts are used in bath preparations, hair dyes, mouth washes, shampoos and sunburn preparations (Duke 1985).

German chamomile is used by herbal enthusiasts in miscellaneous ways, as a hair rinse, insect repellent, antiseptic, and in potpourri. It has been employed since the days of the Vikings in shampoos because it adds luster to blond hair (Castleman 1991).

Matricaria recutita is occasionally cultivated in gardens as an ornamental.

Recipe Sources

Crowhurst (1973) has recipes for Chamomile tea, Chamomile mead, and Chamomile syrup. Other recipes for chamomile tea are provided by Loewenfeld and Back (1974) and Phillips (1986).

Importance

German chamomile is cultivated for its essential oil in Argentina, Egypt, Poland, Germany, Hungary, the former Czechoslovakia, Russia, and several other European countries, and to a small extent in Egypt and India. Wild plants of German chamomile were until recently collected locally in central Europe for the same purpose. About 4000 t of chamomile (German and Roman, but mainly German) were produced annually in the 1980's [Mann and Staba (1986), a figure that has increased to as much as 20,000 t in the 1990's (Franz, personal communication)]. Verlet (1993) estimated the annual world value of "blue chamomile" (presumably German chamile) essential oil to be $5,400,000.00 (U.S.), in contrast to that for Roman chamile, at $3,000,000.00 (U.S.). German chamomile is used in pharmacological preparations more extensively in Germany than in any other country, and high levels of quality control have been developed (Mann and Staba 1986).

Substantial amounts of chamomile, mostly German, are also grown in Europe for chamomile and other herb teas.

According to Tyler (1993*b*), "this herb is perhaps the best example of the wide chasm separating medicinal practice in Western Europe and The United States."

Whereas Europeans use chamomile internally and externally for a variety of conditions, it is basically a culinary tea in North America.

Cultivation Notes

Soil

German chamomile grows well in poor, clay soils, even in saline soils, although commercial cultivation is best in light, sandy loam soil with high levels of potassium (Salamon 1992). Soils in which chamomile has been grown range in pH from 4.8 to 8.3 (Simon et al. 1984), Salamon (1992) recommending a pH range of 4.5-7.5. Many new varieties are best grown at a pH of 5.6 to 6.8 (Letchamo, personal communication).

Climate

Young seedlings will withstand mild frost (Foster 1992/1993). Full sun is desirable, but slight shade will be tolerated. Abundant moisture is desirable for commercial cultivation, although wild plants will tolerate dry conditions. Optimal temperature for flowering is 19-20°C, with the blooming period shortened by higher temperatures (Salamon 1992).

Propagation and Cultivation

German chamomile is grown from seed, which should be provided with plenty of moisture and light. A seedling depth of 6 mm or less, and a soil temperature of about 7°C have been recommended, with seedling emergence usually in 5-10 days (Wang et al. 1993). The seeds are very tiny, and Foster (1992/1993) recommends that the seed bed be well-prepared, and the seeds simply scattered on the sows surface, and gently tamped down. Seedling development is slow initially, requiting good weed control. Young seedlings, 2.5-5 cm tall, are easily transplanted, but not older ones (Foster 1992/1993). Once established, German chamomile self-sows readily. Three to 4 months is the usual time form seeding to harvest in central Europe. Because under very favorable conditions German chamomile can be grown commercially in as little as 2 months, it can be interplanted with other crops, or planted as an early or late crop. Detailed cultivation recommendations are provided in Salamon (1992).

Harvest and Storage

In the home garden, flowers can be picked during the summer, dried naturally or with low artificial heat. When completely dry, they can be stored in jars in the dark. Plastic bags should not be used for storage (Letchamo, personal communcation). Commercial storage conditions were studied by Letchamo (1993).

Commercial collecting is carded out while the flowers are fully developed, and mechanical harvesters may be used. Collected biomass is separated into flowers and waste material, and generally drying is in sheds using forced hot air (Salamon 1992). Yields of 300-500 kg/ha dry flowers are typical in Europe, with as much as 1200 kg/ha possible (Salmon 1992).

Example Cultivars

Salamon (1992) discusses essential oil cultivars used in the former Czechoslovakia, noting that the newly bred Bona, Kosice-1, and Kosice-2 have over twice the essential oil content of the older Bohemia. Salamon and Honcariv (199<h2>4) examine essential oil characteristics of varieties Bohemia, Bona, and Goral. Lutomski (1993) discusses the cultivar Zloty * Lan*. Other pharmacological cultivars are Rubomille, Manzana, and Dugumille (see Carle and Isaac 1985).

Fig. 209.
German chamomile *(Matricaria recutita)*,
prepared by M. Jomphe. (Based on B. de Vries 3139-66
at Agriculture and Agri-Food Canada herbarium,
Ottawa.)

Additional Notes

Chemistry

About 120 secondary metabolites have been identified, of which there are approximately 28 terpenoids and 38 flavonoids (Salamon 1992), including the flavonoids matricarin, and apigenin (Simon et al. 1984). Lawrence (1987*a*) provides an extensive summary of the chemistry of chamomile oil. The essential oil contains chamazulene, -bisabolol, -bisabololoxides A and B, spathulenol, and farnesene (Simon et al. 1984). Chamazulene and bisabolol are considered medicinally effective (Starý and Jirásek 1973). Depending on geographical origin, chamazulene and other components may or may not be present in appreciable quantities (Mann and Staba 1986). Franz et al. (1985) recognized the following chemical races: (a) types free of chamazulene but rich in bisabolonoxide, endemic to southeastern Europe and Asia Minor; (b) chamazulene- and bisabolol-oxide types, predominating in Middle Europe; and a wild chamomile rich in chamazulene and (-)- -bisabolol, native to northeastern Spain. Other constituents that have been found in chamomiles include anthemic acid, antheminidine, matricin, cic-trans dicycloethers, and tannins (Simon et al. 1984; Letchamo, personal communication).

Medicine

German chamomile has been used as a tonic, sedative, and to relieve alimentary gas (Grieve 1931). In folk medicine, it has been employed against asthma, colic, fever, inflammations, and cancer (Simon et al. 1984). Duke (1985) lists many more medicinal uses in different countries.

German chamomile is employed in at least 18 different medicinal preparations in Germany (Mann and Staba 1986), and indeed appears to have useful medicinal properties. German chamomile is also used currently in Chinese medicine (Duke and Ayensu 1985). Tyler (1993*a*) notes that the therapeutic value of chamomile is due to a complex mixture of different compounds. The principal anti-inflammatory and antispasmodic compounds appear to be (-)- -bisabolol and matricin, supplemented by flavonoids such as apigenin-7-glucoside, luteolin, and coumarins in the flower heads. Extracted chamazulene has shown some usefulness as an anti-inflammatory and fever-reducing agent, and other extracts have shown antiseptic, antibacterial, and antifungal properties (Simon et al. 1984). Alpha-bisabolol is regularly recommended in the treatment of ulcers induced by alcohol or X-ray bums (Salamon 1992). Staba and Mann (1986) present an extensive analysis of the medicinal properties of the chamomiles.

Individuals allergic to ragweeds may show hypersensitivity reactions to German chamomile (contact dermatitis, anaphylaxis, or other symptoms). Persons with known sensitivity to other members of the Compositae family (such as ragweed, asters, and chrysanthemums) should avoid contact with both German and Roman chamomile and their products, as "cross-reactivity" is possible. Additional information pertaining to German chamomile is presented in the discussion of Roman chamomile. In some cases, the allergenic potential of chamomile preparations seems to have been due to adulteration with Mayweed (*Anthemis cotula* L.) containing anthecotulide (Franz, personal communication).

Tyler (1993*a*) stated regarding chamomile tea that because of its infrequency "chamomile hypersensitivity should certainly not deter normal persons from consuming it if they so desire." Indeed, some researchers "believe that when the tea is used over a long period, beneficial effects may accumulate" (Tyler 1993*a*).

Nutrition

The chamomiles are consumed in such limited amounts that they do not supply significant nutrition. However, the straw can be used as animal feed to improve milk production (Letchamo, personal communication).

Curiosities

• The genus name *Matricaria* arises from the Latin *mater*, mother, or *matrix*, womb, for its use in treating female complaints (Stuart 1979).

• The ancient Egyptians considered German chamomile to be a sacred present from the sun god, useful for alleviating the effects of high temperatures and sun strokes (Salamon 1992).

• Diurnal cycles of concentration of some essential oil components have been discovered in German chamomile. For example, content of bisabolol and chamazulene increase during the mornings and evenings, while farnesene content is maximum in the morning, and almost undetectable in the evening (Mann and Staba 1986).

• Just which of Roman or German chamomile should be called "true chamomile" and which "false" is open to debate. There is no certainty regarding which plant was meant by the *chamaimelon* of the classical Greek Dioscorides (Stuart 1979). The Germans naturally believe that German chamomile is the true chamomile. Reflecting the English viewpoint of the time, Grieve (1931) referred to the Roman chamomile as the true chamomile.

• An estimated I million cups of chamomile tea are consumed daily, worldwide (Tyler 1993*b*).

• So popular is German chamomile in Germany that it is often called *alles zutraut*, translated by Castleman (1991) and Foster (1992/1993) as "capable of anything."

• The respect afforded German chamomile in folk medicine in Slovakia is reflected by a saying that an individual should always bow when facing a chamomile plant (Salamon and Honcariv 1994).

• Chamomile suppositories are available to treat hemorrhoids in Germany (Weiss 1988; compare Roman chamomile Curiosity regarding danger of an allergenic reaction to a chamomile enema).

• Weiss (1988) relates the following popular method for taking a chamomile steam bath to treat hemorrhoids. Put a handful of the flowers into a bucket and add 2 or 3 L of boiling water. Sit on the bucket, sealing it completely.

Problems and Potential

German chamomile is commonly marketed in chamomile teas, and is widely available, albeit used by relatively few in North America. The market for such culinary use is stable. The pharmaceutical trade shows a continuing interest in using the chamomiles, and the possibility exists of expanding the North American crop, despite established competition in Europe.

Selected References

Grieve (1931); Simon et al. (1984); Mann and Staba (1986); Hamon (1989); Salamon (1992); Foster (1992/1993).

Melissa

Family: Labiatae (Lamiaceae) (mint family)

Genus Notes

Melissa has about three species of perennial herbs native from Europe to central Asia and Iran. Like *M. officinalis* described in detail below, *M. parviflora* Benth., a herb of the temperate Himalayas, is also used to flavor food products (Pandey 1990).

Melissa Officinalis L.

English Names

Lemon balm
Also: balm, balm mint, bee balm, common balm, English balm, garden balm, honey plant, sweet balm
["Bee balm" is usually applied to species of the genus *Monarda* (also treated in this book), and the use of this common name for two different genera has resulted in the frequent confusion of *Melissa* and *Monarda* culinary herbs.]

French Names

Family: Labiées, famille de la menthe
Mélisse (f)
Also: abeliana, céline, citron des abeilles, citron(n)ade, citronnelle (often citronelle), herbe à citron, herbe au citron, herbe citronnée, herbe du citron, mélisse citronnée, mélisse citronnelle, mélisse cultivée, mélisse des jardins, mélisse officinale, mélisse romaine, piment des abeilles, piment des mouches (à miel), piment des ruches, poncirade, thé de France (reflecting historical popularity in France)
["Citronelle" (or "citronnelle") is applied to several species, some of which are treated in this book. Other species mentioned in this book called citronelle include lemon verbena, *Aloysia triphylla*; southernwood, *Artemisia abrotanum* (see Genus notes for *Artemisia*); and lemon grass, *Cymbopogon citratus*. Culinary herb species called citronelle but not discussed in this book include (Bois 1934): *Eucalyptus citriodora* Hooker and *Dracocephalum moldavica* L. Note in the discussion of catnip that mélisse has occasionally been used to designate lemon-scented catnip. Mélisse has also been used for *Perilla frutescens*.]

Description, Taxonomy, and History

Melissa officinalis is a lemon-scented, spreading, erect, bushy perennial herb, growing from a short rhizome, 20-80 (sometimes to 150) cm tall. The flowers are white, yellowish-white, pinkish or sometimes purplish or bluish. The species is a native of the eastern Mediterranean region southward to Israel and Syria and eastward through the Crimea, the Caucasus, and northern Iran to Tien Shan and Pamir. It appears to have been naturalized in the western Mediterranean, in the Alps, and elsewhere in Europe (Mansfeld 1986). It has been collected as a garden escape or naturalized plant in roadsides, open woods and waste places in the eastern U.S., and sparingly across Canada. A variegated ornamental cultivar is sometimes grown. Lemon balm has been cultivated for medicinal and culinary purposes since antiquity, and was well known to the ancient Greeks and Romans as a bee plant.

Uses

Lemon balm can substitute for many of the uses of lemon thyme (*Thymus citriodorus*, also discussed in this book). Lemon balm is grown in kitchen gardens for its lemon-scented, lemon-flavored, bitter leaves, used in salads, sandwiches, soups, stews, butter, stuffings for pork, veal or poultry, fish, egg dishes, vegetable dishes, fruit purées, fruit cups, jams, jellies, dressings, marinades, sauces, and herbal vinegar (particularly tarragon vinegar). Other beverages in which lemon balm may be used include herb teas, wines, and summer punches, and soft drinks. Both dried and fresh leaves are used, and should be employed somewhat more generously than most other herbs because the aroma is rather delicate (Page 1980). The flowers are sometimes candied. Lemon balm oil is used to flavor beverages, ice cream, candy, and baked goods, and is also employed in perfumes (Morton 1976). Crushing lemon balm leaves before use is recommended to release the lemony flavor (Rinzler 1990).

Lemon balm once had a considerable reputation as a medicinal herb. The essential oil is still employed in medicine to some extent, as well as in the perfume industry (it used to find abundant use in cologne), and for such varied manufactured items as furniture polish oil and salve. The oil is also used to flavor alcoholic beverages, particularly Chartreuse, Benedictine and other liqueurs, and in candy and baked goods. The species is frequently grown in home gardens for its attractive scent, and dried leaves are often used in potpourris. Erichsen-Brown (1975) recommends rubbing wooden furniture with fresh lemon balm instead of with lemon oil. Several ornamental varieties are available. Lemon balm is also an excellent bee plant.

Fig. 210.
Lemon balm *(Melissa officinalis)*, from Köhler (1883-1898).

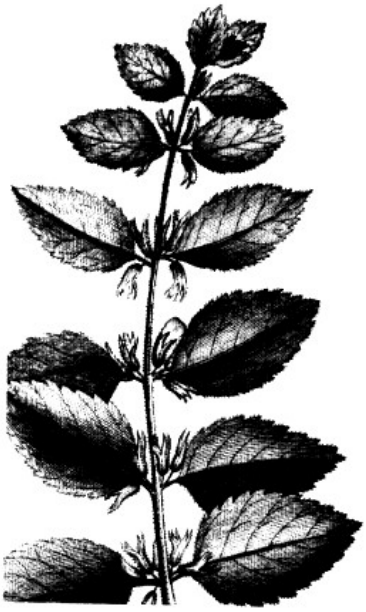


Fig. 211.
Lemon balm (Melissa officinalis),
from Lamarck and Poiret (1791-1823).

Recipe Sources

Rose (1979) gives recipes entitled: Lemon balm wine, Balm-wrapped fish, and Compound balm-water [the cordial commonly called eau de Cannes]. Michael (1980) has recipes for Balm butter with fish, Balm and borage wine cup, and Balm wine. Belsinger and Dille (1984) present 13 recipes for lemon balm, notably: Anchovy balm butter, Lemon balm broth, Baked snapper with onions and balm, Chicken roasted with lemon balm, Vegetable balm vinaigrette, Lemon balm custard sauce, Lemon cake, Pineapple balm sorbet, and Lime balm tart. Hutson (1987) has recipes for Lemon balm vinaigrette, Garden punch, and Elegant lemon balm butter. Leggatt (1987) gives recipes for Lemon balm and elderflower sorbet, and Home-made lemonade with lemon balm and mint flowers. Bremness (1988) has recipes for Spicy lemon balm kebabs and Lemon balm cheesecake. Gilbertie (1988) has recipes entitled: Glazed raspberrry tarts with lemon balm, Chicken and papaya salad with honey lemon balm dressing, Rhubarb lemon balm tea bread, Crepes filled with lemon balm and kiwi, and Microwave lemon balm Spanish orange marmalade. Richardson (1991) has 13 recipes, including Lemon balm white wine cup, Roast lamb with lemon balm, Lemon balm jelly, Puréed summer fruit with lemon balm, Lemon balm-yogurt dessert sauce, Poached fruit with wine and lemon balm, Lemony lemon balm custard, Lemon balm cookies, Lemon thyme cake, and Lemon meringue pie with lemon balm.

Other recipes are: Balm wine (Fox 1933); Balm tea (Grieve 1933; Marcin 1983); Compound spirit of balm (Leyel 1938); Melissa chiffon tart (Crowhurt 1973); Stuffed apples and lemon balm (Loewenfeld and Back 1974); Lemon balm tea mixture (Hériteau 1975); Daffodil Avgolemono (Greek lemon soup) (Owen 1978); Syllabub with lemon balm (Garland 1979).

Importance

Lemon balm is cultivated in Australia, Europe, Morocco, Algeria, Peru, Cuba, Mexico, the U.S., Puerto Rico, Canada, and temperate parts of Asia, as a minor medicinal, culinary, honey and ornamental plant. Less than 50 kg of balm essential oil are produced annually in the world (Lawrence 1992).

Cultivation Notes

Soil

Good growth has been obtained in medium dry, light, sandy soils. In the home garden, poor soils can be used to discourage the plants from becoming weedy. Best growth, however, will be obtained in rich, moist, well-drained soil. According to Crockett and Tanner (1977), "like other lemon-scented herbs, it produces more intense flavor and aroma under infertile growing conditions." Reported pH tolerance ranges are 4.5-7.6 (De Baggio 1987) and 4.5-7.8 (Duke 1978). Crockett and Tanner (1977) recommend a pH range of 6.0-8.0.

Climate

Lemon balm is a fairly hardy herb, although seedlings may be sensitive to frost. The species grows at temperatures between 4 and 25°C, optimally at about 15°C. It will develop best in full sun but also does well in partial shade. Some recommend that lemon balm be cultivated both in moist soil and partial shade to improve the flavor (e.g., Page 1980). Excessive or inadequate moisture are both quite harmful, and the plant is sensitive to cold.

Propagation and Cultivation

Balm is reproduced by seeds, root division, or cuttings. The seeds are very slow to germinate, sometimes requiring a year. They need light to germinate, so they should be sown shallowly (6 mm or less) or on the soil surface. Crockett and Tanner (1977) state that the seeds are so tiny that they need not be covered with soil. Seedling emergence is usually in 8-12 days (Wang et al. 1993). Crockett and Tanner (1977) recommend starting the seeds indoors, 8-10 weeks before the expected date of the last frost, for transplanting; or sowing the seeds outdoors in late fall so that they may germinate the following spring. Dividing the plant (assuming one has it) is the simplest method of propagation. In addition to root division, the plant can also be easily started from stem cuttings taken in spring or summer. Periodic division in spring or fall (every 3 or 4 years) encourages tender growth. According to Erichsen-Brown (1975), in Ontario established plants may not show renewed growth until June, so that seemingly dead plants in late spring should be given more time to emerge. The tops should be pinched back to increase the foliage and to discourage flowers from developing. Regular weeding is recommended. Once established in a garden, lemon balm self-sows freely and often spreads like a weed. It needs to be confined.

Lemon balm can be gown indoors for a continuous supply of fresh leaves. Potted house plants should be provided at least 5 hours of direct sunlight or 14-16 hours of artificial light daily (Crockett and Tanner 1977). Regular pruning promotes a desirable bushiness.

Harvest and Storage

When cultivated commercially for essential oil, lemon balm is grown either as an annual, harvested at flowering, or as a perennial, additionally harvested in two successive seasons before being discarded (Simon et al. 1984).

When cultivated for culinary purposes, commercial yields of dry herb of about I t/ha have been obtained, the more marketable flowering tops comprising about half of this (Sievers 1948).

Plants for personal culinary use should be cut back regularly to produce fresh shoots, as the aroma of older leaves deteriorates and develops a stale and musty flavor. The home gardener can cut the plants back to ground level as the flowers begin to appear, and dry the harvested plants in a shady, airy place, either on racks or hung up. Once crisply dry, the leaves can be hand-rubbed or screened and the resulting material kept in air-tight jars. Alternatively, individual leaves can be harvested for use either fresh or dried. They are at their best early in the year. Crockett and

Fig. 212.
Lemon balm *(Melissa officinalis)*,
from Syme et al. (1863-1886).

Tanner (1977) state that the color and flavor are best retained by drying as quickly as possible, preferably at temperatures above 32°C.

Example Cultivars

All Gold, Lime, Aurea [see Facciola (1990) for descriptions].

Additional Notes

Chemistry

Fresh leaves have about 0.1% volatile oil. Caryophyllene oxide, estragol, 4-terpineol, anethole and linalool are abundant components in the essential oil of

lemon balm (Nykänen 1985). Components listed by Simon et al. (1984) include geraniol, citronellol, cintronellal, eugenol acetate, and nerol. The leaves also contain caffeic acid, protocatechuic acid, rosmarinic acid, and some flavonoids (Morton 1981). Tannins comprise about 5% of the fresh plant (Smart 1979). The highest levels of essential oil have been extracted in late summer from the lower parts of the plants (Simon et al. 1984). The petals of lemon ball appear to produce small amounts of essential oil with components that are different from the essential oil of the rest of the plant, probably as an attractant for pollinators (Schultze et al. 1992).

Medicine

Lemon balm was traditionally used to treat respiratory inflammations, fever, flatulence, headache, influenza, and toothache (Simon et al. 1984). It was employed also as a sedative and to increase perspiration. Morton (1981) outlined folk uses in Middle America. Recently it was shown that lemon balm oil does indeed have a sedative action, on the central nervous system of laboratory mice (Simon et al. 1984). Oil of balm has also been shown to have antiviral, antibacterial, and antispasmodic activity (Simon et al. 1984). The essential oil has been used in aromatherapy to counter depression (Miske 1994). In Germany, balm extract is in a commercial ointment used to treat cold sores and genital herpes (Castleman 1991). Tannins of lemon balm may be responsible for the activity of this cream (Tyler 1993*b*). The sedative actions of the volatile oil of lemon balm have been attributed largely to citronellal as well as other volatile terpenes such as citronellol, geraniol, caryophyllene, 1onalool, citral, and limonene, and the phenylpropanoid compound eugenol (Tyler 1993*b*). The antispasmodic and antibacteral properties may also be due to some of these same constituents (Tyler 1993*b*). On the basis of reports that balm interferes with the thyroid-stimulating hormone thyrotropin, Castleman (1991) suggests that anyone with a thyroid condition should be cautious in consuming the herb. Rinzler (1990) states that prolonged contact with lemon balm may cause dermatitis.

Nutrition

No nutritional advantages for lemon balm have been recorded.

Curiosities

• Lemon balm was one of the sacred herbs in the ancient temple of Diana (Hemphill and Hemphill 1984).

• In ancient Greece, lemon balm leaves applied externally were considered to be a certain cure for the bites of venomous beasts and the stings of scorpions (Grieve 1931).

• Lemon balm has a historical reputation for promoting longevity. The Swiss alchemist and physician Paracelsus (1493-1541) called it the "elixir of life" (Miske 1994).

• Lemon balm was selected as the "medicinal plant of the year" in Europe in 1988 (Tyler 1993*b*).

• Not only the flowers, but even the vegetative portion of the plant attracts honeybees (Simon et al. 1984). Since classical Greek times, the recommendation has often been recorded to rub honeybee hives with balm in order to attract new colonies. This exceptional attraction to bees is reflected in the name of the genus, *Melissa*, from the Greek word for bee. The odor of the essential oil of lemon balm resembles that of a pheromone (chemical attractant) produced by bees, which accordingly find the plant very attractive (Tyler 1993*b*). Curiously, while attractive to bees, lemon balm oil has been shown to be an insect repellent (Simon et al. 1984).

Problems and Potential

Lemon balm is grown for harvest of oil in many countries of the world today on a commercial basis. It is one of the more easily-grown herbs for North America, suggesting that it should be grown more, but the marketplace is competitive and difficult to expand. By contrast with the market for extracted oil, the culinary use of lemon balm is quite restricted and likely to remain so. However, this herb could be considered by local market suppliers as one of several to be grown commercially.

Selected References

Simon et al. (1984).

Fig. 213.
Lemon balm *(Melissa officinalis)*, from Vilmorin-Andrieux et C^{ie} (1883).

Fig. 214.
Peppermint *(Mentha ×piperita)*, from Köhler (1883-1898).

Mentha

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

Chambers (1992) recognizes 18 species and 13 hybrid species of *Mentha* [19 species are recognized in Chambers and Hummer (1994)]. All the hybrids have two or more European species of section *Mentha* as parents. If the parents have the same chromosome number, the hybrids are fertile and produce seeds; otherwise, they are sterile and reproduce vegetatively, not by seeds. Of the 18 non-hybrid species, nine are primarily European (some extend into Asia), five are endemic to Australia, and one species is native to each of North America, North Africa, Japan, and New Zealand. Many of the European species have become garden escapes and pasture weeds on other continents. The National Clonal Germplasm Repository in Oregon has about 500 accessions of *Mentha* (Chambers 1992; Corliss 1992).

The early literature contains many references to mints, but the descriptions are inadequate to determine their identity (Nelson 1950). The ancient Egyptians grew mint, and there are several references in the Bible (Nelson 1950; see spearmint Curiosities). The Japanese have grown mint for at least 2000 years (Nelson 1950). Cultivation since antiquity has led to complex variation patterns in the genus *Mentha* (Kokkini 1991). Several cultivated mints have hybridized among themselves, resulting in a number of intergrading forms (Prakash 1990).The literature for several of the species discussed here is difficult to interpret, since names are used in different senses, and various authors frequently have different conceptions of what should be included in a particular species. There is also often disagreement about whether a species is a hybrid or not, and dispute about the identity of parents of particular hybrids. Mindful of these difficulties, Page and Steam (1993) provide a descriptive identification key for most of the major culinary species of *Mentha* described below. However, as noted in the following, their scientific nomenclature does not match the names given below for Scotch mint and round-leaved mint.

The classification of *Lime mint* is illustrative of the difficulties of classifying some mints. Lime mint has been interpreted to include selections known as Bergamot mint, Eau de Cologne mint, Lemon mint and Orange mint, reflecting various impressions of the aroma. The citrus-scented essential oil is much like true bergamot oil (from *Citrus bergamia*, discussed in the chapter on *Monarda*), used in Chartreuse. This mint is sometimes considered to be a form of peppermint (*Mentha piperita*; several strains of peppermint are discussed below), or of spearmint (*M. gracilis*). Other formal names include *M. citrata* Ehrh. of some authors (e.g., Mansfeld 1986), "*M. odorata*" of other authors, *M. aquatica* var. *citrata* (Ehrh.) Benth. of still other authors (e.g., Bailey and Bailey 1976), and perhaps most desirably *M. aquatica* subsp. *citrata* (Ehrh.) Briq. (Chambers, personal communication). This selection is sterile, probably representing a single clone that arose about 200 years ago in Europe. It is commercially cultivated in Italy and the Pacific Northwest of the United States. According to Stuart (1979) "this mint is one of the most attractively scented of all herbs and should occupy a place in every herb garden." It is used sparingly in teas, jellies, cold drinks, and salads, as well as in a range of scented and cosmetic articles (Stuart 1979). According to Morton (1981), "its bitter principles must be removed before it can be used for food flavoring in the United States." About 26.5 t of bergamot mint essential oil are produced annually worldwide (Lawrence 1992).

Many of the other mint cultivars known in North America are also not reliably identified as to species or parentage. Facciola (1990) lists several quite attractive cultivars without clarifying their species relationship: Chocolate Peppermint (Chocolate Mint) is a strain with deep chocolate brown stems, and an aroma allegedly reminiscent of the taste of a chocolate peppermint patty [Tucker and Maciarello (1993) note that so-called chocolate mints don't really have a chocolate taste (cf. chocolate geranium)]; Doublemint combines the taste of spearmint and peppermint; Grapefruit is spearmint-scented with a grapefruit overtone; Mintucha combines the flavor of oregano and mint; Red Raripila (Raripila Mint, Pea Mint) is a fruity-scented cultivar with reddish veins, popular in salads and with peas.

Most cultivated mints have creeping rhizomes that can spread widely after planting. Most species are therefore perennials, although some may behave as annuals in areas of severe winter climates. Only one species, *M. micrantha* (Benth.) Schost., is always an annual (Chambers and Hummer 1994). Mints are generally reproduced vegetatively by the rhizomes because seeds, if formed, do not produce plants as desirable as the parents. Hermaphrodite (bisexual) and male-sterile (female) plants occur in many species.

Mint may be the world's most important flavor after vanilla and citrus (Greenhalgh 1979). An analysis of the scientific literature from 1971 through 1980 showed that mint was the most frequently reported herb, spice, or

medicinal plant during this period, with over 500 published research articles associated with mint plants (Cracker et al. 1986).

The essential oils of mints are produced in glandular hairs on the leaves and stems. The various chemicals found in cultivated *Mentha* species are reviewed by Kokkini (1991). Menthol is widely used in cough drops, lozenges, and inhalers to treat cough and sore throat. However, it may induce allergic reactions (contact dermatitis, flushing headache), and applying a mentholated ointment to infants' nostrils for cold relief may cause instant collapse (Duke and Ayensu 1985).

Mints are widely grown as ornamentals, often for the aroma of their leaves in the perennial border.

Mentha smithiana R. A. Graham, is a sterile hybrid that arose from a combination of *M. aquatica, M. arvensis*, and *M. spicata*. This is often referred to as red mint, but as this common name is well established for Scotch mint (discussed in detail below), the name red mint may be misleading. *Mentha smithiana* is now found in many parts of Europe and is sometimes grown as an aromatic plant in Austria (Mansfeld 1986).

Corsican mint, *M. requienii* Benth., also known as Corsican thyme, menthella and crème-de-menthe plant, is native to the Mediterranean including Corsica, Monte Cristo Island, and Sardinia. It is locally naturalized in western Europe (Harley 1972). This miniature herb is employed primarily as an aromatic ground cover (Morton 1976). It is also used as a flavoring, mostly in liqueurs, valued for its very strong crème-de-menthe fragrance and taste (Zverina 1976). Although available in Canada and the northern U.S., it is not notably winter-hardy, and indeed has been described as the "most delicate of all mints" (Zverina 1976). A winter mulch of evergreen boughs may provide sufficient protection where plants are subject to cycles of freezing and thawing (Lima 1986).

The three species of *Mentha* highlighted in the following are the most significant commercial mints for Canada and the northern U.S. The additional species presented are less important in northern North America, but can also be cultivated. Several species of *Mentha* not discussed here are popular in subtropical and tropical areas (Morton 1976).

Mentha Xpiperita L.

Scientific (Latin) Synonyms

M. aquatica L. *M. spicata* L.
[This hybrid designation assumes the parents have been accurately identified, which may not be justified, as discussed below.]

English Names

Peppermint
Also: pepper mint

French Names

Family: Labiées, famille de la menthe
Menthe poivrée (f)
Also: baume, menthe, menthe commune, menthe américaine, menthe anglaise, menthe citronnée, menthe d'Angleterre, menthe française

Warning

Peppermint tea should not be consumed by infants or very young children (see Medicine).

Description, Taxonomy, and History

Peppermint is a perennial herbaceous species that is frequently said to have originated in 1696 as a cross of *M. aquatica* L. and *M. spicata* L. in a spearmint field in England (Mansfeld 1986; Tyler 1993*a*). It was apparently described authoritatively for the first time in that year in England, although a Dr. Eales appears to have discovered it earlier in that country (Nelson 1950). Le Strange (1977) refers to peppermint being used by the ancient Egyptians, Greeks, and Romans. While the hybrid of *M. aquatica* and *M. spicata* could have existed in ancient times, evidence of this is lacking. In any event, exactly which species hybridized to produce the modern peppermint has been debated (Nelson 1950; Green, personal communication). Peppermint plants are sterile, but spread vegetatively by stolons. Unlike the leaves of the other major cultivated mint, *M. spicata*, the leaves of peppermint have petioles (leaf stalks). The flowers are reddish-lilac to purple. Peppermint has escaped from cultivation in North America, where it is often found in wet meadows and along streams. It occurs as far north as southwestern British Columbia, Ontario, Quebec, perhaps New Brunswick, Prince Edward Island, and Nova Scotia (Scoggan 1978-79). In the U.S. peppermint is naturalized as far south as Florida.

Several strains have been selected for differing aromatic and chemical properties (Mansfeld 1986) as noted below.

White peppermint used to be widely grown, especially in France, but it is rarely encountered today.

Black peppermint is extensively cultivated for its essential oil, in Europe, the U.S., Canada, Chile, Argentina, and Australia. It has recently been grown in parts of Africa, Brazil, and Japan. The commercial peppermint industry was started in 1750 at Mitcham, a town near London, England (Nelson 1950). The cultivar Black Mitcham, the original form of black peppermint, has been grown for some time in Europe and the United States. Other local forms

Fig. 215.
Peppermint *(Mentha ×piperita)*,
from Syme et al. (1863-1886),
showing curled mint form.

have evolved resulting in oil of differing composition. A curly-leaved-type of black. peppermint (Curly Mint) is known, [Curly mint is a name given to mints of various species that have leaves that are waved, twisted, and curled.]

Uses

Although the flavor of white peppermint is regarded as superior to that of black peppermint, the former is less winter hardy and somewhat less productive, and is now seldom grown (Green, personal communication). There are two separate commercial products from mint plants. The fresh or dehydrated leaves and stems of peppermint (usually the black mint strain) are known as mint "herb" in the commercial trade. The other product is the distilled essential oil derived from mint leaves and stems.

Mint herb is widely used in the preparation of herbal teas. It is very popular in many countries, especially in West Germany and in North Africa, where mint tea is a popular Arab beverage. Page and Steam (1993) advise that after pouring boiling water on peppermint for making tea, the mixture should not be allowed to steep for more than 5 to 10 minutes before straining, or an unpleasant flavor may develop. Another major use for peppermint is in preparation of mint jelly, used most commonly on foods containing lamb. Fresh crushed leaves are added to beverages, jellies, sherbets, soups, stews, sauces, and vinegar. The leaves are often used to flavor meat dishes containing lamb, veal, beef, or fish. They are also added to vegetables such as peas, carrots, or eggplant (Farrell 1985). Commercially, mint leaves are usually dehydrated and sold whole, rubbed, pulverized, or in the form of mint flakes (Rosengarten 1969). Unless used simply as a garnish, mint leaves should be crushed before use to obtain optimum flavor (Farrell 1985).

Nearly all commercial mint is steam distilled for its essential oils. Peppermint is one of the most important sources of mint oil, and the predominant source in North America; the other is spearmint (*M. spicata*, discussed below). Commercially, black peppermint is the major cultivated strain for flavoring, and is also one of the most important sources of oil used in pharmaceuticals (Greenhalgh 1979; Mansfeld 1986). Additionally, peppermint essential oil is used as a flavor in confectionary, candy, chewing gum, soft drinks, ice cream, syrups, gelatins, baked goods, alcoholic beverages such as crème de menthe liqueur and Benedictine, toothpaste, dental creams, mouth washes, and cough drops. Other products include soaps and household sprays. Menthol (which makes up about half of the essential oil of peppermint) is used in perfumes and cosmetics

for its cooling effect. The tobacco industry often flavors cigarettes with menthol. The oil of the bergamot or lime mint strain, whose main ingredient is linalyl acetate, is used mostly in perfumes. The Eau de Cologne strain is used in the liqueur known as Chartreuse (Greenhalgh 1979; Prakash 1990).

Recipe Sources

Rosengarten (1969) has recipes for Minted lamb kebabs, Tomato mint salad, and Minted yogurt soup. Sanecki (1974) gives recipes for Mint sauce, Southern mint julep, Blue grass mint julep, and Old Virginian mint Julep. Szczawinski and Turner (1978) have recipes for Mint baby carrots, Quick apple-mint jelly, Spiced mint tea, and Mint tea with orange. Belsinger and Dille (1984) give recipes for Minted eggplant croquettes, Mint daiquiri, Buttermint cookies, and Roast duck with gooseberry mint sauce. Tolley and Mead (1985) provide recipes for Minted corn on the grill and Lemon mint sorbet. Hutson (1987) gives the following recipes: Fresh mint butter and Garden mint vinegar. Jeanneret (1987) has recipes for Tuna and mint jelly sandwiches and Peas with mint jelly. Leggatt's (1987) recipes include Mint flower ice cream, and Yogurt and mint soup with mint flowers. Sahni (1990) has recipes for Lamb in mint-flavored lentil sauce and Minted red onion salad.

Other recipes are: Spiced peppermint crisps (Day and Stuckey 1964); Hummus and mint (Garland 1979); Mint julep frosting (McCormick 1979); Mint jelly (Rodway 1979); Mint tea (Marcin 1983); Chicken breasts stuffed with curried cauliflower and mint (Brennan et al. 1985).

Importance

Lawrence (1992) stated that about 2367 t of peppermint essential oil are produced annually worldwide. Verlet (1993) estimated the annual value of world production of peppermint essential oil at $96 million (U.S.). The world's leading producers of peppermint essential oil are the U.S., North Africa, Britain, France, Germany, Italy, the Netherlands, and Brazil (Duke and duCellier 1993). The U.S. is the largest exporter, and the dominant world supplier of essential oils of mint, with about a third of the national production, often worth over $50 million, exported. More than half of the essential oil from the U.S. crop goes into the production of chewing gum (Duke and duCellier 1993).

Some peppermint oil was once used for menthol production. However, synthetic menthol and other plant sources have reduced the importance of peppermint menthol (see discussion of menthol in treatment of *M. arvensis*).

In the U.S., mint production is centered mainly in two areas: the midwestern states, including northern Indiana, southern Michigan and Wisconsin; and, in the Far West, the Wilamette River valley and Madras areas of Oregon, the Columbia basin of Washington, and portions of the Snake River valley in Idaho (Green 1987). In 1993 the U.S. produced 2734 t worth $78.9 million, down from the 1992 earnings of $94.7 million (Dull 1994*a*). United States peppermint oil exports in 1993 amounted to 1655 t worth $53.3 million (Dull 1994*a*). The following table gives U.S. production statistics for the major states for the early 1990's.

The U.S. imports menthol in crystal form. A total of 1351 t valued at $17,833,800 were imported into the U.S in 1988. About 1375 t of menthol, worth $28 million, were imported into the U.S. in 1991 (Duke and duCellier 1993). About half of the imported menthol is used by the U.S. tobacco industry.

In 1988 Canada imported from the U.S. about 63 t of peppermint oil valued at over $2 million (U.S.) and nearly 40 t of spearmint oil valued at about $1.4 million (U.S.) (Anon. 1989*b*). Canada exported only 1.7 t worth $24,800 to the U.S. (Anon. 1989*b*). Embong, Steele et al. (1977) showed that peppermint oil could be produced as far north as central Alberta.

Few statistics seem available on the commercial production of mint herb (in contrast to extracted oils). Over a 10 year period (1966-76), the former Yugoslavia annually exported an average of 380 t, mostly to West Germany. In

Peppermint oil production statistics for U.S. (from Dull 1994a, 1995)

State	Area harvested (1000 ha)				Yield (t)			
	1991	**1992**	**1993**	**1994**	**1991**	**1992**	**1993**	**1994**
Idaho	6.11	6.03	5.75	6.48	493	541	477	581
Indiana	9.71	10.52	7.28	8.09	337	425	294	345
Oregon	19.22	19.22	17.48	17.81	1379	1530	1176	1457
Washington	7.32	6.96	7.45	9.19	583	780	734	906
Wisconsin	3.64	2.43	1.82	2.06	184	73	53	83
Total	46.00	45.16	39.78	43.63	2976	3349	2734	3372

Fig. 216.
Peppermint *(Mentha ×piperita)*,
from Hallier (1880-1888).

the U.S, the trade market for mint herb rarely exceeds 250 t (Greenhalgh 1979) with imports ranging from 142 t valued at $148,600 in 1986 to 67 t valued at $57,000 in 1987 (Anon. 1989*a*).

In addition to its substantial commercial significance, peppermint is widely grown in home gardens for use as a tea and condiment.

Cultivation Notes

Soil

Peppermint grows naturally along stream banks, wet meadows, and other damp places, and the roots may extend into flowing water. However, the plants do not tolerate stagnant water (Duke and duCellier 1993). The species is shallow-rooted, growing mostly in the upper 7.5-10 cm of soil (Duke and duCellier 1993). The plants grow best on muck or deep, loosely textured fertile sandy loams that have considerable humus. Mint plantings are productive for 5-6 years if grown in highly fertile soils (Green 1985; Prakash 1990). Recommended pH range is 5.5-7.0 (Hackett and Carolane 1982) or 6.0-7.5 (Duke and duCellier 1993), although 5.0-8.0 will be tolerated (Duke 1979).

Climate

Commercially cultivated mints are winter-hardy perennials, capable of growth as far north as most of southern Canada. At the northern limit at which peppermint can be grown, survival depends on escaping damage to the stolons that grow under and on the surface of the soil. In Saskatchewan, it was found that excessive winter damage can be prevented or reduced by irrigation of the field prior to freeze-up, by adequate coverage with straw (but not soil), and even by arranging snow fences to produce deep snow cover (Hamon and Zuck 1972). Growth occurs between 7 and 27°C, optimally about 17°C. After temperature, the major limiting factor in the production of mints for their essential oils is daylength. For maximum oil production, both long days (15+ h of daylight) and high light intensities are important (in the home garden, slight shade will be tolerated). To satisfy the requirement for long days, mint production is located above 40° latitude. In the U.S., essential oil yields are consistently higher in the Pacific Northwest than in the Midwest because of more variable light intensity, temperature and other weather conditions prior to harvest in the latter region. Mint requires abundant water, and irrigation is necessary if rainfall is not adequate. Alkire and Simon (1993) showed that in the Midwest of the U.S. peppermint grown on organic soil requires careful irrigation management to achieve high and consistent yields. Commercial growers generally make extensive use of sprinkler and other irrigation systems (Green 1985).

Propagation and Cultivation

Seeds are usually not produced due to pollen sterility, and even if developed will not breed true. Commercial propagation of most cultivated strains of mint is carried out using runners (stolons). New plantings are started from dormant runners dug from fields in the early spring. These are planted with mechanical planters and the crops are generally maintained in rows the first year. In subsequent years in many areas, the mints are treated as meadow crops (rows are no longer maintained), and in late fall, if winters are severe, the dormant runners are covered with soil for winter protection. Mint crops are best rotated, every 4-5 years, followed by at least 2 years of a different crop. Weed control is critical because weeds not only interfere with crop growth, but also may cause discoloration and off-flavor of the essential oil.

Verticillium wilt disease is the major limiting factor in production of peppermint in most areas of the U.S. (Nelson 1950; Greene, personal communication). There are several significant disease and insect problems, but a combination of disease resistant mint varieties with good crop management and chemical control is generally effective in minimizing losses (Green 1959; Rosengarten 1969; Green 1985; Green 1987). Duke and duCellier (1993) provide considerable information about commercial cultivation of peppermint.

Harvest and Storage

The timing of harvest is critical for production of quality mint oil. Prior to harvest and during plant maturation, a complex series of biochemical changes occur. If the plants are harvested prematurely the oil will be low in menthol and high in menthone, and other constituents will be out of balance. If the plants are harvested too late the oil takes on a harsh, musty, and resinous quality (Rowe 1987). Embong, Steele et al. (1977) found that the highest quality oil occurred at 20% bloom in southern Alberta and at full bloom in central Alberta. Other conditions such as climate and presence of weedy plant material mixed in with the mint also affect oil quality.

Mint harvest in the U.S. usually takes place just as flowering begins. In the northern Midwest of the U.S., harvest occurs from mid-summer to early September. In large operations, the harvest and distillation process may continue uninterrupted day and night for 3 to 4 weeks. Since the stems as well as the leaves contain the essential oil, the stems are cut as close to the ground as possible (Rosengarten 1969). The plants are mowed and wind-rowed to dry for 1-2 days and then picked up with a chopper and blown directly into portable distillation tubs that are taken directly to the fields. The tubs are transported to a central distillery for steam distillation. The essential oil is recovered by passing steam over the mint to volatilize the oil contained in glands on the leaves and stems. The residual plant material is returned to the field as organic matter, where it may also serve to reduce wind erosion of soil (Green 1985; Green, personal communication). Depending on geographical area, more than one harvest per season may be undertaken. This tends to weaken the stand, especially in the Midwest where the winters are relatively severe. Oil from the second crop is generally considered more immature, and thus of lower quality (Green, personal communication). The yield of oil in the U.S. can average 61.5 kg/ha, with high yields of 135 kg/ha (Embong, Steele et al. 1977; Farrell 1985). Tests in Alberta produced yields of 7.1 t/ha of plant material resulting in an average oil production of 86 kg/ha (Embong, Steele et al. 1977). Yields of plant material as high as 20 t/ha have been reported (Hackett and Carolane 1982).

Mint leaves are occasionally sold fresh. Leaves intended for fresh use can be harvested at any time, but are best before flowering. The stems are cut close to the ground and the leaves either used immediately or the stems and leaves allowed to dry before use.

Example Cultivars

Three commercial varieties of peppermint are currently grown to produce virtually all U.S. peppermint oil. The cultivar Black Mitcham has largely been supplanted by two comparatively disease-resistant mutant strain selections of Black Mitcham, Todd's Mitcham and Murray Mitcham, the latter the choice of most growers (Green 1985). Other cultivars of minor importance or grown as culinary herbs include Blackstem Peppermint (Black Peppermint), Candymint (Candy, Candy Peppermint), Citrata (Lemon Mint, Eau de Cologne Mint), Crispa, Curly Peppermint, Lime Mint, Variegata (Variegated Peppermint), and Willamette Peppermint (Facciola 1990; Huxley et al. 1992).

Additional Notes

Chemistry

Peppermint oil has more than 200 chemical compounds, notably: -pinene, ß-pinene, 1,8-cineole, limonene, piperitone, *d*-isomenthone, neomenthol, pulegone, menthofuran, *l*-menthone, *l*-menthol, and methyl acetate (Murray et al. 1988). Nearly all commercial mint is steam-distilled for its essential oils. When harvested at peak condition, black peppermint cultivars yield less than 1% oil, called peppermint oil, consisting of about 50% menthol and 25% menthone. Menthol is responsible for a cooling aftertaste of mint (Mansfeld 1986; Prakash 1990). All peppermint oils have varying combinations of these and many other minor constituents, but the ratio varies widely with oils from different geographical areas (see Kokkini 1992 for a general discussion of chemical variation in mint species). The pale yellow oil has a fresh, strong, minty odor, with a pronounced cooling effect on the mouth (Lewis 1984; Farrell 1985).

Medicine

In the past, oil of peppermint has been used in traditional medicine as an antiseptic, deodorant, and stimulant. It was mixed with salt to apply to bites from mad dogs (Farrell 1985). Peppermint oil has been applied externally

to alleviate headaches, rheumatism, and neuralgia. In recent times the oil has been used to treat vomiting, gastritis, cholera, diarrhea, and flatulence (Prakash 1990).

Peppermint is the culinary herb most widely used in modern western medicine. The oils are used to disguise the taste of many drugs. Natural peppermint oil is the primary flavoring agent in most toothpastes and mouth-washes. Because it has a less pleasant taste and aroma, menthol is not used as much as menthone in pharmaceutical preparations destined for internal use. Peppermint has been shown to be effective in facilitating belching (thus reducing gas), reducing menstrual cramps, and stimulating appetite (Tyler 1993*a*). Digestive advantages of peppermint have been substantially attributed to menthol, which is not present in spearmint (Tyler 1993*a*). Menthol and methone may alleviate decompression syndrome and altitude sickness, problems for scuba divers and mountain climbers. These compounds help prevent the cause of both ailments, the aggregation of blood platelets (Corliss 1992).

Herbal teas, including peppermint tea, are commonly consumed in the belief that they do not contain tannins. Peppermint, like many mints, does contain tannin (Duke and duCellier 1993).

Peppermint tea should not be consumed by infants or very young children, since they may experience a choking sensation from the menthol (Tyler 1993*a*).

Nutrition

Peppermint herb has been found to have a very low level of nutrients (Hackett and Carolane 1982). However, fresh mint has as much vitamin C as oranges and as much pro-vitamin A as carrots (Duke and duCellier 1993).

Curiosities

• *Mentha* is said to have been named after Minthe, a charming nymph of classical mythology who attracted the eye of Pluto, god of the dead. In a fit of jealousy Prosperina, the suspicious wife of Pluto, metamorphosed Minthe into a humble plant. Despite his hostility, Pluto gave her plant form a fragrant aroma (Castleman 1991). A different interpretation of the name is given by Page and Steam (1993); they hold that the Latin name *menta* and the Greek *minthe* originated from a long vanished language spoken in the Mediterranean region perhaps 4000 years ago.

• "Peppermint," so-named by John Ray in 1696, is a misnomer, the plant not really tasting like pepper. No satisfactory explanation of Ray's erroneous description of the plant's taste has been given (Stuart 1979).

• During the American Revolution, mint teas were popular because there were no English taxes on them (Angier 1978).

• An Oregon company markets mint chewing tobacco. The all-mint chew is advertised as a nonharmful alternative to smokeless tobacco, the use of which has been linked to oral cancer (Corliss 1992).

•In Guatemala, it has been claimed that eating the leaves or drinking a leaf infusion of the lime mint form of peppermint will prevent conception (Morton 1981).

• About 1 kg of mint oil can flavor 100 000 sticks of chewing gum (Corliss 1992).

• The sharp, penetrating odor of peppermint has proven useful in locating leaks in pipes (Duke and duCellier 1993).

• In a tongue-in-cheek article, Laferrière (1994) recognized a new genus and species of mint, *Epluribus unum* Laferr., with the common name of "Denver mint." The new plant was described as about 50 ¢m tall, with coin-like seeds and leaves like banknotes. It was suggested that the plant be fertilized with gold dust and kept in a seed bank in the hope that it would someday become a major cash crop.

• Mints are often difficult to keep in check in gardens, tending to spread like weeds, so much so that Gilbertie (1988) wrote: "Mints are like some teenagers - easy to grow, but difficult to control."

Problems and Potential

While peppermint herb has long been used in parts of Europe and North Africa as a tea, it is only recently that rapid growth in demand for peppermint leaves has been noted elsewhere. In North America, commercial mint oil production is carded out mainly by contracts between the growers and mint oil companies. There are only five or six major companies in the U.S. that buy mint oil (Green, personal communication). The number of growers, at least in the U.S., remains relatively constant because of the high capital investment required for equipment, especially that required to distil the oil. Potential growers should expect a commitment of several growing seasons to be successful. There may be some potential for some Canadian growers although few markets may become available. There is likely little potential for a significant expanded market for mint herb within Canada. Winter kill could be a problem in the Prairie Provinces (Embong et al. 1977). Marketing strategies should be carefully considered because each peppermint producing area must generally establish its own market.

Selected References

Green (1959); Landing (1969); Greenhalgh (1979); Hackett and Carolane (1982); Farrell (1985); Green (1985, 1987); Duke and duCellier (1993).

Fig. 217.
Spearmint *(Mentha spicata)*, from Hallier (1880-1888).

Mentha Spicata L.

Scientific (Latin) Synonyms

M. viridis L.
[*Viridis* means green, reflecting the bright green color of the herb.]

English Names

Spearmint
Also: brown mint, common mint, erba Santa Marie, fish mint, green mint, julep mint, lamb mint, mackerel mint, our ladies mint, pea mint, Roman mint, sage of Bethlehem, spear mint, yerba buena
[In the U.S., the clonal selection of *M. spicata* grown exclusively for its essential oil is known as "native spearmint" or, less frequently, "American spearmint" (Green, personal communication).]

French Names

Menthe verte (f)
Also: baume (vert), baume à épi, baume à feuilles étroites, baume de Notre-Dame, baume romaine, menthe à épi(s), menthe baume, menthe de Notre-Dame, menthe en épi(s), menthe romaine

Description, Taxonomy, and History

Spearmint is an erect, perennial, herbaceous plant, 30-100 cm tall. It has almost hairless, slightly crinkled leaves with a lemon-mint aroma and bitter, pungent, camphorous taste. Unlike the other major cultivated mint, *M. piperita*, the leaves of spearmint are subsessile (attached to the stem with very short leaf stalks). This species is a cultigen that arose with cultivation in southern or western Europe. *Mentha longifolia* and *M. suaveolens* are believed to be its parents (Mansfeld 1986). Spearmint has escaped from cultivation in North America. It spreads by stolons, and by seeds in those clones that are fertile. Spearmint is found along roadsides, meadows, and waste places in all Canadian provinces except perhaps Alberta (Scoggan 1978-79), and in much of the U.S. (Morton 1976).

Hybrids between *M. spicata* and *M. suaveolens* are sometimes termed *M. cordifolia* (this is not *M. cordifolia* Opiz.) by various authors (Harley 1972). The cultivar Kentucky Colonel (Kentucky Mint or Improved Spearmint) is sometimes assigned to this, or simply to *M. spicata*. It has a fruity, spearmint aroma and flavor, and is available in some North American garden catalogs.

Spearmint was employed as a medicinal plant in ancient Greece and Rome (le Strange 1977). It was probably also used for culinary purposes in these early times. Spearmint was cultivated during the classical Roman era and disseminated throughout the Roman empire by soldiers (Grieve 1931). By the 9th century A.D. it was grown in many convent gardens in Europe (Nelson 1950). By 1816 It was raised commercially in New York and by 1840 in Michigan and Ohio. Spearmint is now grown in Europe, North America, South Africa, and Asia (Rosengarten 1969). It was probably introduced to North America by the Pilgrim Fathers (le Strange 1977). Spearmint first became very popular with Americans. This popularity was subsequently exported back to Europe (Arctander 1960).

Uses

"Spearmint is the most popular mint of temperate climates for garnishing drinks, fruit cups, and vegetables, for seasoning soups and making mint sauce for roast lamb, and for tea" (Morton 1976). The green leaves are added to chutney, vinegar, jellies, and iced drinks such as mint julep (Prakash 1990). They are also crushed and added to stews, sauces, and meat dishes such as veal and beef. The leaves go well with vegetables such as peas, eggplant, carrot, and spinach (Farrell 1985). "Mint has a special affinity for green peas" (Thompson 1986).

Some forms of spearmint are commercially grown for their essential oils, mostly in the U.S. Dried, ground-up plant and extracts are also sold commercially. Mint leaves, oil, or extracts are used commercially to flavor meat products, baked goods, chewing gum, tooth paste, condiments, soft drinks, candy, gelatins, mint jelly, confectionary, alcoholic beverages, and pharmaceutical preparations (Morton 1976; Greenhalgh 1979).

Recipe Sources

Fox (1933) presents recipes for Mint jelly, Mint julep, Mint cocktail, Green pea soup with mint, and Mint jelly with fruit. Leyel (1938) has recipes for Crystallised mint leaves and Fresh mint punch. Day and Stuckey (1964) give recipes for Minted hot chocolate, Minted fruit salad mold, and Green peas with mint butter. Gibbons (1966) has recipes for Mint jelly, Mint aspic (also in Bryan and Castle 1974), Mint sauce, and Mint jam. Macleod's (1968) recipes include Mint ale, Mint pastry, and Mint tea. Szczawinski and Turner (1978) present recipes for Candied spearmint, Minted baby carrots, Mint-raspberry tea, Mint tea, Mint fruit cup, and Quick mint apple jelly. Belsinger and Dille (1984) give recipes for Grape mint jelly, Mint ice cream in chocolate mint cups, Moroccan mint tea (also in Roden 1968), Minted lamb, Moroccan style, Mint ice cream in chocolate mint cups, Minted tomatoes gratin, and New potatoes with mint. Algar (1985) has recipes for Yogurt soup with mint and Lentil soup with mint.

Other interesting recpies are: Spearmint tarts (Bryan and Castle 1974); Aunt Dora's iced tea (Owen 1978); Mint ice cream (Rodway 1979); Mint chutney (Shepard 1979; Solomon 1992); Fresh mint salad (Rose 1979); Peaches trimmed with mint (Mességué and Peter 1982); Mint soup (Batmanglij 1986); Minted brandy ice (Thompson 1986); Easy tomato mint soup (Jeanneret 1987); Marinated pork chops with mint leaves and flowers (Leggatt 1987); Cool cream of mint soup (Sahni 1990); Iced tea with mint and lemon (Holt 1991); Mint liqueur (Fennell 1993).

Importance

Spearmint is commonly considered the second most important commercial mint after peppermint (*M. piperita*). According to Lawrence (1992), about 880 t of *M. spicata* essential oil are produced annually worldwide. Verlet (1993) estimated the annual value of world production of spearmint essential oil at $33 million (U.S.). The U.S. produces most of the world's output, but spearmint is also cultivated extensively in Russia, Japan, Great Britain, Germany, and the Netherlands (Farrell 1985).

About 530 t of Scotch spearmint (*M. gracilis*) essential oil are produced annually, worldwide (Lawrence 1992). Scotch spearmint, not spearmint (*M. spicata*), is likely the second most important mint (after peppermint) grown in the U.S. (Green, personal communication). Of the 1992

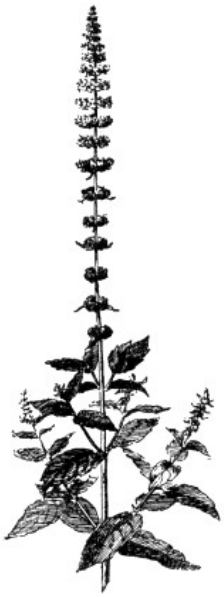


Fig. 218.
Spearmint *(Mentha spicata)*,
from Bailey (1900).

U.S. acreage, about 65% was devoted to Scotch spearmint, and 35% to spearmint (based on information provided to Dr. Green from the Wm. Leman Co., Bremen, Indiana). Since crop reporting services for the U.S. rarely break down "spearmint" to separate figures for spearmint (*M. spicata*) and Scotch spearmint (*M. gracilis*), it is difficult to evaluate the relative importance of the two mint species.

In 1988 in the U.S., "spearmint" grown for essential oil production [including both *M. spicata* and Scotch mint (*M. gracilis*)] amounted to 791 t grown on 9150 ha (Anon. 1989*b*). That year the total crop value was $22.2 million. In 1989, 2620 ha of spearmint were grown in Washington State, the leading producing state (Hinman 1990). In 1990, 13 600 ha of spearmint were grown in the U.S. (Hays 1992). In 1991, the U.S. exported $22.3 million worth of spearmint oil, second only to peppermint oil (Duke and duCellier 1993). In 1992 the spearmint oil crop was worth $46.6 million, and in 1993 1225 t worth $32.5 million were grown (Dull 1994*a*). In 1992, 644 t worth $21.3 million were exported, and in 1993 701 t worth $22.6 milion (Dull 1994*a*). U.S. production statistics for "spearmint" for the early 1990's are given below.

The commercial culinary use of spearmint is less established than the use for oil. Some trade sources have complained that it is difficult to purchase whole spearmint leaves of satisfactory quality.

Cultivation

Cultivation requirements are similar to those of peppermint (*M. piperita*). A soil pH tolerance range of 4.5 to 7.5 has been reported (De Baggio 1987), somewhat lower than that of peppermint.

Example Cultivars

Emerald 'n' Gold (Green and Gold, Variegated Spearmint), English Mint, Curly Spearmint (Curly-Leafed Spearmint, Curly Mint), Menthol (Menthol Mint), Mint the Best, Moroccan, Narrow-leaved Spearmint, Spiral Spearmint (all described by Facciola 1990). Other cultivars include Chewing Gum (with the scent of bubble gum), Crispa, and Kentucky Colonel (Huxley et al. 1992). "Native" or "American" spearmint acreage exceeds by far that of all of the named cultivars (Green, personal communication).

Spearmint oil production statistics for U.S. (from Dull 1994a, 1995)

State	Area harvested (1000 ha)				Yield (t)			
	1991	**1992**	**1993**	**1994**	**1991**	**1992**	**1993**	**1994**
Idaho	1.30	1.17	.89	.61	131	136	84	57
Indiana	3.04	3.44	2.43	2.43	102	116	87	93
Michigan	1.21	1.17	1.13	1.09	49	41	41	35
Oregon	.81	.81	.77	.69	73	77	73	64
Washington	7.00	7.04	5.38	4.25	846	1184	875	662
Wisconsin	3.80	3.00	2.55	2.43	209	97	74	93
Totals	17.16	16.63	13.15	11.50	1410	1651	1234	1004

Additional Notes

Chemistry

Steam distillation yields an essential oil representing approximately 0.6% of the leaves and stems. The oil is composed mainly of carvone (about 56%), with several minor constituents (Prakash 1990). The constituents that provide the characteristic flavor are dihydrocuminyl acetate, dihydrocuminyl valerate, and dihydrocarvyl acetate. The odor is strong, fresh, and minty, and the flavor is smooth, sharp, and herbaceous (Farrell 1985). A more detailed analysis of chemical constituents is provided in Duke and Ayensu (1985).

Medicine

The first-century Greek physician Dioscorides thought that mint would reduce swelling caused by tumors (Farrell 1985). The leaves have been used as a remedy for infant troubles, vomiting during pregnancy, hysteria, fever, and bronchitis. Infusions of the leaves have been taken orally to relieve hiccough, flatulence, giddiness, and indigestion (Prakash 1990). Spearmint has also been employed in folk anti-cancer remedies, in mint juleps, as an antidote for poisons, to whiten teeth, heal mad dog bites, repel rats and mice, and treat a variety of other ailments (Duke and Ayensu 1985). Folk uses in Middle America are outlined by Morton (1981), and range in importance from use as a footbath deodorant to treatment of heart conditions and cancer. Spearmint odor has been found to be calming (Laurance 1997). The species is still used in modern Chinese medicine.

Nutrition

Fresh leaves contain more provitamin A than carrots and as much vitamin C as oranges (Duke and Ayensu 1985).

Curiosities

• The specific epithet *spicata* (spike) in the scientific name and the "spear" in the common name of spearmint reflect the shape of both the inflorescence and the leaves (Stuart 1979).

• Classical Greeks and Romans rubbed crushed mint leaves on table tops because the aroma symbolized hospitality (Rosengarten 1969). Finishing a meal with an after-dinner mint had its counterpart in the ancient custom of concluding feasts with a sprig of stomach-soothing mint (Castleman 1991).

• In ancient Greece, it was customary to use different perfumes to scent particular parts of the body. Mint was reserved for the arms (Macleod 1968).

• The ancient Hebrews scattered mint leaves on the floors of synagogues, so that each footstep produced a fragrant scent (Rosengarten 1969).

• In Luke (11:39), Jesus scolded the Pharisees: "You pay tithes of mint and rue...but have no care for justice and the love of God" (Castleman 1991; a similar quotation for mint, from Matthew, is given in the Curiosities for cumin, *Cuminum*).

• The ancients believed that mint prevented coagulation and acid fermentation of milk. Therefore, cows were not allowed to feed on mint if their milk was destined for cheese production (Grieve 1931).

• The Greek physician Dioscorides (50-100) suggested that mint was an effective contraceptive (Farrell 1985).

• During the Middle Ages mint leaves were strewn on streets to welcome triumphant warriors, while orators chewed it to make their voices more resonant (Farrell 1985).

• In Mexico, mint species are often known as *yerba buena*, good herb. Most often this is spearmint, and it is frequently used in herbal mixtures to cure *la cruda*, hangover (Hutson 1987).

Problems and Potential

While spearmint herb has long been used in parts of Europe and North Africa as a tea, it is only recently that demand has arisen for leaves in North America. Because of competition from existing producing areas in the U.S., establishing new production areas of spearmint oil requires careful consideration. There is likely little potential for a significant market for spearmint herb in Canada, but some potential for increasing the market in North America as a whole. A financial assessment of starting a spearmint crop appears in Hinman (1990).

Selected References

Rosengarten (1969); Greenhalgh (1979); Green (1985, 1987); Hinman (1990).

Mentha Xgracilis Sole

Scientific (Latin) Synonyms

M. cardiaca (S.F. Gray) Bak. [The name *M. gentilis* L. is commonly assigned to this species, but this is incorrect according to Tucker and Fairbrothers (1990).]

English Names

Scotch mint
Also: American applemint, cardiac mint, ginger mint, gingermint, red mint, redmint, slender mint

Fig. 219.
Scotch mint *(Mentha ×gracilis)*,
from Syme et al. (1863-1886).

French Names

Menthe écossaise (f)
Also: baume des jardins, herbe du coeur, menthe des jardins, menthe romaine

Description, Taxonomy, and History

Scotch mint is a perennial herbaceous plant, 30-90 cm tall, of European origin. The sterile hybrid apparently arose as a cross between *M. arvensis* L. and *M. spicata* L. Scotch mint is widely grown in gardens in western and central Europe. In North America it has either escaped from cultivation or simply been introduced from Europe. It is found along shores and in wet meadows and waste places as far north as southern British Columbia and from Ontario east to the Island of Newfoundland (Scoggan 1978-79). In the U.S. it is fairly common in the Northeast (Fernald 1970).

Scotch mint is an important commercial essential oil plant in the U.S., particularly in Michigan, Indiana, and the Pacific Northwest states (Green 1985). As pointed out in the discussion of spearmint (above), Scotch mint is probably the second most important species of *Mentha* in North America. It was introduced for commercial use from Europe in the early 1800's and relatively pure clonal lines have been maintained from that time by vegetative reproduction (Green 1987). The clonal material known in the commercial trade as "Scotch spearmint" was discovered about 1908 in a garden in Wisconsin, although it was originally imported from Scotland (Tucker and Fairbrothers 1990).

There is considerable chemical variation in Scotch mint, determined by the chemical characteristics of the parents that went into the origin of particular clones (Tucker et al. 1991). Possible components of the oil (some depending on strain) listed by Morton (1981) include menthol, linalool, carvone, limonene, caryophyllene, - and ß-pinene, sabinene, myrcene, - and -terpinene, terpinolene, carvacrol, *p*-cymene, and 3-dodecanone. In 1989, 1706 ha of Scotch mint were grown in Washington State (Hinman 1990). Statistics for Scotch mint are often included in those for spearmint (*M. spicata*). Scotch mint oil consistently receives a higher dollar value than spearmint (Anon. 1989*b*). A financial assessment of starting a Scotch mint crop appears in Hinman (1990).

The essential oil is the principal source of "oil of spearmint" used to flavor chewing gum (Facciola 1990). It has a greater oil content than spearmint, but seems to be more sensitive to damage from cold, pathogens, and insects.

Fig. 220.
Scotch mint *(Mentha ×gracilis)*,
from Hallier (1880-1888).

Austrian and ginger mint strains are available through some North American garden catalogs. Facciola (1990) provides descriptions (listed under *M. gentilis*) of Austrian, Ginger, Golden and Scotch; these cultivars are available in the U.S. Ornamental cultivars include Aurea and Variegata (Huxley et al. 1992).

Mentha Aquatica L.

English Names

Water mint
Also: bishop's mint, hairy mint, marsh mint, pepperwort, smartweed (better reserved for the genus *Polygonum*), wild mint

French Names

Menthe rouge (f)
Also: baume aquatique, baume d'eau, calament des marais, menthe à grenouilles, menthe aquatique, menthe hérissée, riolet

This perennial species is found in Europe, North Africa and western Asia, and has been introduced into North America, Australia, and New Zealand. It is very variable, and a number of varieties have been recognized. The species also hybridizes readily with other mints. True to its name, it occurs on wet soil, beside streams, in damp ditches, and on regularly flooded land. In Canada, water mint has been locally introduced in southwestern Quebec and perhaps Nova Scotia (Scoggan 1978-79). Fernald (1970) lists it as growing wild from Nova Scotia to Deleware.

This plant was likely cultivated by the ancient Romans 2000 years ago, and is still cultivated in northern Italy, for the essential oil constituent linalool. Other constituents in the volatile oil include menthofuran, limonene, and *l*-carvol (Stuart 1979).

A warm tea of water mint was given to patients in traditional medicine. It was considered beneficial for diarrhea and influenza. The tea was also prescribed for stomach complaints and for difficult menstruation (Grieve 1931). Large doses may be emetic (Stuart 1979).

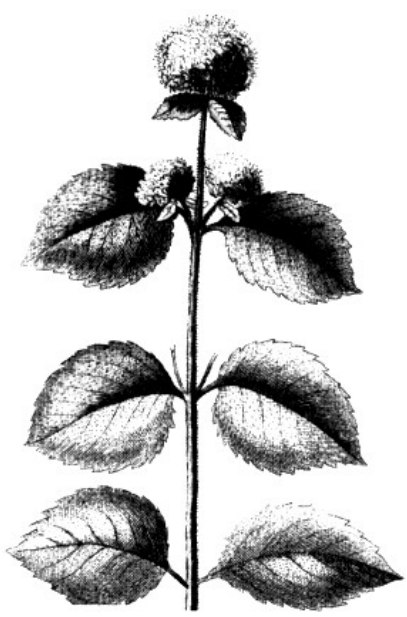


Fig. 221.
Typical form of water mint *(Mentha aquatica)*,
from Lamarck and Poiret (1791-1823).

Fig. 222.
Crisp-leaved form of water mint *(Mentha aquatica)*,
from Hallier (1880-1888).

Morton (1976) and Facciola (1990) have described the culinary uses of the species. The herb has been employed to season vegetable, egg, cheese, and meat dishes in Southeast Asia, and for tea in South Africa. *Mentha aquatica* var. *crispa* (L.) Benth. (curled mint, crisp-leaved mint, cross mint) has a pineapple odor, and serves to flavor jellies, sauces, dressings, punches and liqueurs, and to make tea. The cultivar Variegata is grown as an ornamental.

Mentha Arvensis L.

English Names

Field mint
Also: brook mint (better reserved for *M. longifolia*, discussed below), Canada mint, corn mint, garden mint, Indian mint, Japanese mint, pole mint, whorled mint, wild mint

French Names

Menthe des champs (f)
Also: baume à salade, baume des champs, baume des jardins, calament des champs, coq de jardin, menthe, menthe commune, menthe cultivée, menthe des jardins, menthe romaine, pouliot thym

Warning

It is recommended that field mint not be consumed. Field mint tea may be particularly dangerous for infants or very young children (See peppermint, Medicine, with regard to high menthol content, and the following).

Field mint is a perennial herbaceous plant native to Europe and Asia. Although not often pointed out, it is almost certainly also native to North America. The species (probably including both introduced and native

Fig. 223.
Field mint *(Mentha arvensis)*, from Syme et al. (1863-1886),
showing three different forms.

forms) is found across North America, as far north as Alaska, Yukon, and the District of Mackenzie in the Northwest Territories (Scoggan 1978-79). Some taxonomists divide *M. arvensis* into several species (Mansfeld 1986).

There are several wild forms (Hultén and Fries 1986; Mansfeld 1986) including: subsp. *laponica* (Wahlenb.) Neuem, a native of northern Europe; and subsp. *canadensis* (L.) Hara, likely native to North America. It is said that the American Indians used the leaves of wild plants for flavoring corn meal mush (hence the name corn mint) and for baking fish (Facciola 1990). American Indians used the species very extensively for a variety of medicinal purposes (Moerman 1986). Chemical variation of essential oil of *M. arvensis* is discussed by Tucker et al. (1991).

Japanese mint is a cultivated form of field mint. According to Morton (1976) it is a hybrid, with *M. arvensis* as one of the parents. This is recognized as subsp. *haplocalyx* (Briq.) Briq. by some (e.g., Mansfeld 1986), or as subsp. *piperascens* (Malinv.) Hara. by others (e.g., Hultén and Fries 1986). It originated in East Asia and is now found throughout that region. The plant was introduced into Japan from China in the third century A.D., and became a major Japanese crop. Chemical variation in "*M. arvensis* var. *piperascens* Briq." is examined in Gasic et al. (1992). This is the world's major source of menthol (Green, personal communication). Japanese mint has been traditionally grown in east Asia for its menthol-rich oil. Since the Second World War it has been grown commercially in Angola, Argentina, Australia, Brazil, India, Formosa, Korea, and South Africa (Morton 1977). It has also been grown in California (Morton 1977).

Chinese mint ("bo he" or "po ho" in Chinese), probably a form of Japanese mint, has a sweet spearmint aroma and flavor. It has been employed medicinally in China to dispel "wind" and "heat." Japanese mint is used to produce Japanese peppermint oil, an inferior substitute for true peppermint oil (Morton 1976). Japanese mint has a strong menthol flavor and is the source of Japanese menthol, used to flavor drinks and candies, mouthwash and toothpaste. It has been employed in traditional medicine, both internally and externally.

Java mint (a kind of *M. arvensis*) is grown in the East Indies (Morton 1976), Fresh leaves of this herb are used to flavor vegetable and rice dishes (Morton 1976).

Propagation of cultivated strains is by cuttings or transplanting of rooted suckers (Morton 1976). Both the Chinese and Japanese mint strains are available from catalogs in North America.

Mentha arvensis may be the world's most important essential oil plant, with about 8600 t produced annually worldwide according to Lawrence (1992). However, Verlet (1993) estimated the annual value of world production of cornmint essential oil at $57,600,000.00 (U.S.), which is less than his estimate for peppermint essential oil ($96,000,000.00 [U.S.]). Leaves contain 1-2% essential oils with menthol representing from 50 to 70% (Morton 1977; Prakash 1990; Nguyêñ-Xuân-Duñg and Dô-Tât-Loi 1991). The oil is added as a flavor and aromatic to tooth paste, mouthwash, menthol cigarettes, cosmetics, and pharmaceuticals. The "de-mentholated oil" (which may contain about 10% menthol) is used in perfumes and confectionary. NO FOOD USE OF JAPANESE MINT OIL IS ALLOWED IN THE U.S. (Morton 1977).

The U.S. imports most of its menthol, especially from China and India, and the chief plant source is *M. arvensis* (Dull 1994*a*). Brazilian and Paraguayan menthol are noted for their quality and sell for a premium (Dull 1994*a*). Imports of menthol (including synthetic menthol) to the U.S. in the early 1990's were: 1991: 1 373 944 kg worth $27,910,300; 1992: 1 532 825 kg worth $23,526,900; 1993: 1 533 484 kg worth $18,005,200 (Dull 1994*a*). The

Fig. 224.
Field mint *(Mentha arvensis)*, from Hallier (1880-1888).

Fig. 225.
Silver mint *(Mentha longifolia)*, from Syme et al. (1863-1886).

U.S. imported 359 677 kg of cornmint (*M. arvensis*) oil worth $2 774 500 in 1991; 292 935 kg worth $1,777,400 in 1992; and 248 841 kg worth $1 157 700 in 1993 (Dull 1994*a*). The tobacco industry uses half of the U.S. imported menthol, with most of the balance used by the cosmetic and pharmaceutical industries (Dull 1994*a*).

The dried plant has been employed in traditional medicine to treat stomach and intestinal problems, jaundice, and numerous other ailments. The juice of the plant has been used externally to alleviate stings and bites. The leaves pounded with salt have been applied to wounds (Prakash 1990). American Indians used field mint to treat a variety of illnesses (Duke 1986). Indeed, of 2147 species of plants listed as employed for medicinal purposes by American Indians in Moerman's (1986) monumental *Medicinal Plants of Native America, M. arvensis* was the fourth most used species. The species is still employed for many purposes in Chinese medicine, including sore throat, measles, cold, headache, cold sores, toothache, and dermatitis (National Academy 1975; Duke and Ayensu 1985), to treat fever and malaria in Vietnamese medicine (Nguyêñ-Xuân-Duñg and Dô-Tât-Loi 1991), and various ailments in other Asian countries (Perry and Medzger 1980).

The toxicity of menthol has been discussed by Morton (1977). Menthol has been responsible for asphyxiation in infants. Other problems include possible irritation and allergic reactions.

The leaves of this mint are added to vegetable dishes in several countries of southeast Asia as well as Cuba and Mexico (Mansfeld 1986). The aroma and flavor are strong, and not as attractive from a food viewpoint as the mints commonly used as herbs.

The culinary uses of *M. arvensis* are insignificant, while the extracted oil is of doubtful safety for culinary purposes. From an economic viewpoint, this species is a medicinal and industrial plant, not a culinary herb.

Selected References

Morton (1977).

Mentha Longifolia (L.) L.

Scientific (Latin) Synonyms

M. sylvestris L., *M. tomentosa* D'urv.

English Names

Silver mint
Also: brook mint, fish mint, horse mint, horsemint, long horse mint, long-leaved mint
[The name horse mint is widely applied to this species. Unfortunately this name is commonly used for other plants, including *Monarda fistulosa* and *M. punctata*, discussed in this book.]

French Names

Menthe chevaline (f)
Also: baume sauvage, baume vert (also used for *M. spicata*), chevaline, mentastre, menthe à longues feuilles, menthe sauvage

Mentha longifolia is an erect or sprawling herb, 30-130 cm in height. It is extremely variable, and many subspecies have been recognized. This species is native to Europe, the Middle East, western Asia, and parts of Africa. It has been introduced to parts of North America and is now found along roadsides and damp shores as far north as southwestern British Columbia, Ontario, Quebec, and Nova Scotia (Scoggan 1978-79). Variety *incana* (Willd.) Briq. was once cultivated in India and Afghanistan as a substitute for peppermint. Field trials in Pakistan around 1968 were promising (Mansfeld 1986). Variety *asiatica* (Boriss.) Rech. f. is cultivated in southern Russia (Mansfeld 1986).

Some forms of silver mint have been used for tea, as a vegetable, or to flavor candy, yogurt, or chutney. Leaves are also sometimes candied. A volatile oil from the plant is used much like peppermint oil in the flavoring of candy (Morton 1976). In traditional medicine in Asia, silver mint has been employed to alleviate stomach and intestinal problems. A decoction of the plant has served to treat fever (Prakash 1990).

Silver mint is available in North American garden catalogs, for use as an attractive ornamental herb, grown for its grey-green, spearmint-scented leaves. Facciola (1990) described the cultivars Capensis (Cape spearmint) and Silver (Silver Mint). According to Page and Steam (1993), some cultivated plants that have been called *M. longifolia* are probably *M. villosonervata*, discussed below.

Mentha Pulegium L.

English Names

Pennyroyal
Also: brotherwort, churchwort, flea mint, mosquito plant, penny royal, pennyroyal mint, poley, pudding grass, pudding herb, run-by-the-ground
["Pennyroyal" is a corruption of the French *puliol royale*, literally royal thyme. Puliol is an old French name for thyme, and was applied to pennyroyal because of superficial similarities in appearance and aroma to thyme (Stuart 1979).]

French Names

Menthe pouliot (f)
Also: chasse-puces, dictamne de Virginie, frétillet, herbe aux puces (herbe-à-la puce = poison ivy, *Rhus radicans* L.), herbe de Saint-Laurent (herbe de saint-Laurent), péliot, petit baume, poley, pouliot, pouliot royal

Warning

This plant is toxic and should not be consumed, notwithstanding recommendations often encountered in herbal books that it is edible.

[American pennyroyal (*Hedeoma pulegioides* (L.) Pers.) is a rather similar North American species. It is cultivated only to a limited extent (Simon et al. 1984). Its oil has been used for much the same purposes as the oil of pennyroyal. Ingesting the essential oil can be lethal, and contact with it (often used in insect repellents) can cause dermatitis (Foster and Duke 1990).]

Pennyroyal is probably a native of Europe, the Mediterranean area, and Western Asia. It has become naturalized in temperate parts of the world, so that its original distribution range is somewhat difficult to

Fig. 226.
Pennyroyal *(Mentha pulegium)*, from Syme et al. (1863-1886). Although used as a culinary herb in the past, pennyroyal contains toxic pulegone.

ascertain. Pennyroyal was grown in the past in Europe and parts of the Americas for its essential oil. In previous centuries in Britain, pennyroyal was a popular culinary herb (Quelch 1946). It was called pudding grass because the leaves were once added to puddings. The leaves also were mixed with stuffings, often with pepper and honey, and used in meat sauces. The odor resembles spearmint, but is less attractive. The taste is initially warm, aromatic, bitter, and acidic, and later cooling. Currently pennyroyal is used for culinary purposes mainly in a few Asian countries where it is grown as a condiment. It is a popular ground cover in rock gardens, thriving in moist, shady locations, although tolerating full sun.

Pennyroyal was also once considered useful for whooping cough and gout, and was thought to strengthen the gums (Grieve 1931). The herb has long been employed in folk medicine to induce menses (Briggs 1989). The oil has been used as an abortifacient, but doses required to terminate pregnancy can cause severe liver damage, neuro-toxicity, and death (Briggs 1989).

About 18.5 t of pennyroyal essential oil are produced annually worldwide (Lawrence 1992). Verlet (1993) estimated the annual world value of pennyroyal essential oil to be $180,000.00 (U.S.).

Several chemical races of pennyroyal have been described (see Stengele and Stahl-Biskup (1993) for summary and references). Pennyroyal contains the chemical pulegone, a compound that repels fleas, ticks, and mosquitos (Corliss 1992). Several of the alternative common names given for pennyroyal (both in English and French) refer to its insect-repulsing properties. Indeed, the specific epithet *pulegium* is derived from *pulex* (flea), the Latin name of the plant, coined by the Roman scholar Pliny (23-79) in reflection of the use of the plant to eradicate the insect. The oil is used for scenting soaps and deter-gents, and as an insect repellent. However, this oil can be toxic, and in the U.S., the leaf and oil cannot be sold legally (Duke 1985). In Canada pennyroyal oil is listed by Health and Welfare Canada as a substance that is hazardous to health that should not be sold as food (Briggs 1989). Health food stores and pet shops may sell products containing the oil, including flea collars, flea shampoos, flea powders, and the pure oil. A 30 kg dog became sick and died after its owner applied 60 mL of pennyroyal oil to get rid of fleas (Sudekum et al. 1992). The oil was obtained from a health food store and, as noted elsewhere in this book, rather dangerous herbs and herbal products are sometimes stocked in these outlets. Humans have also exhibited symptoms of toxicity after misuse of this oil, and cases of death after ingesting very small quantities have occurred (Duke 1985). The essential oil can cause nausea, vomiting, diarrhea, depression, and convulsions (Simon et al. 1984). Pulegone, which may make up more than 90% of pennyroyal oil, is toxic, and even small amounts can cause severe liver damage (Duke 1985). The oil can also irritate skin (Briggs 1989). Contact with the plant can also cause dermatitis (Simon et al. 1984).

Fig. 227.
Pennyroyal *(Mentha pulegium)*,
from Lamarck and Poiret (1791-1823).

Although no longer considered a culinary herb, pennyroyal is an important source of pulegone, which is used as a starting material for the manufacture of synthetic menthol (Simon et al. 1984). The essential oil is also used as a fragrance in cosmetics (Simon et al. 1984).

Pennyroyal is available through North American garden catalogs, sometimes advertised for use as a tea considered useful for headaches. The herb is much less dangerous than the oil, and it has been said that it "is unlikely to cause problems when consumed in normal quantities by a healthy individual, except in pregnancy" (Briggs 1989). In Canada, pennyroyal used as a herb is "considered safe when consumed as food" (Blackburn 1993). Nevertheless, the consumption of pennyroyal herb is probably unwise. There are far more pleasant mints that can be used to brew tea.

Selected References

Duke (1985); Briggs (1989); Stengele and Stahl-Biskup (1993).

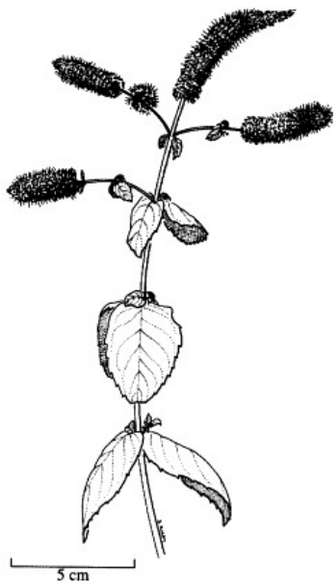


Fig. 228.
Apple mint *(Mentha suaveolens)*, prepared by
S. Rigby. (Based on greenhouse plant
from Richters.)

Mentha Suaveolens Ehrh.

[This is sometimes identified as *M. rotundifolia* by authors, although it is not *M. rotundifolia* (L.) Huds., discussed below.]

English Names

Apple mint
Also: applemint, pineapple mint
[The name round-leaved mint is also applied to this plant, for example by Mansfeld (1986), and Page and Steam (1993), but should be reserved for *M. rotundifolia*, discussed below.]

French Names

Menthe ananas (f)

Mentha suaveolens grows 60-100 cm tall, and has stems that are thickly covered with grayish-white hairs, and downy leaves that are whitish on the underside. This perennial herbaceous plant is native to southern and western

Europe, and is naturalized in the rest of Europe and in North America (Mansfeld 1986). Two wild subspecies, apparently not cultivated, are known. These are subsp. *insularis* (Req.) Greuter from the islands of the western Mediterranean, and subsp. *timija* (Cosson ex Briq.) Harley, native to the mountains of Morocco (Mansfeld 1986). Cultivated plants are in subsp. *suaveolens*. Apple mint has become naturalized in central Europe, and in parts of the United States from Maine to Mexico.

Although its downiness is distracting, applemint is thought by many to be superior to spearmint for culinary purposes (Morton 1976). Accordingly, it is widely grown in mild-temperate areas. It is particularly popular in England for mint-sauce and homemade teas. The crushed stems smell like a combination of ether and peppermint (Morton 1976). The leaves have a delicate apple aroma. The main ingredient of the essential oil is piperitenone oxide, which has a scent of ripe apples (Mansfeld 1986).

The cultivar Pineapple mint has a sweet, fruity scent. The young foliage is distinctly pineapple-like in fragrance and flavor, although more mint-like when mature (Facciola 1990). The young leaves are used for flavoring, as a garnish, or brewed into tea (Facciola 1990). This cultivar is also grown as an ornamental for its beautiful, apple-green, woolly, rounded leaves that are flecked and bordered with creamy white.

Mentha × Villosa Huds.

[Stace (1990) notes that the correct name for this hybrid combination of *M. spicata* L. *M. suaveolens* Ehrh. is *M. villosa*.]

English Names

Wooly mint
Also: round-leaved mint, fox-tail mint
[Facciola (1990) calls this species applemint and round-leaved mint. While it often has the apple flavor of one of its parents (*M. suaveolens*), the name apple mint has been used mostly for *M. suaveolens*. The name round-leaved mint is best reserved for *M. rotundifolia*, discussed below.]

French Names

Menthe velue (f)

This highly sterile, highly variable hybrid between *M. spicata* and *M. suaveolens* is widely naturalized in Europe (Harley 1972). It may have originated spontaneously more than once (Mansfeld 1986), this accounting for its variability. As the epithet *villosa* suggests, some

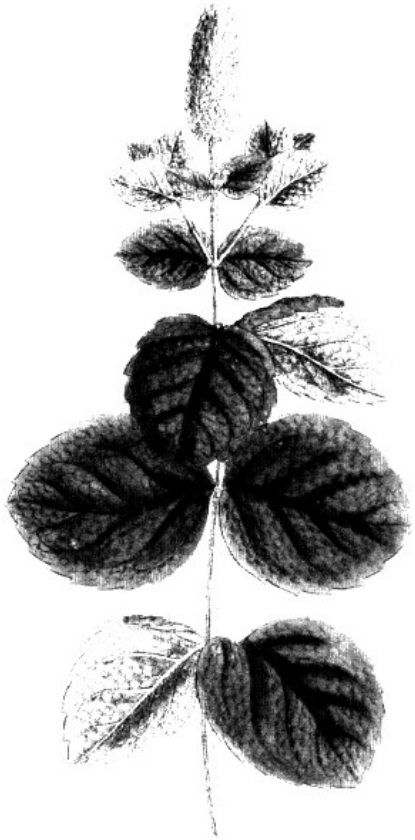


Fig. 229.
Wooly mint *(Mentha ×villosa)*,
from Syme et al. (1863-1886).

plants are quite hairy; however, others are quite lacking in hairs (Harley 1972). Some plants are almost indistinguishable from *M. suaveolens* (discussed immediately above), and others closely resemble spearmint, *M. spicata* (Harley 1972). The species is cultivated in gardens in Europe, Morocco, and parts of southeastern Asia as a tea, medicinal plant, and occasionally as a pot herb (Mansfeld 1986). A variety, *alopecuroides* (Hull) Briq., is sometimes recognized. Mansfeld (1986) lists this as Bowles Mint,

Fig. 230.
Wooly mint *(Mentha ×villosa)*, prepared by M. Jomphe.
(Based on Gavioli 133 at Agriculture and Agri-Food Canada herbarium, Ottawa.)

noting that it is extensively cultivated in Great Britain to make mint sauce. Facciola (1990) lists Bowles, Egyptian, and Wooly as cultivars of *M. ×villosa*.

Page and Steam (1993) provide the following information about Bowles mint. This mint is named after Edward Augustus Bowles (1865-1954), who recommended it for mint sauce. It grows 60 to 120 cm tall, does well on soils drier than tolerated by most mints, and has some resistance to mint rust that is a particular problem for spearmint. Bowles mint wilts quickly when picked, and therefore has no commercial value. It is useful in the home garden because of its excellent taste, and the atttractive lilac flowers that can be used in flower arrangements.

Mentha × Rotundifolia (L.) Hudson

Scientific (Latin) Synonyms

M. rotundifolia (L.) Huds. The name *M. villosa* is sometimes misapplied to this plant.

English Names

Round-leaved mint
Also: apple mint (a name best reserved for *M. suaveolens*, discussed above), Egyptian mint, horse mint (better reserved for *M. longifolia*, discusssed above), wild mint

French Names

Menthe à feuilles tondes (f)
Also: baume sauvage, bon-homme, menthastre, menthe blanche, menthe crépue, menthe de cimetière, menthe ridée [Names from Wijk (1911). It is unclear whether some of these names have traditionally been used for *M. villosa*, discussed above.]

This species is a highly variable fertile cross of *M. longifolia* and *M. suaveolens*. Round-leaved mint was often grown in monasteries where it was regarded as refreshing for the brain (Grieve 1931). It is still grown occasionally in European gardens, and has been introduced in North America. This species is found along roadsides and waste places as far north as parts of southwestern Ontario (Scoggan 1978-79). It is frequently confused with *M. villosa* and *M. suaveolens*. However, it is of little interest today as a culinary herb. "It is very rarely found in cultivation. . . it is frequently confused with *M. villosa*" (Harley 1972).

Another hybrid of garden origin between *M. longifolia* and *M. suaveolens* is *M. villoso-nervata* Opiz. By contrast with *M. rotundifolia*, this is sterile (Huxley et al. 1992). It is rated as capable of growing as far north as U.S.D.A. climatic zone 5 (Huxley et al. 1992).

Fig. 231.
Round-leaved mint *(Mentha ×rotundifolia)*,
from Hallier (1880-1888).

Micromeria

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

The taxonomy of *Micromeria* is rather controversial, some authors doubting the wisdom of its separate recognition, and most finding it difficult to delimit taxonomically (Pérez de Paz 1994). For those who accept the genus, *Micromeria* is composed of about 70 perennial, occasionally annual, herbs or dwarf shrubs of the Mediterranean region, Caucasus, southwestern China, and western America. The species occur in temperate and warm temperate regions, mostly on dry, rocky, exposed habitats, and so several are grown as ornamentals in rock gardens.

Micromeria is closely related to *Satureja*, also discussed in this book, and several economically significant species commonly referred to the former are better placed in the latter. Information on *S. biflora* (Buch.-Ham. ex D. Don) Briq. [=*M. imbricata* (Forssk.)Christen], *S. brownei* (Sw.) Briq. [= *M. brownei* (Sw.) Benth.], *S. douglasii* (Benth.) Briq. [=*M. douglasii* Benth.], and *S. viminea* L. [=*M. viminea* (L.) Urb.] is given in the treatment of *Satureja*.

Micromeria fruticosa (L.) Druce is found in the eastern Mediterranean area. It is commonly used for herbal tea. The major component (about 70%) of its essential oil is pulegone (Dudai et al. 1993), which is quite toxic (see information in this book for pennyroyal, *Mentha pulegium*).

Two collections of Micromeria, unidentified as to species, are in circulation in the seed trade (e.g., Richters 1994). These are (after Facciola 1990):

Micromeria sp. Emperor's mint. This was found thriving amidst the ruins of Emperor Hadrian's remarkable summer villa near Rome. It has a bold, mint-like fragrance and flavor.

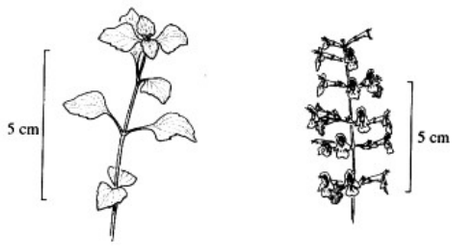


Fig. 232.
Emperor's mint *(Micromeria sp.)*, vegetative and flowering branches, prepared by S. Rigby.
(Based on greenhouse plant grown from seed from Richters.)

Micromeria sp. Roman mint. This was found growing wild near Rome, where it is widely used in cooking. It has a mint-like odor and flavor, reminiscent of both spearmint (menthol) and pennyroyal.

Micromeria Juliana (L.) Reichenb.

[Bailey and Bailey (1976) and Morales Valverde (1991) cite the name as *M. juliana* Benth. ex Reichenb. Huxley et al. (1992) cite the name as *M. juliana* Benth. The above citation follows Greuter et al. (1986).]

Fig. 233.
Savory *(Micromeria juliana)*, from Hallier (1880-1888).

Scientific (Latin) Synonyms

Satureja juliana L., *M. minoa* Coust. & Gand.

English Names

Savory
[The name savory is well established for species of *Satureja* (discussed in this book). Accordingly, it is usually necessary to refer to this species by its scientific name to avoid ambiguity.]

French Names

Family: Labiées, famille de la menthe
Sarriette de Saint-Julien (f)
[Herbe de Saint-Julien is summer savory, *Satureja hortensis*, discussed in this book.]

Description, Taxonomy, and History

Micromeria juliana is indigenous to the Mediterranean region, and in the wild is found in rocky places and other dry habitats. It is a dwarf shrub, 10-40 cm tall, producing clusters of small, purplish flowers. The species has been used as a minor medicinal plant since ancient times (see Medicine). It has been grown in European gardens since the 16th century.

Uses

The species is occasionally used as a culinary herb, as a medicinal plant, and as an ornamental.

Recipe Sources

None located. The herb can be used, at least experimentally, like the species of savory (see recipes for *Satureja*).

Importance

This species has no commercial value.

Cultivation Notes

Soil

This plant has been cultivated for centuries in European gardens and does well in loamy, well-drained soils. It succeeds in poor soils.

Climate

Micromeria juliana is a tender shrub that can only be grown outdoors as far north as U.S.D.A. climatic zone 7. It should be provided with a sunny location.

Propagation and Cultivation

This species can be grown from seed, by plant division, and by cuttings of half-ripe wood.

Fig. 234.
Savory *(Micromeria juliana)*,
from Lamarck and Poiret (1791-1823).

Harvest and Storage

No information found. The home gardener may follow the advice given for harvesting and storage of summer savory, *Satureja hortensis*.

Example Cultivars

No cultivars appear to have been selected.

Additional Notes

Chemistry

Carvacrol has been found to be the major component of the essential oil of *M. juliana* (Phokas et al. 1980).

Medicine

An infusion of *M. juliana* was recommended for health purposes in ancient Greece; a usage still known in Europe (Phokas et al. 1980).

Nutrition

No information found. As with most herbs, too little is consumed in order to add significant nutrition to human diet.

Curiosities

• The generic name *Micromeria* comes from the Greek *mikros*, small, and *meris*, part, referring to the usually very small flowers.

Problems and Potential

Old world species of *Micromeria* are occasionally used as culinary herbs, and sometimes offered in the garden trade for this purpose. They are generally poorly known, unused commercially, and seemingly insufficiently attractive to be cultivated except as garden curiosities.

Selected References

Hedrick (1972).

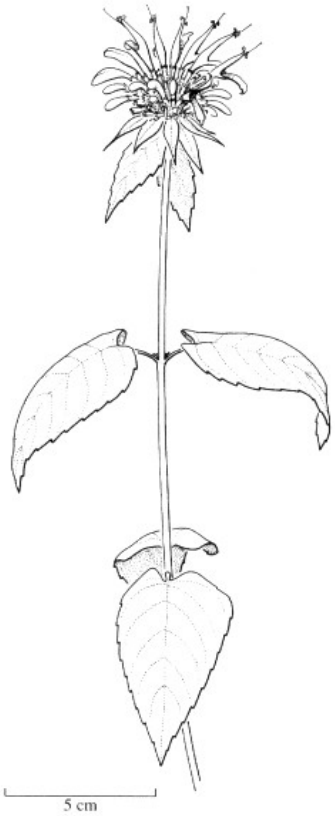


Fig. 235.
Bergamot *(Monarda didyma)*,
flowering branch,
prepared by S. Rigby.
(Based on L. Newstrom
449 at Agriculture and Agri-Food
Canada herbarium, Ottawa.)

Monarda

Family: Labiatae (Lamiaceae) (mint family)

Genus Notes

Monarda is made up of 16 species of aromatic annual or perennial herbs native to North America. In addition to the species discussed in detail below, several others, as well as hybrids, are grown as ornamentals.

Monarda punctata L., known as dotted monarda, spotted bee balm and horsemint, is a native of a large region of North America, from the eastern and central U.S. to northern Mexico. At least one colony of this species is native to Canada (in Ontario) (J.K. Morton 1987). It was grown in the 1920's as a source of the chemical thymol (Mansfeld 1986). This species has been employed medicinally (Simon et al. 1984), and leaf extracts have reportedly been used in nonalcoholic beverages (Furia and Bellanca 1975). Derailed instructions for its commercial cultivation are given in Hood (1916). Kindscher (1987) refers to this as lemon mint, a name that could be confused with the species known as lemon bergamot, discussed below.

Monarda austromontana Epling is very similar to *M. citriodora* (lemon bergamot, described below), especially in the southern part of its range (Epling 1935). Turner (1994) treats this as a variety of *M. citriodora*, namely *M. citriodora* var. *austromontana* (Epling) B.L. Turner. This low-growing annual occurs in Arizona, New Mexico, and Mexico, has a flavor like that of oregano (Hutson 1987), and is locally called oregano (Morton 1976). It has been used for many years by Indigenous People and others of northern Mexico and the Southwest of the U.S. to season food and as a tea considered good for the stomach (Morton 1976; Hutson 1987).

Monarda Didyma L.

English Names

Bergamot
Also: American melissa, bee balm (bee-balm), crimson bee balm, fragrant balm, horse mint, Indian('s) plume, mountain balm, mountain mint (better reserved for *Pycnanthemum*, treated in this book), North American swamp plant (Page 1980), Oswego tea, red balm, red bergamot, scarlet monarda, sweet bergamot ["Bergamot mint" refers to selections of several species of *Mentha* (see discussion of true mints in this book). "Field balm" is catnip, *Nepeta cataria*, also discussed in this book.]

French Names

Family: Labiées, famille de la menthe
Bergamote (f)
Also: monarde, monarde écarlate, monarde d'Amérique, thé d'Oswego, thé d'Oswégo, thé de Pen(n)sylvanie

Description, Taxonomy, and History

Bergamot is a perennial, thick-stemmed, herbaceous plant, 60-120 cm tall, usually with crimson or scarlet flowers in wild plants, or with variously colored flowers in cultivars. The flowering head is a rather shaggy-looking head of trumpet-shaped florets. Often the upper leaves and surrounding bracts are red or bronze. The plants form clumps, sometimes 1 m across. Bergamot is native to the eastern U.S. from Michigan and New York in the north to

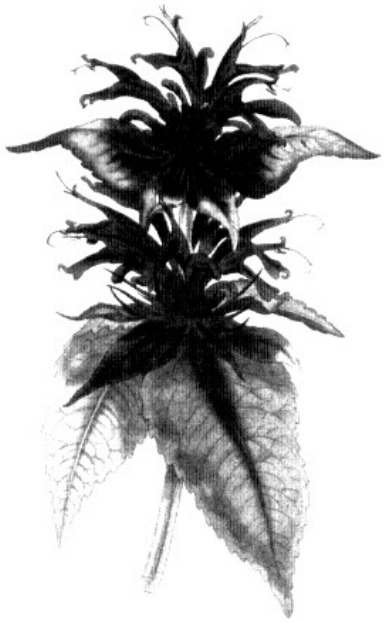


Fig. 236.
Bergamot *(Monarda didyma)*,
from Curtis (1787-present; # 546).

Georgia and Tennessee in the south. It is often found in thickets and along stream banks. Bergamot has escaped cultivation elsewhere in North America, such as in the southern parts of Ontario and Quebec (Scoggan 1978-79). It was introduced into Europe as an ornamental in 1754 (Muenscher and Rice 1955).

Uses

The main culinary use of bergamot is in tea. It can be used to make an "Earl Grey tea" (see Recipes), but the oil of bergamot used to make Early Grey tea comes from the "bergamot orange," *Citrus bergamia* Risso & Poit., discussed below. The leaves can either be mixed with other plants as a hot tea or combined with a slice of lemon to make a refreshing cold tea. The fresh leaves and tender sprigs have a pungent, lemonlike aroma and bitter flavor. They make a delicious addition to wine drinks, lemonades, fruit drinks, jellies, fruit ice cups, and cheese. Tender sprigs and flowers are added to tossed salads and fruit salads. Bergamot leaves can serve as a substitute for sage in stuffings and meat recipes (Prakash 1990). Young bergamot leaves go well with pork and veal (Hemphill and Hemphill 1984).

Bergamot has been cultivated experimentally in the Crimea for its essential oil used in flavoring and in perfumes (Mansfeld 1986). Bergamot oil from *Monarda* should not be confused with bergamot oil from the fruit of *Citrus bergamia*. [The name bergamot was first used for *C. bergamia*, and the resemblance of the pungent, lemony scent of *M. didyma* to the former led to its also being called bergamot (Simon et al. 1984).] This tropical Asian citrus tree is grown almost exclusively in a narrow coastal strip in the southern part of Calabria, Italy (Arctander 1960).

Bergamot is often grown as an ornamental. The tall plants with red, pink, purple, or white flowers are particularly attractive to hummingbirds, butterflies, and bumblebees.

Recipe Sources

Michael (1980) gives recipes for Bergamot in salad, Bergamot sauce, and Bergamot tea. Barash (1993) has recipes for bergamot flowers entitled Monarda snapper, Bee balm ice cream, Bee balm pound cake, Bee balm tea, and Bee balm tartlets.

Other recipes are: Bee balm tea (Crowhurt 1973); Bergamot jelly (Garland 1979); Bergamot tea (Marcin 1983; Phillips 1986 under the title "Oswego tea"); Tomato and bergamot loaf (Hemphill and Hemphill 1984); Blue cheese pasta with bergamot [flowers] (Leggatt 1987); Herbal "Earl Grey" tea blend (Bremness 1988); Peach shortcakes with bergamot flowers (Belsinger 1991).

Importance

The culinary significance of bergamot is very limited, and the plant is only occasionally grown commercially as a food plant, primarily for incorporation into tea mixtures.

Bergamot oil production in North America appears to be confined to Alberta (Ference 1989). In 1987, Canada exported 11 t of bergamot oil valued at $39,400 but exported none in 1988 (Anon. 1989*b*). In 1991, western Canada grew approximately 43 ha of bergamot (Belisle 1991).

Cultivation Notes

Soil

Bergamot performs well in rich, moist, slightly acid, highly organic soils (Hayward 1983; Kublick 1990). The desirable pH range is 5.5-6.5 (Hayward 1983). The roots are fragile, do not penetrate deeply into the soil, and should never be allowed to dry out in summer (Page 1980). Roots (and the plants) tend to die out in winter in heavy soils that become compacted, so that a loose, open-textured sod is desirable (Page 1980).

Climate

Bergamot does best if provided with slight shade in hot weather (Goode 1984), especially south or west of its native range (Widrlechner, personal communication). Plants should be kept moist during dry periods (Kublick 1990). This perennial is generally winter hardy across southern Canada. Because the plants are shallow-rooted they benefit from a winter mulch in cooler regions of Canada and the northern U.S.

Propagation and Cultivation

Bergamot is easily propagated by division of mature plants. It is best to divide the plants in the spring every few years to retain plant vitality (Garland 1979). The divisions should be taken from the outer, more vigorous parts of the clump and transplanted slightly deeper than the mother plants (Lima 1986). Seeds can also be used to reproduce the plant. They are sown indoors or in cold frames and the seedlings transplanted (Huxley et al. 1992). Bergamot spreads by a large number of underground stolons produced each fall. The most effective method for large-scale increase of plants is by stem cuttings, taken in May or early June. When treated with hormone(s), the stem cuttings will root in 10-14 days in a misting bed. Stolons placed in fiats of soil with only a small amount of the growing tip exposed can also be used to generate new plants. Bergamot planted in May or June is well-established the first year and remains productive for 5-7 years (Marshall 1983). Crockett and Tanner (1977) recommend

cutting off the flower heads the first year before the plants bloom, in order to direct the energy of the plants into vegetative growth.

Bergamot is particularly susceptible to powdery mildew, especially if the planting site lacks good air circulation (Goode 1984). Hayward (1983) recommends growing the plants at least 25 cm apart to allow good air circulation, avoiding excessive watering, and using pine needles as mulch rather than broad leaves or lawn clippings; pine needles allow a degree of air circulation at ground level and hold less moisture. Affected plants should be cut back to 8 cm after blooming, and damaged leaves and stems should be burned to destroy the overwintering stages of the fungus. Fungicides can also be used, but this makes the plants much less desirable for culinary purposes. Marshall's Delight (as noted below, a hybrid between *M. didyma* and *M. fistulosa*), is mildew-resistant.

Many gardeners find that bergamot grows so rampantly that it is invasive and requires control. Bergamot can be restricted to a small area in the home garden by growing it in a pot in the ground or by segregating it with a plastic or metal collar extending from above to several centimeters below the earth.

Bergamot cultivar Marshall's Delight is a sterile triploid (i.e., it has three sets of chromosomes rather than the normal two sets). This selection is reproduced by cuttings, as it cannot be propagated from seed (Ference 1989). (Dandelion is another example of a triploid, but dandelions do produce seeds. As noted in *Taraxacum* Curiosities, dandelions do not reproduce sexually, and the seeds are generated by a non-sexual method.)

In a home garden, in 3 or 4 years a clump of bergamot can expand to more than a meter, the underground runners spreading outwards from the center and sending up new stems. By the 4th or 5th year, the central stems have decreased in vigor. To renew the attractive appearance of the planting, the center of the clump can be excavated and replanted with vigorous divisions from the periphery (Goode 1984).

Harvest and Storage

The leaves can be harvested at any time for fresh use. Leaves and flowers intended for drying are best collected in mid summer. The home gardener may dry the leaves and blooms by spreading them out on a wire rack in a shady place (Hemphill and Hemphill 1984). The dried leaves should be stored in an airtight container. Flowers and fresh, chopped leaves can be frozen for use as required.

Bergamot that is intended for extraction of the essential oil is collected when the plants are in full bloom. The crop is cut by a forage harvester and blown into a closed steel wagon. Steam is introduced through the bottom of the wagon and passes up through the chopped fresh plants to a condenser. The resultant water and oil mixture is then separated in a special tank by flotation (Marshall 1983).

Example Cultivars

Croftway Pink, Panorama. Huxley et al. (1992) list a number of ornamental cultivars with flowers of various colors.

Creasy (1988) recommended Cambridge Scarlet, Croftway Pink, Adam Red and Snow White for their edible flowers, and recommended against Panorama for this purpose.

Numerous cultivars are derived from hybrids of *M. didyma* and *M. fistulosa*, for example Marshall's Delight, developed at Agriculture and Agri-Food Canada's Research Station in Morden, Manitoba, from a cross between *M. didyma* cultivar Cambridge Scarlet and *M. fistulosa* subsp. *menthifolia* (the latter is discussed below) (Collicutt 1989; Mazza and Marshall 1992).

Additional Notes

Chemistry

The essential oil is obtained by steam distillation. The yield is about 0.3-1.0% from the fresh flowers and leaves whereas the dried flowers and leaves yield 2.7-3.1% (Prakash 1990). Carvacrol is the major chemical constituent (ca. 67%) with numerous minor constituents (Prakash 1990).

Hybrids of bergamot and *M. fistulosa* with distinctive fragrances for use in the perfume industry have been developed in Canada (Mazza et al. 1993). These strains are rich in geraniol, linalool, carvacrol, thymol or cineol (Anon. 1992*a*).

Medicine

Details regarding early Amerindian medicinal uses of *M. didyma* are sometimes difficult to separate from information about *M. fistulosa*, since both are commonly called monarda and bee balm, and the latter sometimes is called Oswego tea, like the former. Where both species grow in the same region, it is somewhat uncertain which species was used for medicinal purposes, and in any event both seem to have been used somewhat similarly (see *M. fistulosa* for a list of medicinal uses of that species). Moerman (1986) outlined the uses of bergamot by the

Fig. 237.
Bergamot *(Monarda didyma)*, vegetative branch, prepared by S. Rigby. (Based on greenhouse plant grown from seed from Richters.)

Cherokee indians; they used bergamot to treat "female obstructions," cold, flatulence, pain, headache, colic, fever, heart trouble, weak bowels and stomach, nosebleed, hysterical conditions, and sleeplessness.

Early colonists took seeds of bergamot to England in the mid-1700's and from there its use spread throughout Europe as a treatment for colds and sore throats (Kublick 1990). The oil from the leaves was used for treatment of bronchial infections, colds, female disorders, flu, gas, kidney problems, stomach upsets, pneumonia, and worms (Erichsen-Brown 1979; Foster and Duke 1990). Fresh tea made from bergamot leaves was regarded as calming (Prakash 1990).

Nutrition

No information found. Since small amounts of material are used, the herb contributes little to human nutrition.

Curiosities

• The genus *Monarda* is named after a Spanish medical botanist, Nicholas de Monardes (1493-1588), who in 1569 authored the first medicinal flora from North America, a book whose title was translated to the delightful "Joyfull Newes out of the Newe Founde Worlde" (Lima 1986).

• Bergamot is sometimes called Oswego tea after the tribe of Native Americans, who resided in what is now upstate New York, who used the plant extensively (Goode 1984).

• Tea made from bergamot became known as one of the "freedom teas" that were used by early American colonists during their conflict with Britain over a tax on imported tea (Kublick 1990).

• Early American settlers used bergamot oil to perfume hair tonics made from bear grease (Goode 1984).

Problems and Potential

Bergamot is a minor ornamental and culinary herb. Its potential as a culinary crop is very limited, although it can be marketed as a tea. It has some potential as an oil crop in northern North America. A review of essential oil crop possibilities for Canada (Ference 1989) concluded that "Monarda... would appear to offer the strongest economic potential for new domestic crop options, given current international market conditions." Synthetic geraniol provides considerable competition for natural geraniol obtained from monarda and other plants, and at present established overseas suppliers provide most of North America's needs. In Canada, some bergamot has been cultivated for extraction of oil, primarily for sale to the U.S. market. Several perfume strains developed by Canada's federal agriculture department have been licensed for sale by private companies (Anon. 1992a). This is an example of the private sector being reluctant to develop a limited crop, but quite willing to market it after development. Ference (1989) concluded that for the crop to develop successfully in North America, marketing and the

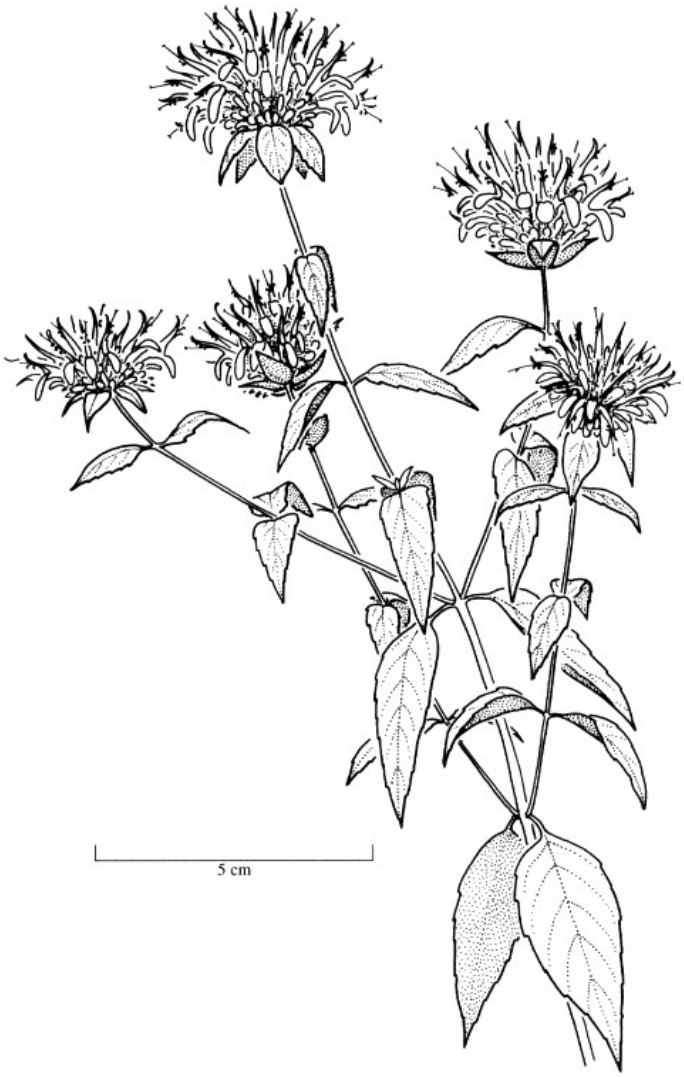


Fig. 238.
Wild bergamot *(Monarda fistulosa)*, prepared by S. Rigby.
(Based on greenhouse plant grown from seed from Richters.)

development of an assured supply were necessary, as well as extension support for growers, since little information on cultivation is available.

Selected References

Hayward (1983); Lima (1986); Prakash (1990).

Monarda Fistulosa L.

English Names

Wild bergamot
Also: American horse mint, bee balm, bergamot, dry-land mint, fern mint, horse mint (horsemint), plains bee balm, purple bee balm
[Turner and Szczawinski (1978) and Kindscher (1987) assign the name Oswego tea to *M. fistulosa*, but this name is best reserved for *M. didyma*, discussed above.]

French Names

Monarde fistuleuse (f)
Also: bergamote sauvage, menthe de cheval, monarde velue

Description, Taxonomy, and History

Wild bergamot is a perennial herb found in dry thickets, clearings, and borders of woods. It grows 30-120 cm high, from creeping rhizomes. The plant is native to North America, occurring as far north as the Northwest Territories (Straley 1986), and from British Columbia to Quebec and south through the U.S. to Georgia, Alabama, Arizona, and into northern Mexico [Scoggan (1978-79); Kindscher (1987) provides a distribution map]. Wild bergamot is a species of prairie hillsides, pastures, roadsides, banks, occasionally in open woods, and usually in rocky soil (Kindscher 1987). Within the native range there are three subspecies and several forms (Scoggan 1978-79).

Subspecies *menthifolia* (Graham) Fern. [= var. *menthifolia* (Graham) Fernald, and often rendered "*menthaefolia*"], known as Oregano de la sierra, wild oregano, mint-leaved bergamot, horsemint, and bee balm, is found in western North America [from British Columbia to Manitoba and south into Mexico (Scoggan 1978-79)]. It was used by native Americans along the Rio Grande, notably the Pueblo people of the southwest, to season beans and stews, make tea, and for medicinal purposes (Niethammer 1974; Kindscher 1987). It has an oregano-like taste that is favored by chefs in the southwestern U.S. for flavoring semi-soft ricotta cheese, meat, and wild game (Hutson 1987).

Fig. 239.
Wild bergamot *(Monarda fistulosa)*,
prepared by S. Rigby.
(Based on Dore & Kemp
16757 at Agricultureand Agri-Food
Canada herbarium, Ottawa.)

The Apache, Tewa, and Hopi also used wild bergamot as a seasoning (Kindscher 1987). Wild bergamot was not only extensively used by American Indians as food, but also for medicine (see below). Still additional uses by Native Americans are mentioned by Turner and Szczawinski (1978) and Kindscher (1987). The Cheyenne employed the chewed leaves to seem the manes and tails of their horses. The Crow mixed wild bergamot with other sweet-smelling herbs and applied the mixture as a perfume, often with a drop of castorium (a secretion produced by beavers to protect their fur from being soaked by water). The Omaha and Ponca used wild bergamot as a fragrance for a hair pomade. The Kootenay and Flathead employed the dried pulverized leaves to repel flies and maggots on curing meat.

Fig. 240.
Wild bergamot *(Monarda fistulosa)*,
from Curtis (1787-present; #145).

Wild bergamot was reportedly cultivated for its greens by the Hopi, who dried the plants for winter use (Kindscher 1987). It may also have been inadvertently propagated by the Indians of the Missouri River region, who could have spread seeds of the species while carrying wild harvested plants (Kindscher 1987).

Uses

The twigs can be used as a potherb, cooked with other foods such as meats, or dried for future use. Kindscher (1987) recommends use of the early leaves as a substitute for mint tea. The later, pre-flowering leaves make the best oregano-tasting seasoning, and the old leaves, which are the hottest, can be used in a hot sauce. The flowers make an attractive edible garnish in salads (Facciola 1990).

The lavender flowers of wild bergamot make it an appealing garden ornamental. As described in the following, the plants are attractive to bees and may have some value as honey plants. As also noted below, wild bergamot may have some potential as a source of industrial chemicals, particularly for perfumery.

Importance

Wild bergamot is grown locally in the southwestern U.S. as a culinary and medicinal plant, sometimes as "Mexican oregano" (a name more usually associated with *Lippia graveolens*, discussed in this book). Trials have been conducted on wild bergamot for its potential use as a bee honey forage. Unfortunately, the plant is susceptible to certain diseases (powdery mildew and rust) that limit production (Widrlechner 1987).

Monarda fistulosa is a sigificant source of geraniol. The major producing countries for geraniol (irrespective of plant species, and in decreasing order of importance) in 1984 were China, Egypt, Morocco, Algeria, Reunion, India, and Israel, with small amounts in France, Tanzania, Zaire, the Ivory coast, Comores, Madagascar, Hungary, Portugal, Yugoslavia, South Africa, Spain, and Portugal (Ference 1989). In 1988, the U.S. imported over 52 t of "bergamot oil" valued at $2,191,400, mostly from Germany and Italy (Anon. 1989*b*).

Recipe Sources

Turner and Szczawinski (1978) and Phillips (1986) give recipes for making tea from the leaves.

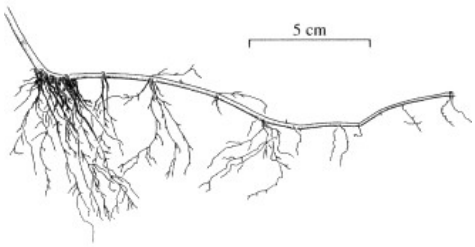


Fig. 241.
Wild bergamot *(Monarda fistulosa)* root, prepared by S. Rigby.
(Based on Dore & Kemp 16757 at Agriculture and
Agri-Food Canada herbarium, Ottawa.)

Cultivation Notes

Soil

Wild bergamot grows naturally in dry sandy soils of hillsides, meadows, roadsides and prairies, preferring a pH of 6.5-7.5 (Hayward 1983). As noted above, the plant also is frequently found in fairly rocky soils.

Climate

Wild bergamot is a hardy plant, widely distributed in southern Canada and the U.S., and therefore tolerant of the climates of these areas.

Propagation and Cultivation

See information for bergamot, above. Wild bergamot is easily propagated by division of the roots in the spring, or the tiny seeds can be planted in the spring about 6 nun deep (Kindscher 1987). Some Canadian and U.S. garden catalogs offer seeds of wild bergamot.

Harvest and Storage

See information for bergamot, above.

Example Cultivars

Morden No. 3, noted below.

Additional Notes

Chemistry

Mazza et al. (1987) studied a geraniol-rich selection called Morden No. 3, and concluded that it had commercial potential. Geraniol is a rose-scented oil, widely used by the fragrance industry to prepare rose-scented perfumes and scented soaps. It can be obtained from high-geraniol strains of *M. fistulosa*, rose geranium (*Pelargonium graveolens*), citronella grass (*Cymbopogon nardus*), thyme (*Thymus vulgaris*), all discussed in this book, as well as from other species. Synthetic geraniol is produced from turpentine and petroleum, and provides strong competition for the plant-based sources (Ference 1989). *Monarda fistulosa* has a geraniol content that far exceeds that of geranium oil (Marshall 1983). Wild bergamot has yielded essential oil containing over 95% geraniol when grown in Quebec and Manitoba on a variety of soil types (Simon et al. 1986). The yield of essential oil, obtained by steam distillation is 0.5-1.0% of the fresh leaves and stems.

Medicine

Medicinal uses of wild bergamot by American Indians have been described by Moerman (1986). Native Americans, including the Kootenay of British Columbia, the Iroquois of Quebec, and the Teton Sioux of Wyoming, regarded bergamot as an important medicine. It was used in the treatment of headaches and fevers. The Teton Sioux boiled the blossoms in a tea for fevers. The Tewa ate the ground leaves and placed a poultice of the leaves on the head for headache. The blossoms were employed as an eyewash and the roots and boiled blossoms were prescribed for intestinal parasites. Boiled leaves were used to cleanse acne and heal wounds. The Cherokee used wild bergamot for headache, colds, female problems, colic, flatulence, fever, intestinal, stomach, and heart problems, and as a sedative. Wild bergamot was used by white pioneers and travellers, and it was eventually officially recognized by early pharmacologists as a medicine for increasing perspiration, encouraging menstrual flow, and relieving upset from excess gas in the stomach (Turner and Szczawinski (1978).

Nutrition

No information found. As with most other herbs that are used in small amounts, there is very limited contribution to human nutrition.

Curiosities

• Crushed leaves of wild bergamot were employed by North American Indians to reduce the sting or itching associated with insect bites, hence the common name beebalm (Moerman 1982).

• The Pawnee recognized four varieties of *M. fistulosa*, including *tsusahtu* ("ill-smelling"), *parakaha* ("fragrant"), *tsostu* (not translated), and *tsakus tawirat* ("shot many times still fighting") (Kindscher 1987).

• *Monarda fistulosa* was the first species from the province of Ontario to be recognized by a scientific name, and also the first species introduced to European horticulture from Ontario (Pringle 1987). Gabriel Sagard, a lay brother at an early mission to the Hurons, first sent the plant to France, apparently in the early 17th century. He noted that the Hurons used the leaves to season boiled meat (Pringle 1987).

• The name beebalm (or bee balm) has sometimes been taken to suggest that the genus *Monarda* is good bee forage. However, the flowers of many of the species, particularly *M. fistulosa*, have floral tubes that are too long to allow most bees to extend their proboscis to reach the nectar (Ayers et at. 1994).

Problems and Potential

Wild bergamot has limited potential as a culinary herb. It has more potential as a source of industrial chemicals, and perhaps also as a honey plant.

Selected References

Hayward (1983); Kindscher (1987).

Monarda Citriodora Cerv. ex Lagasca

Scientific (Latin) Synonyms

M. dispersa Small

English Names

Lemon bergamot
Also: lemon bee-balm (lemon bee balm), lemon mint

French Names

Monarde citronnée (f)
[French name coined for this book.]

Lemon bergamot is an annual herb, 30-100 cm tall, with white, purplish, or pink and purple-dotted flowers in pagoda-like whorls. Entire young plants may be rather pink when young (Morton 1976). According to Tucker (1994), the species usually has the scent of thyme, not of lemon. Lemon bergamot is native to central and southern parts of the U.S., from Missouri to Nebraska and southward to northern Mexico. Eastward, it has escaped cultivation. Reports of lemon bergamot in southeastern British Columbia where it was probably introduced require confirmation (Scoggan 1978-79).

The scented leaves are a tasty addition to tea. The leaves can also be tossed in salads, floated in punches, or used as a garnish (Miske 1994). Leaves were employed by the Hopi indians of the southwestern U.S. to flavor wild game (Facciola 1990). The Tewa used lemon bergamot as a cooked green (Kindscher 1987).

Lemon bergamot makes an attractive ornamental plant. Propagation is by seeds sown in place in late spring. Seeds of lemon bergamot are offered by Canadian and U.S. garden catalogs. The seedlings are susceptible to damping-off when started indoors. The plants should be grown in full sun. Soil of average fertility is best. Rich soil produces tender plants that tend to flop over.

Lemon bergamot has been grown experimentally in the Crimea for its essential oil (Mansfeld 1986). The oil is predominantly thymol (Marshall 1983) which is known to be have antifungal, antibacterial, and anthelminthic (against parasitic worms) properties (Turner and Szczawinski 1978). Other chemical constituents include carvacrol, citral, and thymohydroquinone (Prakash 1990).

Fig. 242.
Lemon bergamot *(Monarda citriodora)*,
from Curtis (1787-present; #3526).

Curiosities

• Some Native Americans may have used the leaves of lemon bergamot to repel insects and maggots on curing meat, in the same way that wild bergamot was used for this purpose (as noted above). This is reminiscent of the widespread use of herbs and spices in Europe and Asia in past times to prevent deterioration of meat in the absence of refrigeration.

Fig. 243.
Sweet cicely *(Myrrhis odorata)*, from Hallier (1880-1888).

Myrrhis

Family: Umbelliferae (carrot family)

Genus Notes

Myrrhis has one species, discussed below.

Myrrhis Odorata (L.) Scop.

English Names

Sweet cicely
Also: anise fern, British myrhh, candy plant (Inglett 1982), cow chervil, fern-leaved chervil, garden myrrh, giant chervil, great chervil, shepherd's needle, smooth cicely, sweet bracken, sweet chervil, sweet fern, sweet myrrh Additional old-fashioned English names for sweet cicely are given by Grieve (1931).
[Species of *Osmorhiza*, another genus of the Umbelliferae, are also known as sweet cicely. Several of these are used for medicine, food, and ornament (Facciola 1990). For food purposes, these are basically collected from the wild. *Osmorhiza claytonii* (Michx.) C.B. Clarke of central and eastern Canada and the U.S. is sometimes consumed as a medicinal tea; the roots and stems are occasionally eaten as vegetables; and the roots and unripe seeds have been employed as anise-like condiments. *Osmorhiza longistylis* (Torr.) DC. (known as American sweet cicely) and *O. occidentalis* (Nutt.) Torr., also of North America, have been similarly employed. The carrot-like roots of *O. chilensis* H.&A. of North and South America have been eaten by Native Peoples (Kuhnlein and Turner 1991). Roots and leafstalks of *O. aristata* Makino & Yabe of Asia have been consumed as a vegetable.

The genus name *Myrrhis* is reminiscent of myrrh. The biblical myrrh or true myrrh refers to several species of small East African and Arabian trees of the genus *Commiphora* (of the family Burseraceae). The word myrrh also refers to the fragrant gum resin, typically in tear-shaped or irregular masses that have exuded naturally or from incisions made in the bark of the trees. This was once esteemed for its fragrance for ceremonial, religious and embalming purposes. At present, myrrh is used in some medicinal preparations (of uncertain usefulness) and for its antiseptic properties in mouthwashes; as a fragrance in soaps, cosmetics, and perfumes; and as a flavoring in food products such as candy and baked goods.]

French Names

Family: Ombellifères, famille de la carotte
Cerfeuil musqué (m)
Also: cerfeuil anisé, cerfeuil d'Espagne, cerfeuil odorant, cicutaire odorante, myrrhide, myrrhide odorante, myrrhis odorante

Description, Taxonomy, and History

Sweet cicely is a robust, aromatic, perennial herb, 60-100 cm in height, or as much as 2 m in favorable circumstances. It has hollow stems, highly dissected, soft, silky, fern-like leaves, small whitish flowers, and a large, thick, deeply growing root. A native of mountainous regions of Europe and Asian Russia, it is also found as an escape along roadsides and hedgerows in these regions (Garland 1979; Huxley et al. 1992). Wild and cultivated forms are indistinguishable.

The ancient history of mankind's association with sweet cicely is uncertain. Some authors (e.g., Hedrick 1972) suggested that sweet cicely was one of the plants referred to by Pliny (62-113) in ancient Rome. Its usage has never been great, and although it was widely cultivated in England as a potherb, sweet cicely has fallen out of favor. The plants are still grown in some European countries, such as Germany (Hedrick 1972).

As with other members of the carrot family, the fruit consist of two halves called mericarps, each generally referred to as a seed and each containing a seed. This convention is followed here. The seeds are about 2 cm long — rather large by comparison with other cultivated members of the carrot family discussed in this book. Another striking characteristic of the seeds is that they are held quite upright on the plant.

Uses

Sweet cicely is cultivated for its aromatic, anise-flavored stems, leaves, and unripe seeds. It has an aroma and flavor similar to that of anise (*Pimpinella anisum*, also discussed in this book). The leaves are eaten either raw in salads or boiled in soups and stews. They can be chopped with tarragon in butter to garnish steaks and chops. The leaves have a markedly sugary taste, hence the "sweet" in the name. Grieve (1931) stated "the leaves taste as if sugar had been sprinkled over them." If cooked with sour fruit such as rhubarb or gooseberries, the need for sugar is reduced. Fresh leaves and green seeds can also be used as a sugar substitute in sweet conserves and tart fruit dishes. According to Page (1980), the delicate flavor of sweet cicely leaves is lost if the herb is used in highly seasoned dishes.

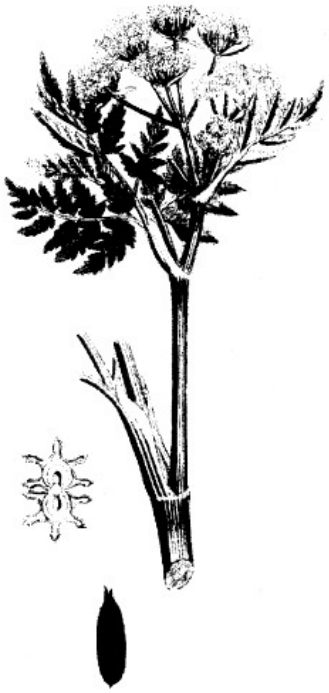


Fig. 244.
Sweet cicely *(Myrrhis odorata)*,
from Syme et al. (1863-1886).

The seeds have a more powerful, sweetly liquorice flavor than the leaves. When the seeds are green (unripe) they can be chopped and placed in salads, whipped cream, or ice cream. Whole ripe seeds are added to apple pies, like cloves, and to other baked goods. They are also used for their anise taste in the flavoring of brandy and Chartreuse. Oil from the seeds has also been employed as a flavoring for liqueurs, as well as in perfumery (Stobart 1977; Mansfeld 1986).

Pieces of very young stems can be baked in cookies and quickbreads. The roots are peeled, chopped raw, and consumed as a salad with vinegar and oil or other dressings, or boiled as a vegetable. They may also be candied (Lima 1986). Sweet cicely is also useful as a honey plant and as an ornamental.

Recipe Sources

Garland (1979) presents recipes for Candied sweet cicely roots, Early spring salad (with sweet cicely leaves), and Sweet cicely cream cheese. Boxer and Back (1980) give recipes for Apples with sweet cicely and Fruit salad with sweet cicely. Bremness (1988) has recipes for Sweet cicely baked mackerel; and Angelica, mint and sweet cicely yogurt drink.

Other recipes are: Sweet cicely tea (Marcin 1983); Sweet cicely tart (Rogers 1983); Summer fruit salad with sweet cicely (Bonar 1985); Quince and apple custard tart with sweet cicely cream (Holt 1991).

Importance

Sweet cicely is a very minor herb. It is cultivated commercially on a small scale in western Europe, as a sugar substitute for diabetics (Roecklein and Leung 1987). No statistics seem available on its usage. The plant is popular in French cooking, and is reasonably well known in Britain and Chile, but not elsewhere (Morton 1976).

Cultivation Notes

Soil

Sweet cicely grows best in deep, rich, moisture-retentive, loamy soils. The soil should be kept moist and the addition of compost or manure is beneficial. A pH tolerance of 4.5 to 7.5 has been reported (Duke 1978). Crockett and Tanner (1977) recommend a pH of 5.5 to 6.5. Soil should be dug deeply to accommodate the deep taproot.

Climate

This plant is winter hardy as far north as southern Canada. It will tolerate winter temperatures down to at least-15°C (Huxley et al. 1992). Sweet cicely grows well both in full sun and shade, and is a good plant for a shady area (Reppert 1987*a*).

Propagation and Cultivation

Although the roots of sweet cicely can be divided, the plant is usually reproduced by freshly harvested seeds sown in mid- to late summer. Indeed, seeds are shipped just after harvest (usually July) by seed supply rums. The plant self-seeds around the base of mature plants. The seeds can take months to germinate (Morton 1976), although they may sprout in 6-10 days (Wang et al. 1993). Seeds should be planted at a depth of 6 mm or less in late summer, while they are still fresh (Wang et al. 1993). According to

Crockett and Tanner (1977), sweet cicely seeds germinate best after freezing during the winter months. De Baggio (1988) described a method of ensuring good germination of seed collected from fruiting plants. The fruits are sufficiently ripe when they can be shaken from the plant. They are mixed with damp peat moss and placed in a plastic bag in a refrigerator. Between the end of January and mid-February the seeds begin to germinate. Germination is irregular so that development should be checked frequently in order to transplant seedlings to pots. Plants can also be multiplied by division, provided that each section of the upper root contains an eye. Once established the plants should last for years. To avoid unwanted volunteers, the fruiting stalks should be removed before the seeds ripen (Lima 1986). For home use, a single plant is generally enough, although several make an attractive backdrop to a perennial border.

Harvest and Storage

The leaves and stems are collected when young. The leaves wilt quickly and are best picked just before use. The foliage does not dry well (Garland 1979), and even loses some flavor when frozen (Jacobs 1972). Seeds are harvested while unripe and green. The texture of the seeds can be evaluated by chewing them, to test that they have been collected while they are still non-fibrous (Lima 1986).

Example Cultivars

Cultivars do not seem to be available.

Additional Notes

Chemistry

Trans-anethole makes up about 85% of the essential oil, and accounts for the odor of the plant (Tkachenko and Zenkevich 1993). Trans-anethole has been associated with an anise smell (Hussain et al. 1990). "The large amounts of trans-anethole in various parts of this species... no doubt account for its sweet taste" (Hussain et al. 1990). This chief flavoring ingredient of sweet cicely is widely used by the food industry as a flavoring agent in beverages, candy, baked goods and chewing gum (Hussain et al. 1990).

Medicine

Sweet cicely was considered a wholesome herb, useful for strengthening the lungs, for warming "old and cold stomachs oppressed with wind and phlegm," and for stimulating the appetite (Garland 1979). The plant was once an ingredient of wound-healing ointments (Stuart 1979). The roots were highly regarded for protection against the plague. In ancient times a root decoction boiled in wine was employed to treat bites of poisonous snakes, spiders, and mad dogs (Marcin 1983). The seeds reportedly have a mild laxative effect (Garland 1979). Sweet cicely is rarely used medicinally today.

Nutrition

The leaves and stems of sweet cicely are said to contain up to 40% sugar in a form useful for a diabetic diet (Lima 1986).

Curiosities

• The genus name *Myrrhis* comes from the Greek *myron*, perfume, or *myrrha*, myrrh or scent of plant (Hereman 1868). [Stearn's (1992*a*) interpretation is that *Myrrhis* was the Greek name for *M. odorata* and also for the biblical myrrh, noted earlier.] *Myrrhis odorata*, as implied by its name, is scented. The name is unusual in that both words of the binomial refer to the scented nature of the species.

• According to Leyel (1938), sweet cicely was one of the aromatic herbs used in making the holy oil of the Tabernacle with which Moses anointed the sacred vessels.

• A salad with sweet cicely roots was supposed "to be very good for old people that are dull and without courage" (Grieve 1931).

• In northern England until the 20th century, the large oily seeds were gathered and crushed to make an anise-scented polish for wooden furniture, especially oak (Fox 1933; Morton 1976).

• Sweet cicely is sometimes rubbed inside hives to attract honeybees (Morton 1976; see *Melissa* Curiosities, where the more frequent use of lemon balm for this purpose is described).

Problems and Potential

Sweet cicely is of very minor importance and has little commercial Potential, barring the discovery of dramatic, new uses for its constituents. It will likely remain a curiosity of home gardens in North America.

Selected References

Garland (1979); Lima (1986).

Fig. 245.
Myrtle *(Myrtus communis)*,
from Thomé (1903-1905).

Myrtus

Family: Myrtaceae (myrtle family)

Genus Notes

The two species of *Myrtus* are evergreen shrubs, native to the Mediterranean, and northern Africa.

Myrtus Communis L.

English Names

Myrtle
Also: common myrtle (bush), Greek myrtle, Jew's myrtle, myrtle tree, sweet myrtle
[A number of unrelated species have "myrtle" in their name, for example: the Oregon myrtle, sometimes just called myrtle, *Umbellularia californica* (Hook. & Am.) Nutt.; myrtle whortleberry, *Vaccinium myrtillus* L.; (creeping) myrtle, *Vinca minor* L. (better known as periwinkle); sand myrtle, *Leiophyllum buxifolium* (Bergiums) Elliott; cape myrtle, *Myrsine africana* L.; and crape myrtle, *Lagerstroemia indica* L.]

French Names

Family: Myrtacées, famille du myrte
Myrte (m)
Also: myrte commun
[In Old French, myrte was applied to species of bilberry and whortleberry (myrtleberry; see *Vaccinium*, above) (Moldenke and Moldenke 1952).]

Note

Myrtle contains considerable tannin, which may cause health problems if consumed regularly over long periods.

Description, Taxonomy, and History

Myrtle is an evergreen bush, or a tree (in favorable circumstances) up to 5 m in height. It has white or pink-white flowers to 3 cm across, and ellipsoid or subglobose, blue-black berries 7-13 mm long. The leaves are dark green and glossy, with leathery texture and pointed tips. The leaves and flowers are flagrant, containing many tiny, transparent oil glands that can be seen with a magnifying glass if the leaves are held up to strong light. Myrtle grows wild in most of the countries bordering the Mediterranean, but has been so widely grown since ancient times that its original native range before mankind began cultivating it is uncertain. Several subspecies and varieties have been recognized (Campbell 1968; Huxley et al. 1992).

Fig. 246.
Myrtle *(Myrtus communis)*, from Hallier (1880-1888).

Uses

The spicy leaves and berries are used fresh or dried for cooking like bay leaves (*Laurus nobilis*, also discussed in this book). They have been added to stuffing and wild game meats since ancient times (Garland 1979). The fruits and flower buds flavor poultry, sauces, wines, liqueurs, and syrups. Dried flower-buds and fruit can be crushed like pepper-corms and used as a spice. Fresh myrtle fruit juice has been drank as an appetizer (Stuart 1979), and a tart drink is made in Greece from the fermented fruits (Morton 1981). Sprigs were formerly added to wine to

increase its potency. An essential oil obtained from the leaves is mixed with other spices for use as a condiment (Mansfeld 1986). The oil is used in liqueurs and, in some countries, in flavoring sauces and canned meats (Furia and Bellanca 1975). The oil was once employed in manufacturing eau d'ange (toilet water) (Roecklein and Leung 1987). By itself, myrtle oil is somewhat bitter and sharp, but it blends well with other herb oils (Arctander 1960). Myrtle branches are burned to give a rich, spicy flavoring to meat roasting over an open fire. Fresh flowers were once added to salads (Stuart 1979).

The oil is also used for non-culinary purposes. It has been valued in perfumery since antiquity. Its attractive scent has resulted in the use of myrtle in home-made cosmetic recipes (Smart 1979). Oil from the flowers, leaves and berries serves to tan fine Turkish and Russian leathers (Bumpus 1975). The bark and roots have also been employed for tanning (Perry 1974).

Myrtle has been traditionally grown as an aromatic ornamental and as an addition to triumphal garlands and bridal wreaths (Huxley et al. 1992). The dried flowers are added to potpourris (Garland 1979). In Europe the leaves of myrtle were once crushed and rubbed on furniture to give it a spicy scent (Garland 1979). The berries were employed to dye hair and sweeten breath. The wood is hard, richly golden with dark brown mottling, producing distinctive patterns that are attractive in carved figurines commonly sold where the tree grows.

In warm parts of the temperate world, myrtle is considered an ideal subject for hedges. It is one of the best of all herbs for the indoor garden, and provides beautiful specimens that can be moved out in summer to adorn patios or gardens.

Recipe Sources

None found. The recipes for bay leaves may be tried, substituting myrtle for all or part of the bay.

Importance

Myrtle is primarily an ornamental shrub of warm countries. It has limited use as an essential oil and culinary crop. In the Mediterranean and western Asia, wild plants can be harvested. The plants are cultivated to a small extent in Great Britain and the southern U.S. (Roecklein and Leung 1987). In northern North America, myrtle is merely an attractive houseplant with culinary potential. Production statistics for myrtle seem to be unavailable (Roecklein and Leung 1987). Verlet (1993) estimated the annual world value of myrtle essential oil to be $250,000.00 (U.S.).

Cultivation Notes

Soil

Pots in which myrtle is to be grown should contain moderately fertile, well-drained, loam-based soil, enriched with leafmold or other well-composted organic material. Myrtle does not tolerate wet soil. Reported pH tolerance ranges are 5.5-8.0 (De Baggio 1987) and 5.5-8.3 (Duke 1978). Around the Mediterranean, myrtle is a calcifuge (Campbell 1968), i.e., it avoids basic soils (pH > 7.0).

Climate

Myrtle tolerates winter temperatures between -10°C and -15°C, depending on cultivar. The small-leaved Tarentina tolerates -15°C (Huxley et al. 1992). Myrtle grows at temperatures between 10 and 24°C, optimally about 17°C. It is usually slow-growing in cool areas. In regions subject to freezing, it is best cultivated as a pot plant, taken indoors during cold periods. Myrtle grows well outdoors in full sunlight, but tolerates slight shade. Cold winds can damage the foliage, causing it to turn brown. The plants should be watered when actively growing. Light levels and watering are reduced during the winter months when growth usually stops. According to Crockett and Tanner (1977), myrtle grown indoors tolerates low light, and will survive even on reflected light near a window.

Propagation and Cultivation

Propagation is by seeds, by cuttings taken from young shoots in midsummer, or by layering (bending branches to the ground and covering a portion) until roots form (Garland 1979). Seeds germinate well between 20° and 27.5°C (Scortichini 1986). Cuttings from the current year's basal stem growth can be taken in autumn and rooted indoors. The plants should be repotted every other year in early spring (Huxley et al. 1992). Actively-growing myrtle must have ample water to flourish, and potted plants allowed to dry out will drop their leaves. The small-leaved cultivar Microphylla can be grow in dwarfed form as bonsai (Hume 1976).

Harvest and Storage

The leaves and flowers can be gathered in late spring or early summer for drying. They are stored in airtight jars for later use.

Example Cultivars

Several horticultural forms have been selected. In Canada the following are available as living plants: Microphylla (German myrtle) and Microphylla Variegata

Fig. 247.
Myrtle *(Myrtus communis)*, from
Lamarck and Poiret (1791-1823).

(variegated German myrtle). These small-leaved forms have been traditionally used for corsages and in wedding bouquets. In the U.S., Triloba (Sacred myrtle) is also offered. This cultivar is esteemed in Judaism for use in religious ceremonies and for decorating during the Feast of Tabernacles (see Curiosities). Huxley et al. (1992) list several additional cultivars.

Additional Notes

Chemistry

Terpenes and terpene alcohols make up almost all of the volatile compounds of the essential oil of myrtle (Mazza 1983). Boelens and Jimenez (1992) have briefly reviewed myrtle oil chemistry. Well over 100 constituents have been found in the various oils of myrtle. Moreover, leaf and fruit chemicals may differ in concentration, and some constituents change dramatically as ripening progresses. Yields are approximately: leaves: 0.4-0.5%, flowers: 0.4%, unripe fruits: 0.5%, ripe fruits: 0.02%. Typically, the essential oil contains substantial amounts of -pinene, limonene, cineol, and other components (Diaz and Aberger 1987). The fixed oil contains the following acids: lauric (1.4%), myristic (1.1%), palmitic (ca. 24%), stearic (2.8%), oleic (ca. 14%), linoleic (ca. 48%), and linolenic (ca. 9%) (Asif et al. 1979). The plant also contains considerable tannin (Diaz and Aberger 1987).

The leaves are important chemically because of their flavor. The flavor of the leaves is sweet and aromatically spicy, due to eugenol, methyl eugenol, and eugenyl acetate.

The aroma of the oil is important in perfumery. The fragrant olfactory quality of myrtle leaves is refreshingly floral, due to oxygenated monoterpenoids, particularly myrtenyl acetate, myrtenol, and myretanal. The fresh flower oil differs from the leaf oil in having a sweet, creamy aspect, but extracts from dried flowers are much like the leaf oil. The odor of the unripe fruit oil is similar to that of the leaf oil. However, the ripe fruit oil is harsher.

Medicine

Myrtle was employed in traditional medicine to reduce flatulence and to treat tuberculosis and chest complaints (Sanecki 1974). It has had many medicinal uses in southern Europe, especially Spain (Morton 1981). In the Middle East it was used as an astringent dusting powder for babies wrapped in swaddling clothes. A leaf decoction has been applied to bruises and hemorrhoids, and an infusion used as a medicinal douche (Stuart 1979). The plant was also taken internally for psoriasis and sinusitis (Stuart 1979). It has been used to treat headaches and epileptic fits (Elisha et al. 1988). In Libya, where myrtle has been employed in folk medicine to treat diabetes, a study with mice showed that myrtle could reduce blood sugar level (Elfellah et al. 1984). On the whole, myrtle has not received much medicinal use, and is not used today in western medicine.

The considerable tannin in myrtle makes it advisable that its culinary use be limited. Morton (1975) discussed problems associated with overconsumption of tannin, and warned of the danger of gastric cancer.

Nutrition

Myrtle has been noted to contain significant vitamin C (Stuart 1979). However, so little is normally consumed that the plant does not furnish significant levels of nutrients.

Curiosities

• The name *Myrtus* is derived from its Greek name, *myrtos* (Steam 1992*a*), the Greek word for perfume (Bumpus 1975). The Hebrew name for myrtle, *hadas*, means sweetness (Bumpus 1975).

• According to legend, when Adam was expelled from Paradise, God allowed him to take wheat, the chief of foods; the date, the chief of fruits; and the myrtle, the chief of scented flowers (Moldenke and Moldenke 1952).

• An Arabian legend relates that Adam, banished from paradise, brought a sprig of myrtle to Eve and declared his love for her (Bremness 1988).

• Another Arabian legend holds that the rose must bow her head in the presence of the myrtle (Bumpus 1975; but see *Rosa rugosa* Curiosities regarding pompous pretensions of superiority!]

• In the Old Testament (Isa. 41:19) Yahweh promised to plant a myrtle in the wilderness for the children of Israel (Mercatante 1988). The ancient Israelites were ordered by Nehemiah in 455 B.C. to gather myrtle to build the booths where they would sit during the week of the Tabernacle Feast (Bumpus 1975).

• The ancient Greeks and Romans considered myrtle sacred to Aphrodite (the Greek Goddess) or Venus (the Roman counterpart) and it was worn by winners at the Olympic Games (Bumpus 1975).

• In the legends of the time of Charlemagne (742-814), Alcina was a powerful enchantress and the embodiment of carnal pleasure. After her sexual conquests, she changed her lovers into trees, fountains, and rocks. One of her victims was Astolpho, who she changed into a myrtle tree (Mercatante 1988).

• Myrtle is a mythological emblem of sensual love and passion. Venus wore a wreath of it when Paris gave her a golden apple. This symbolism may account for the association of myrtle with weddings. In Britain it was customary to have a sprig of myrtle in the bridal bouquet, and for a bridesmaid to plant the sprig in a sheltered spot (Sanecki 1974). Israeli brides also carry myrtle at weddings (Smart 1979).

• Although Roman brides and bridegrooms wore myrtle sprigs, myrtle was sometimes identified with unlawful and incestuous love in ancient Rome, and was not allowed to be displayed at some public functions (Mercatante 1988).

• Mytle's reputation as an aphrodisiac, and its dedication to Venus, the goddess of love, "was almost certainly because the aromatic leaves bear a resemblance to the female pudenda" (Smart 1979).

Fig. 248.
Myrtle *(Myrtus communis)*,
from Engler and Prantl (1898).

• *Myrtus communis* is the sole native representative in Europe of the Myrtaceae, which includes nearly 3000 species, mainly in tropical regions (Bumpus 1975).

Problems and Potential

Myrtle is basically an edible potted plant, without commercial potential for culinary purposes in northern North America.

Selected References

Bumpus (1975); Boelens and Jimenez (1992).

Nasturtium

Family: Cruciferae (Brassicaceae)

(mustard family)

Genus Notes

"Nasturtium" as a common name refers to species of the South American genus *Tropaeolum* (also discussed in this book), not to species designated by the scientific name *Nasturtium*. This curious transfer came about through the similar taste of the leaves, flowers, and fruits of *Nasturtium and Tropaeolum*, as the popularity of growing the latter in flower gardens increased (Fernald et al. 1958).

Nasturtium consists of six species of perennial herbs adapted to water or wet soils. The genus is native from Europe to central Asia, North Africa, and North America. *Nasturtium officinale* is discussed below. *Nasturtium microphyllum* (Boenn.) Rchb. (= *N. officinale* var. *microphyllum* (Boenn.) Thell. = *Rorippa microphylla* (Boenn.) N. Hyl. ex A.&D. Löve) is a more cold-hardy species than *N. officinale* (Huxley et al. 1992). It has been collected from the wild and used as a salad plant. In the autumn the plants turn purplish-brown (Simon et al. 1984). The species hybridizes with *N. officinale*, and the hybrid is known as brown cress (apparently inheriting the brown color from *N. microphyllum*). Brown cress was commercially cultivated for a period, until it proved vulnerable to diseases (Huxley et al. 1992). Cultivated cress is susceptible to viruses, which can be eliminated by growing the plants from seed. However, the hybrid is sterile, cannot be grown from seeds, and so is relatively prone to disease (Howard 1976).

Nasturtium Officinale R. Br.

Fig. 249.
Watercress *(Nasturtium officinale)*,
from Nicholson (1885-1889).

Scientific (Latin) Synonyms

Rorippa nasturtium-aquaticum (L.) Hayek
[*Rorippa nasturtium-aquaticum* is widely used today as the scientific name of the plant, especially in Europe.]

English Names

Watercress
Also: green watercress, town cress, water cushie, water crishes
[Stephens (1978) gives a variety of other obsolete names, including biller, billers, bilure, brown cress, eker, long tails, rib cress, teng tongue, and well grass. Garden catalogues sometimes supply seeds under the name "true watercress." In the Oriental marketplaces of British Columbia, the plant is known as *sai-yeung choy* (Li 1992*a*).]

French Names

Family: Crucifères, famille de la moutarde
Cresson de fontaine (m)
Also: cresson (aquatique), cresson d'eau, cresson officinal, cresson au poulet, cresson de misseau, nasilord, nasturce officinal, santé du corps

Warning

Wild-growing watercress may be in contaminated water, and should not be eaten.

Description, Taxonomy, and History

Watercress is a fast-growing, evergreen, succulent, herbaceous plant adapted to wet soils and flowing shallow water. It roots in stream beds, the stems extending from 0.3 m to as much as 2.5 m in length, and 50 cm in height to the surface, where they float (Morton 1981). White flowers are produced in elongated inflorescences. Adventitious roots form in the leaf axils of the shoots beneath water level. These are considered a disadvantage in marketing the plants. This perennial sometimes reproduces as an annual (Howard and Lyon 1952). Cultivated selections resemble wild plants. Watercress is native to Europe, northern Africa, and western Asia (Clapham et al. 1987), and has become naturalized in temperate and mild climates throughout the world. It is a serious river weed in some areas, such as New Zealand (Clapham et al. 1987). Watercress tends to occur at the edges of rivers, streams, ditches and springs, just below or just above water level (Howard and Lyon 1952). It usually produces

roots from the leaf nodes. It is presumed that it can obtain mineral nutriments from both the water and the soil (Howard and Lyon 1952). In Canada, watercress has been introduced in British Columbia and Alberta. It is found in almost all of the states of the U.S., and also occurs in Mexico (Rollins 1993). *Nasturtium microphyllum* is found across southern Canada, and the hybrid between it and watercress has been found in Alberta and Nova Scotia (Scoggan 1978-79). In the U.S., *N. microphyllum* occurs from Canada to Florida.

Howard (1976) outlined the economic history of watercress. It was primarily used as a medicinal plant in Eurasia from the first century A.D. to the 19th century. The ancient Persians fed watercress to their children to improve their growth, and to their soldiers in the belief that it would improve their health (Seelig 1974). According to Syme (1873), the classical Greeks considered water-cress not only a valuable medicine but also an agreeable vegetable. Watercress was first grown in France, in the 14th

Fig. 250.
Watercress *(Nasturtium officinale)*,
from Hallier (1880-1888).

century (Stevens 1972). The first widespread cultivation of watercress may have been in southern Germany, especially near Erfurt, as early as 1750. Large-scale cultivation in England began in 1808 to supply the' London market and, in France, near Paris in 1811. Watercress was raised in Germany and France, while in England both watercress and hybrid cress (brown cress) were grown. More recently, cultivation of watercress spread to many tropical and temperate regions.

Uses

Watercress is peppery tasting, reminiscent of radish. This leafy green is useful for spicing-up a variety of foods. The leaves and young shoots of watercress are eaten raw in salads and sandwiches, added to soups, sauces, stuffings, omelets, chopped herb mixtures, and dressings, steamed with rice, and employed as a garnish for meat dishes. "The watercress sandwich is as English as apple pie is American" (Seelig 1974). Potage cressionier is a thick soup of potatoes and watercress popular in France. In Italy, cress is added to minestrone and other soups, while the Chinese use it in egg drop, won ton, and other soups. According to Li (1992*a*), watercress is commonly consumed as a cooked vegetable in China, not as a fresh vegetable as in North America. Watercress is also used as a potherb in southeast Asia (Tindall 1983), and is highly prized by the Mohammedans of western India and Pakistan (Seelig 1974).

The seeds are occasionally made into mustard, or grown to produce edible sprouts (Facciola 1990).

Recipe Sources

Claiborne and Lee (1972) have recipes for Watercress garnish for duck, Stir-fry watercress, Watercress and pork ball soup, and Watercress and chicken giblet soup. Szczawinski and Turner (1978) give recipes for: Savory watercress canapé; Hearty watercress canapé; Seafood canapé; Cress salad, French style; Watercress soup; Scrambled eggs with watercress, English style; and Watercress sandwiches. Chang et al. (1979) have recipes for Water-cress pork soup, Watercress liver soup, and Watercress fish fillet soup. Jaffrey (1981) presents recipes for Bean curd with watercress, and Watercress salad with sesame seeds. Belsinger and Dille (1984) present 11 cress recipes, notably Cress eggrolls, Cress Bearnaise, Cress crêpes, and Cress turbot mousse. Leggatt (1987) has recipes for Baked potatoes with watercress and marigolds; and Watercress, apple, walnut and chrysanthemum salad. Levy (1987) presents recipes for Green vegetable quenelles with mushroom cream, Watercress salad with goat cheese, and

Watercress velouté soup with cheese puffs. Richardson (1990) gives recipes for Watercress and avocado salad, Watercress dressing, and Pear and watercress soup.

Other recipes are: Watercress & sorrel soup (Hooker 1971); Spicy minced watercress (Kuo 1977); Watercress and orange soup (Garland 1979); Chicken soup with watercress (Buishand et al. 1986); Broccoli & rice casserole with cress sauce (Thompson 1986); Spinach and watercress salad with savory mayonnaise (Creasy 1988); Watercress in sweet gravy (Solomon 1992); Watercress and shrimp (Hacker 1993).

Importance

Watercress is commercially produced in several European countries, including Britain and France (Buishand et al. 1986). It is one of the most popular salad plants of Mexico (Morton 1981).

Watercress is grown in California and the mid-Atlantic states in the U.S. (McCoy 1987). Production is highest in the hilly limestone regions of Virgiana, Maryland, and Pennsylvania, where neither summer or winter temperates are extreme (Shear 1968). However, the plant is cultivated to some extent from the southern U.S. to the northern states along the Canadian border (Shear 1986). Winter supplies are grown in the South, whereas summer and autumn supplies come from the North (Seelig 1974). Crockett and Tanner (1977) state that watercress is grown commercially in Alabama, California, and Virginia. It has been estimated that the U.S. consumes about 20 million bunches of watercress a year, and that this is grown "on several hundred acres" (Seelig 1974).

Watercress is a minor crop in Canada. In 1991, 40 t of domestically grown and 1195 t of imported watercress were unloaded at 10 major Canadian markets (Anon. 1992*c*); in 1992, 57 t of domestic watercress was delivered in these markets (Anon. 1993*b*); and in 1993, 89.8 t of domestic watercress (Sundue 1994). In 1991, domestic production of watercress was less than 5% of the total used in Canada. All of the domestic watercress unloaded at major Canadian markets occurred during the summer growing season (Anon. 1992*c*), indicating that little watercress is grown in Canadian greenhouses during the winter months.

Cultivation Notes

Soil

Watercress grows naturally in very wet soils or in watercourses. Although it grows on wet soil, it grows best in slow-running water. In England, it grows well in chalk or limestone districts fed by deep springs or artesian wells

Fig. 251.
Watercress *(Nasturtium officinale)*, from Vilmorin-Andrieux et C^{ie} (1883).

with water temperature constantly about 10°C. A gravel substrate is often used in commercial operations. The pH should be 6.5-7.5 (Tindall 1983), optimally 7.2 (Huxley et al. 1992), with a range of tolerance of 4.3-8.3 (Duke 1978). Watercress obtains nitrogen from the water in which it grows, and it is recommended that the water should contain over 2 parts per million of nitrate (Seelig 1974). In greenhouses and indoors, watercress is grown on a variety of substrates and lends itself to hydroponic gardening. Habegger et al. (1989) found that for water-cress grown in submerged pots, mixtures of poorly and well decomposed peat provided a good substrate. Crockett and Tanner (1977) note that although it will grow with less vigor than in water, watercress can be grown on very rich, moist, garden soil. Li (1992*a*) states that fertilizer requirements are minimal, only phosphate needed.

Climate

Watercress is a hardy, cool-season semi-aquatic that grows naturally in clear, cold, shallow, slow-moving streams. Although very tolerant of shade, it thrives in full sunlight. Watercress is adapted to cool water, submersed portions surviving so long as the water does not freeze (Simon et al. 1984). Trials in Britain have shown that watercress is damaged by frost and that use of a plastic tunnel is superior to submerging the plants, which injures and promotes yellowing of leaves (Rothwell and Robinson 1986). The plant requires temperatures of at least 10°C to grow (Li 1992*a*). Temperatures for propagation of seed are best between 18 and 21°C, and water temperatures for

growth are ideally between 10 and 11.5°C (Huxley et al. 1992). Watercress flowers when daylength is over 12 h per day.

Propagation and Cultivation

Commercial production generally uses running water beds (natural or constructed) to provide required growing conditions. Watercress is propagated by seeds or cuttings. Most commercial production employs seeds to prevent the spread of vegetation-born viruses such as the turnip mosaic virus (Wainwright and Marsh 1986). The seeds are very small, and mixing them with several times as much dry sand helps in sowing thinly. Seeds are generally covered lightly with soil. The soil is misted to keep the seeds moist until germination. Seedlings generally need a moist soil, not running water, to initiate growth. A continuous source of slow-running water is directed through the beds once seedlings are established. After germination the water level is increased to about 5 cm in depth, the plants growing either floating or rooted to the bottom. Alternatively, cuttings are rooted in containers that are submerged in water. Partial shade should be provided (Trodall 1983). Buds are usually pinched off to prevent flowering and to promote branching (Tindall 1983; Chadwick 1985).

In commercial operations watercress is usually raised outdoors from seed and treated as an annual crop, generally in specially-constructed beds. The beds can be side-by-side, or tiered with water flowing in at the high end and out the low end. In Britain the recommended flow-rate of water is 720 L/h per 0.3 m width of the bed. The beds are traditionally 9 m wide and 48-70 m long. Nursery beds are used for seed propagation and the seedlings are transplanted to the water beds either by hand or by a modified rice planter (Chadwick 1985).

Another method is to grow watercress in greenhouses, either in beds or in pots. The advantage of using pots is that the plants are not cut at harvest time but are sold rooted in the pots, avoiding the quick withering and loss of quality of cut watercress. The pots can either be submerged in flowing or non-flowing water. Small-sized pots produce plants with thinner stems with a higher proportion of leaves, and are more efficient for crop production (Habegger et al. 1989).

Much of the seed used commercially in Britain is produced by the growers, who have little time to improve their seed stocks (Wainwright and Marsh 1986). Vegetative propagation of plants has the potential to improve water-cress production. Lines can be cloned en masse to provide improved seed uniformity and quality, and clonal stock beds could be established as sources for propagation. Such procedures have been demonstrated to be commercially viable.

Algae can be very troublesome, especially under warm conditions. Copper sulphate at a concentration of 2-10 parts per million is said to kill most algae without undesirable effects on the crop, fish, or other wildlife (Shear 1968).

The home gardener can grow watercress outdoors by digging a trench lined with plastic and placing about 5 cm of sand and peatmoss on the bottom for the seeds. Alternatively, a wet soil is suitable. A trickle of running water, if this can be arranged, will improve growth. An unpolluted watercourse can also be used if it has quite shallow areas (Halpin 1978). A few cuttings can simply be pushed into the wet soil and allowed to grow, or plants in containers of soil can be placed in rocky or gravelly areas lacking soil. Sprigs from a supermarket can be used. Once planted, beds of watercress can be maintained for about 10 years without resowing or replanting (Simon et al. 1984). Trimming half to two thirds of the length of mature plants will stimulate fresh, succulent growth. A few plants covering a square meter will produce enough watercress to supply the average family. In a greenhouse, the home gardener can grow watercress in pots on saucers of water placed in the shade, or under benches.

Harvest and Storage

In Europe commercial harvesting depends on the culture method. Watercress grown in beds is collected when it reaches a minimum height of 16 cm. Bunches with stems about 14 em long are manually cut, tied together, and cut again to produce watercress 8 cm long. These are packed in bulk for supermarkets. Mechanical bunching machines have been developed, requiring two operators, that can produce 20 000 bunches/hour compared to about 300 bunches/hour/person curing manually (Chadwick 1985). Yields are of the order of 50 t/ha of leafy stems (Roecklein and Leung 1987).

In the U.S., commercial growers harvest plants in two ways. From March to October, when the air is warm and the crop grows above. the water, the plants are cut and the stubble below water is allowed to regrow. When there is danger of frost the water level in the beds is raised to cover the plants. Leaves and some plants are harvested, leaving as many as two-thirds of the plants intact. The roots are cut off and the plants are bunched (McCoy 1987). Average yields in the U.S. of about 23 bunches/square metre (2500 bunches per thousand square feet) of well-established bed have been reported (Seelig 1974).

Watercress wilts, loses its color, and becomes slimy if improperly handled. The home gardener may pick the crop in the early morning, to prevent wilting (Li 1992*a*). Water-cress stores for 3-4 days at 0-1°C and high humidity. It is often sold in plastic bags, open to allow frequent spraying

with cold water during shipment and display in stores (Tindall 1983; Buishand et al. 1986; McCoy 1987). Crushed or flaked ice is often added, and refrigerated transport is critical. Watercress is also grown and sold in small pots and fiats. This reduces loss of quality and increases storage time (Habegger et al. 1989).

Findley (1971) noted that the leaves can be dried for use as a cooking herb (although this is not normally done). The tender leaves are spread on a clean dry sheet and left in warm shade for several days until completely dry. They are then crushed and sealed in spice jars for use in soups and teas.

Watercress is a year-round delicacy, shipped to principal city markets all over North America. Because of its perishability, it is generally sold directly to dealers with special facilities for handling the crop, or directly to hotels and restaurants.

Example Cultivars

Improved broad-leaved (essentially = Broad Leaf and Large Improved; described in Facciola 1990).

Additional Notes

Chemistry

Watercress yields 0.06% of a pungent volatile oil, mainly containing phenethyl isothiocyanate (Morton 1981). Volatile compounds, studied by Spence and Tucknott (1983), seem to contribute to the aroma of watercress. The flavor is apparently related to the presence of phenethyl isothiocyanate, enzymatically produced from the corresponding glueosinolate (Freeman and Mossadeghi 1972).

Medicine

Folk medicinal uses for watercress include treatment of anemia, boils, liver disorders, tumors, and warts, (Simon et al. 1984), as well as asthma, baldness, bronchitis, eczema, flu, goiter, hepatitis, impotence, polyps, scabies, scurvy, and tuberculosis (Duke 1992*a*). Costanoan Indians used watercress tea to treat fevers and kidney and liver complaints (Moerman 1986). In Chinese medicine, watercress is used to treat dry cough and phlegm in the throat (Duke 1992*a*). Watercress has been an ingredient of herbal cosmetics used for skin blemishes and freckles (Duke 1992*a*).

Overuse of watercress can lead to kidney problems, and the undiluted juice can produce throat and stomach inflammations (Chadwick 1985). Rinzler (1990) notes that food plants in the mustard family, like watercress, contain goitrogens (gluconasturtiin is the watercress goitrogen); these sulfur compounds slow the thyroid gland's production of hormones, and might be troublesome for people with thyroid disorders.

Fig. 252.
Watercress *(Nasturtium officinale)*,
from Syme et al. (1863-1886).

The dangers of harvesting watercress from the wild need to be emphasized. Wild watercress has been reported to be a source of liver fluke in humans, especially in areas frequented by livestock (Chadwick 1985). Cases of typhoid fever have been traced to eating watercress from streams and ditches fouled by sewage or by passing animals (Quelch 1946). Poisonous wild aquatic plants sometimes grow with wild watercress, and could mistakenly be harvested by wild food gatherers.

Nutrition

Watercress is an extremely nutritious herb (Duke 1992a). It is a good dietary source of the vitamins A, B_2, C, D, E, and nicotinamide, and the minerals calcium,

iodine, iron, manganese, and phosphorus (Chadwick 1985). It is also high in protein (Simon et al. 1984). Halpin (1978) stated that watercress contains almost twice as much vitamin A as broccoli, and 100 g of raw stems and leaves has more calcium than half a glass of milk, and as much vitamin C as an orange.

Curiosities

• The generic name *Nasturtium* comes from the Latin *nasus tortus*, "a convulsed nose," in reference to the mustard-oil taste characteristic of the genus (Fernald et al. 1958).

• The classical Greeks considered watercress particularly useful for disorders of the brain, leading to a common proverb in early Greece, "eat cress to learn more wit" (Syme 1873).

• *Kers* is an Middle English word from which *cress* is derived. The expression "not worth a kers" (i.e., cress), used to indicate that something is of little value, has been corrupted into "not worth a curse" (Seelig 1974).

• The Greek armies of Alexander the Great's time (356-323 B.C.) ate watercress because they believed it gave strength during battle (Belsinger and Dille 1984). Ancient Greeks also regarded watercress as a cure for insanity (Harrington 1978).

• The classical Romans ate large quantities of watercress, partly in the belief that this would prevent their hair from falling out (Harrington 1978).

• In 16th century England, eating watercress was recommended to "restore their accustomed bloom to the faded cheeks of sickly young ladies" (Syme 1873).

• The Kings of Erin (Ireland) were entitled to tributes of watercress (Howard 1976).

• The following "selling words and phrases" have been recommended to market watercress (Seelig 1974): Adds extra flavor; adds snap to salads or meats; appetizer in sandwiches; adds zip to sandwiches, appetizers and soups; bright green; crisp and clean; crisp and peppery; dainty and bright dress-up for a salad; eat the tender stems as well as leaves; fresh as a mountain spring; fresh as the running water it grows in; good source of trace minerals; high in vitamin A and vitamin C; long-stemmed, thick-leaved cress; nippy; peppery; piquant; pungent; refreshing; salad garnish that looks good, tastes great; snappily fresh; spices up cold meat; tangy; tasty; zesty; zingy.

Problems and Potential

Watercress requires special growth conditions (Howard 1976). It has been said not to lend itself to mechanization, and to be a labor-intensive crop (Howard 1976), but large areas of watercress can be harvested rapidly by machines and the washing and packing process can be mechanized (Gilby and Wainwright 1989). The elaborate cultural and machinery requirements necessitate investment, however, limiting this minor crop in North America.

Selected References

Howard and Lyon (1952); Anon. (1956); Shear (1968); Seelig (1974); Howard (1976); Yamaguchi (1983); Chadwick (1985).

Nepeta

Family: Labiatae (Lamiaceae) (mint family)

Genus Notes

Nepeta has about 250 species of perennial, sometimes annual, herbaceous plants native to dry habitats in temperate Europe, Asia, northern Africa and the mountains of tropical Africa. Several species are grown as ornamentals and as ground covers.

Nepeta Cataria L.

English Names

Catnip
Also: catmint, catnep, catrup, catwort, English catnip, field balm, nep, nip
[Many of the ornamental species of *Nepeta* are called catmint, particularly *N. faassenii* Bergmans ex Steam (*N. racemosa* Lam. *N. nepetella* L., also known as *N. mussinii* hort.), a sterile hybrid with several cultivars.]

French Names

Family: Labiées, famille de la menthe
Népéta cataire (f)
Also: c(h)ataire (commune), herbe à chat(s), herbe au(x) chats (herbe-aux-chats), herbe-des-chats, mente à chat(s), menthe au(x) chat(s), menthe de(s) chat(s), nepeta, népéta chataire, népéte, népète c(h)ataire
[The lemon-scented variety of this species (cultivar citriodora) is sometimes called mélisse (Fournier 1947-48), although this name is best reserved for lemon balm, *Melissa officinalis*, discussed in this book. C(h)ataire is also used for the weed *Glechoma hederacea* L.]

Description, Taxonomy, and History

Nepeta cataria is an erect perennial, 0.3-1.6 m high, which produces small whitish or pinkish (occasionally blue or lilac), purple-or red-dotted flowers. The plant is strongly scented with a mintlike odor, rather like pennyroyal (discussed in this book), which many find somewhat disagreeable. Catnip is native from the eastern Mediterranean region to the western Himalayas, central Asia, southern Siberia, and China. It has been introduced in Japan, North America, South Africa, and Java. Catnip has become widely introduced in North America, and has been collected as far north as Alaska. As a weed, it is found in hedges, fencerows, roadsides, stream banks, and waste places.

Nepeta cataria var. *citriodora* (Becker) Balb. contains a relatively high proportion of lemon oil.

Catnip was cultivated for cats by the classical Greeks and Romans (le Strange 1977). By 1265 it was a familiar herb of kitchen gardens in England (le Strange 1977). During the early medieval period the leaves and young shoots are known to have been used as a seasoning in the kitchen. In 15th century England, catnip leaves were used for rubbing meats before cooking, and also sprinked in mixed green salads (Macleod 1968). Before modem Chinese tea became widely available, catnip tea was frequently consumed in England (Duke 1985).

Fig. 253.
Catnip *(Nepeta cataria)*,
from Syme et al. (1863-1886).

Fig. 254.
Catnip *(Nepeta cataria)*,
from Bulliard (1784).

Uses

The principal culinary use of catnip is as a tea, which is reputedly sedative and soporific (sleep-inducing). Fresh or dried leaves and young shoots are sometimes used for flavoring sauces, soups, and cooked foods. Dried leaves are employed in herb mixtures for soups, stews, and condiment sauces. Catnip has a strongly minty, warm, pungent, bitterish, camphoraceous taste.

The cultivar Citriodora has a mild lemon aroma that is more appealing to most people for culinary purposes than regular catnip, but less appealing to cats (Miske 1994). This lemony catnip makes a tasty tea, and the leaves can be rubbed on meat for flavoring, or candied with egg white and sugar to serve as after dinner mints (Miske 1994).

Catnip is extensively grown for extraction of its oil. Lemon oil from catnip is used in perfumes, candies, and pharmaceuticals. Nepetalactone (see Chemistry) is employed to prepare feline attractants, sometimes used on toys for cats. The oil from catnip has been used in the past as an attractant to bait wild animal traps, but has been replaced by less expensive synthetic products (Simon et al. 1984).

Catnip was once used extensively in medicine, but it is now best known for inducing a euphoric response in cats. Cats purr contentedly, tear with delight, and roll in ecstasy on the crushed leaves of catnip. Information on past medical usage and the catnip response is presented in Additional Notes.

Catnip also attracts bees, but not for the same reason that it attracts cats. It is an excellent honey plant, providing nectar for honeybees and other bees. According to Crockett and Tanner (1977), goldfinches are drawn to the dry seed heads in winter.

Recipe Sources

Catnip tea (Crowhurt 1973; Marcin 1983); Catnip tea (after Grognet 1990): Put 1 oz. (ca. 28 g) in 1 American pint (ca. 473 mL)of boiling water. Adult dose: 2-3 tablespoonfuls (30-45 mL); Child dose: 2-3 teaspoonfuls (10-15 mL). [Note: if too much tea is ingested, vomiting may occur.]; Candied catnip leaves (Gibbons 1966).

Importance

Catnip is cultivated as a medicinal plant, bee pasturage, for the essential oil, and for use as a condiment, principally in Europe, North America, India, the Soviet Union and China (Mansfeld 1986), and to a small extent in the U.S. (Ferguson et al. 1988). Less than 50 kg of catnip essential oil are produced annually in the world (Lawrence 1992).

Cultivation Notes

Soil

Dry sandy soil is recommended, but the plant also grows well (and bushier) on well-drained, moderately rich garden loam. Catnip has a pH tolerance range of 4.9-7.5 (Simon et al. 1984; De Baggio 1987).

Climate

Catnip is a hardy plant that will grow well in much of North America. Growth occurs between 4 and 21°C, optimally about 13°C. It can be cultivated in full sun but thrives in partial shade.

Propagation and Cultivation

The plant is easily propagated by seeds, which remain viable for 4 or 5 years, and may germinate erratically. They should be sown at a depth of 6 mm or less, with seedling emergence usually in 8-12 days (Wang et al. 1993). Once in place, catnip self-sows. Because catnip seeds are extremely

Fig. 255.
Catnip *(Nepeta cataria)*, from Johns (1853).

small and seed quality is frequently low, catnip may be established by transplants rather than by direct seeding (Ferguson et al. 1988, which see for additional information on commercial cultivation). Propagation can also be by root division and stem tip or softwood cuttings. The plants need little attention, except weeding, although they themselves are weeds. Pinching the plant at the appearance of the first flower buds produces a bushy plant with superior leaf production (Crockett and Tanner 1977).

Catnip can be grown as a house plant. It should be provided with moist, not soggy soil, and at least 5 hours of direct sunlight daily. The plants will do best at temperatures of 12-16°C, and benefit from a commercial poring mixture supplemented with lime (Crockett and Tanner 1977). Indoor catnip tends to become straggly, and should be pruned to promote a bushy shape.

Harvest and Storage

Fresh-picked leaves can be used for teas, and for stimulating cats. Dried leaves will also serve these purposes, although not quite as effectively. The flowering head and tender herbage are cut off, dried in the shade, stripped, crumbled by hand-robbing or screening, and stored in jars. Commercial harvesting is carded out at full bloom; when seeds begin to form, the volatile oils have decreased and the plants are past their prime (Ferguson et al. 1988). Commercial harvests of 3400 to 5600 kg/ha are normal in North Carolina (Ferguson et al. 1988). Drying needs to be carefully controlled in commercial harvests to prevent deterioration of the volatile oils, and storage should be at temperatures no higher than 40°C (Ferguson et al. 1988).

Example Cultivars

Citriodora.

Additional Notes

The response of domesticated cats to catnip has been extensively studied. Any branches of catnip that have been braised or broken will emit the catnip chemicals. The cats sniff, then lick and chew while shaking their heads, followed by chin and cheek robbing and a headover roll and body robbing. They may become quite vocal. Because the reaction is similar to estrous rolling patterns, and sexual stimulation is apparent (even in neutered cats), some have interpreted catnip as an aphrodisiac. Cats take great pleasure in rolling in and eating the foliage, returning daily to repeat the experience. Catnip does not appear to harm cats.

While most domesticated and wild cats are affected by catnip, not all are "nipaholics." A dominant gene has been shown to be responsible for inheriting the response. Kittens

Fig. 256.
Catnip *(Nepeta cataria)*,
from Lamarck and Poiret (1791-1823).

less than 2 months old do not react or react only partially, and the full behavioral pattern may not develop until cats are 3 months old.

What benefit could catnip plants derive from stimulating cats? Apparently none. The chemicals in catnip that stimulate cats do have an adaptive function, however. They have been shown to repel many insects, and so protect the plants (Eisner 1964; Tucker and Tucker 1988). The same or similar chemicals that protect catnip are synthesized by other plants, many of which have also been shown to attract cats (see Curiosities for a list of species). Moreover, the same or similar chemicals that protect the plants mentioned above have been found in some insect species, and have been shown to protect these species by repelling other insect species. Perhaps most astonishingly, cats have been shown to be strongly attracted to some ants that possess these catnip-like chemicals (Eisner 1964; Tucker and Tucker 1988).

Chemistry

Catnip contains volatile oils, sterols, acids, and tannins. Notable constituents include nepetalactone, nepetalic acid, nepetalic anhydride, - and ß-citral, limonene, dispentine, geraniol, citronellal, nerol, ß-caryophyllene, and valetic acid (Simon et al. 1984). Nepetalactone constitutes 70-99% of the essential oil of catnip. The main constituent attracting cats is the *trans, cis*-isomer of nepetalactone, which is metabolized and excreted in the urine. Nepetalic acid, a metabolic product of nepetalactone, is the most active constituent, and cats can respond to air concentrations of 1×10^{10} to 1×10^{11} Waller and Johnson (1984) studied the metabolism of nepetalactone. Additional information on chemistry of catnip is in Simon et al. (1984), Duke (1985), and Duke and Ayensu (1985).

Medicine

Catnip has long been used medicinally, as a tea, juice, tincture, infusion, and poultice. The tea was used to treat cancer, insanity, nervousness, nightmare, scurvy, and tuberculosis, while a root extract served as a mild stimulant. Catnip was employed orally to treat colic, diarrhea, flatulence, hiccups, whooping cough, the common cold, measles, asthma, yellow fever, scarlet fever, smallpox, jaundice, and to induce parturition and encourage menstruation. Poultices were used for hives, sore breasts of nursing mothers, and to reduce swelling. A poultice of catnip and other herbs was employed to treat aching teeth in the Ozark Mountains (Simon et al. 1984). Catnip was sometimes smoked to relieve respiratory ailments. Despite this long list of uses, catnip is not employed in modern Western medicine, although it is still used in Chinese medicine (Duke and Ayensu 1985).

Tyler (1993) noted that no one has found evidence of harmful effects from catnip consumption, and concluded that there is no reason to avoid drinking catnip tea.

Nutrition

Catnip has good content of vitamins A and C (Gibbons 1966), but because so little is consumed no nutritional advantages have been identified.

Curiosities

• The generic name *Nepeta* is said to have been derived from the town Nepete in Italy where catnip was once cultivated (Bunney 1992).

• In the belief that catnip roots made even the kindest person mean, early American hangmen consumed catnip roots before executions to harden themselves for their work (Castleman 1991).

• Catnip is by no means the only plant species known to elicit the catnip response in cats (Tucker and Tucker 1988). The following have also been reported to affect cats (some notes are provided where plants may be available in North America, for those wishing to test their attractiveness to felines): *Actinidia kolomikta* (Rupr. & Maxim.) Maxim. (miyama-mata-tabi; occasionally cultivated in North America); *A polygama* (Sieb. & Zucc.) Maxim. (silver vine, mata-tabi; occasionally cultivated in North America); *Boschniakia rossica* (Cham. & Schlecht.) B. Fedtsch. (a plant parasite of the roots of alders, found in northern areas); *Lippia javanica* (Burro. f.) Spreng.; *Menyanthes trifoliata* L. (buckbean, a bog plant found in North America, occasionally in bog gardens); *Nemophila menziesii* Hook. & Arnott (baby blue-eyes, an annual often grown in gardens); *Origanum dictamnus* L. (dittany of Crete, discussed in this book); *Teucrium marum* L. (marum, cat thyme, a Mediterranean shrub sometimes cultivated in North America); *Valeriana celtica* L. (a wild native of the Alps); *Valeriana officinalis* L. (common valerian, garden heliotrope, cat's valerian, a garden plant that has become naturalized in Canada and the U.S.); *Valeriana phu* L. (a native of southern Europe and western Asia, sometimes grown in gardens); *Viburnum opulus* L. (cranberry bush, an ornamental bush with edible fruit widely grown in the Northern Hemisphere).

• Both cats and rats are fond of *Valeriana officinalis* (mentioned above), and it has been used as a bait for trapping wildcats and rodents (Morton 1976).

• Nepetalactone chemicals responsible for the intoxication of cats seem to be similar to the natural sedatives (valepotriates) in valerian, supporting the traditional use of catnip as a mild tranquillizer and sedative (Castleman 1991).

• The young twigs and leaves of *Actinidia polygma* (mentioned above) have been used for centuries in Asia to tranquillize lions and tigers in zoos (le Strange 1977).

• Catnip growing near houses has long had a reputation for repelling rats, no doubt because the plants attract cats.

• Catnip, itself sometimes referred to as cat-marihuana, was used in the 1960's as a substitute for marihuana, apparently producing visual and auditory hallucinations when smoked (Grognet 1990). Tyler (1993) castes doubt on the mind-altering properties in humans alleged for catnip.

• The physicians who first described the drug use of catnip by people, published their findings in *The Journal of the American Medical Association* in 1969 with a

Fig. 257.
"Catnip high," prepared by B. Brookes.

drawing of catnip labelled as marihuana and vice-versa. Over 1600 letters were received by the editor pointing out the mistake (Tyler 1993).

• Cats tend to leave catnip plants alone, unless the plants are bruised and so release the attractive chemicals. There is an old saying about catnip (Grieve 1931):

> If you set it, the cats will eat it,
> If you sow it, the cats don't know it

The rationale is that catnip grown from seed will not be bruised, while transplanted (i.e. "set") plants will usually be bruised during planting.

• Catnip has been shown to increase the frequency of catnaps in chicks (Sherry and Koontz 1979).

• Mustard oil (see *Brassica* in this book) and asafetida (the fetid gum resin of various Oriental species of *Ferula* (of the carrot family), formerly used in medicine) are thought to repel cats (Duke 1985).

Problems and Potential

The culinary use of catnip is too restricted to be of economic interest. The plant is, however, widely cultivated in Eurasia, as a source of oil used for various purposes, which would suggest that there may be some economic potential for the plant as a North American crop. As with many of the other herbs discussed in this book, the strongly established foreign crop limits possibilities for the U.S. and Canada.

Selected References

Simon et al. (1984); Ferguson et al. (1988); Tucker and Tucker (1988); Grognet (1990).

Nigella

Family: Ranunculaceae (crowfoot family)

Genus Notes

Nigella has about 20 species of annual herbs native to the Mediterranean area and western Asia. Several are grown as ornamentals. *Nigella damascena* L. is a beautiful garden ornamental known as "Virgin in the Green" (in Europe) and "Love-in-a-mist" in North America (one of the names also applied to *N. sativa*, discussed below). Essential oil of this species is used in perfume and lipstick (Morton 1976).

Fig. 258.
Love-in-a-mist *(Nigella damascena)*,
from Köhler (1883-1898).

Fig. 259.
Black cumin *(Nigella sativa)*, from Hallier (1880-1888).

Nigella Sativa L.

English Names

Black cumin
Also: black caraway, devil-in-the-bush (devil in a bush), fennel flower (fennel-flower), fitch, love-in-a-mist, nigella, nutmeg flower, Roman coriander, small fennel
[Black cumin should not be confused with cumin, *Cuminum cyminum*, also treated in this book. Particularly confusing, the cultivar *C. cyminum* cultivar Black is also commonly called black cumin (see discussion of cumin for additional details). The Middle Fastern *Bunium persicum* B. Fedtsch. is also known as black cumin (Rosengarten 1973). *Bunium persicum* grows wild in the Middle East, but is of limited importance as an export crop (Rosengarten 1969). Fennel flower and small fennel are names that could lead to confusion with fennel, *Foeniculum vulgare*, discussed

in this book. In fact, the resemblance of the finely cut foliage of black cumin to that of fennel is why black cumin is often called fennel flower.]

French Names

Family: Renonculacées, famille de la renoncule
Nigelle aromatique (f)
Also: araignée, barbe de Capucin, cheveux de Vénus, cumin noir, épicerie, faux cumin, graine noire, herbe aux épices, nielle, nielle du Levant, nielle romaine, nigelle, nigelle cultivée, nigelle de Crète, nigelle des jardins, nigelle romaine, patte d'araignée, quatre épices, senonge, toute épice (toute-épice)
[Some of the alternative French names for black cumin also refer to other plants. Barbe de Capucin is better reserved for chicory, *Cichorium intybus*, treated in this book. In French, the names quatre épices (or quatre-épices) and route épice (toute-épice, toute-épices) usually designate allspice (*Pimenta dioica* (L.) Merrill) (Bois 1934). Also, quatre épices designates a standard French "four-spice" blend, based on pepper, usually with nutmeg, cloves and ginger, sometimes with cinnamon or allspice (Norman 1990). This is commonly used in charcuterie and in dishes requiring long simmering, such as stews.]

Description, Taxonomy, and History

Nigella sativa is found in central and southern Europe, North Africa, and western Asia. It typically grows 30-45 (to 60 or more) cm in height and produces whitish-blue flowers 2-3 cm across. The triangular, dull-black seeds are the economic part of the plant. The seeds are 2-3 mm long, and have a rough surface. They are produced in odd, toothed or horned fruits. The five horns of the fruit are produced from the styles of the flower. The Sanskrit names indicates that black cumin was used in India at a very early date (Pandey 1990). It Was also known to the ancient Hebrews, Greeks, and Romans (Fox 1933). The seeds preceded black pepper as a major spice of the Near East (Morton 1976). The alternative name Roman coriander reflects its popularity in cooking among the Romans.

Uses

The seeds of black cumin are used for seasoning and are employed in spice mixes. The odor of crushed seeds has been described as like lemons with a faint suggestion of carrots (Burkill 1935), while the taste is strong, pungent, peppery, rather oddly aromatic, and nutty, "like a cross between poppy seeds and pepper" (Norman 1990). The alternative name nutmeg flower reflects similarity with the strong, agreeable aromatic odor of nutmeg. The seeds

Fig. 260.
Black cumin *(Nigella sativa)*, from Köhler (1883-1898).

are added to curries, pickles, cheeses, eggs, fish, poultry, meats, game, pickles, conserves, fruit pies, and confections, particularly cookies, rolls and bread. They are also used to flavor a variety of vegetable dishes. The seeds used to be employed as a substitute for pepper. French cooks use the seeds under the name quatre épices or toute épice (Stobart 1977; Pandey 1990). Black cumin is an essential ingredient of *choereg*, semi-sweet rolls widely found in Middle Eastern breakfasts (see Recipes Sources).

The seeds are also sometimes used for medicinal purposes (see Medicine). They are stored with clothing to repel insects (Morton 1976). They were once an ingredient in snuff tobacco, and are sometimes employed in perfume (Fox 1933).

Black cumin is grown as an ornamental. According to Crockett and Tanner (1977) "fennel flower is a dainty annual grown as much for its beauty as for the usefulness of its seed for flavoring."

Recipe Sources

Norman (1990) gives recipes entitled: Arab bread and Garlic pickle. Hitchings and Bird (1993) have recipes called Choereg-coffee rolls, and Six vegetable pickle.

Importance

Black cumin is used as a spice in Egypt, the Middle East, India, and to a small extent in Europe. It is grown the Mediterranean area and in the Orient, while cultivation in Europe has become insignificant (Zeven and de Wet 1982).

Cultivation Notes

Soil

Rich, well-drained, medium-textured soil is recommended. The pH range tolerated is 5.0-8.2 (Duke 1979). Commercial fertilizer (phosphorus and potassium) requirements of the crop were studied by Ghosh et al. (1981).

Climate

Black cumin prefers warm conditions. It should be given full sun, but will tolerate slight shade. Growth occurs between 5 and 25°C, optimally about 14°C. In North America, black cumin is ready to harvest about 4 months after planting (Crockett and Tanner 1977), so that it requires a reasonably long season.

Propagation and Cultivation

"The cultivation of *Nigella sativa* in the northern or colder zones in the United States and Canada requires planning" (Hitchings and Bird 1993). Seeds of black cumin may not be readily available from seed supply outlets. However, they can often be obtained in Middle Eastern grocery stores (often as "black seed") and Indian food stores (as *kalaunji, kalonji*, or "onion seed") (Hitchings and Bird 1993). According to Crockett and Tanner (1977), the seeds will remain viable for 3 years. Seeds should be started indoors in a warm area. The seedlings do not transplant well, so it is advisable to use fiber pots that can be placed directly into the ground.

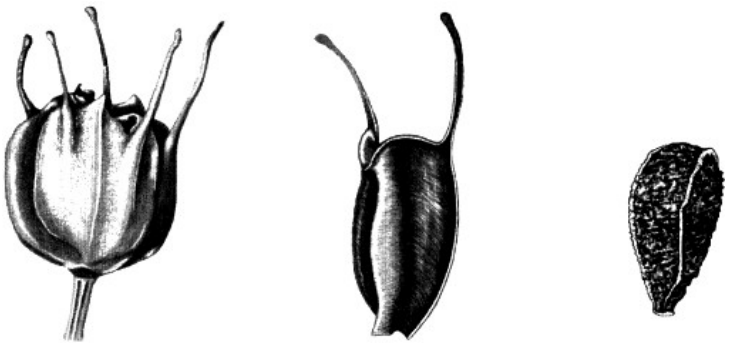


Fig. 261.
Black cumin *(Nigella sativa)*, showing horned fruit, long section of fruit, and seed.
Prepared by M. Jomphe. (Based on V. Tyranovets 2291 at Agriculture and Agri-Food Canada herbarium, Ottawa.)

Harvest and Storage

The seed pod turns from green to brown when ripe, at which time the pods (or whole plants) can be collected. The pods may be rubbed between one's palms to free the seeds. After drying, the seeds should be stored in an airtight container. Many plants are needed to produce even a small amount of seed (Hitchings and Bird 1993). The seeds can be used like pepper after they are ground.

Example Cultivars

Named cultivars do not seem to be available, at least not in North America.

Additional Notes

Chemistry

The whole seeds of black cumin contains 30-35% oil, of which over 60% is linoleic acid, with oleic acid next in predominance (Üstun et al. 1990). The oil is of a semi-drying type. Additionally, the seeds contain 0.5-1.5% essential oil (Heath 1981). Sterols of the seeds were studied by Menounos et al. 1986. A paralysing alkaloid, nigelline, is present in the seeds (Grieve 1931). Additional information on the chemistry of the seeds is found in Nergiz and Ötle (1993).

Medicine

Black cumin has been extensively used in folk medicine in Europe and Asia, as a tonic, to increase flow of body fluids, including menstrual flow, lactaction, discharge of pus and urine, and to treat nausea, vomiting, intestinal worms, constipation, headache, blood-poisoning, enlarged liver, fever, chest complaints, and other problems (Burkill 1935; Perry and Metzger 1980). The seeds were once held in the mouth to treat toothache (Fox 1933). As Burkill (1935) noted "perhaps it may be said in brief that the Malays possess enough faith in the power of *Nigella* seed to add it to almost anything." *Nigella sativa* is widely used in folk medicine in several countries of the former USSR, and is cultivated for medicinal purposes in the Ukraine, Byelorussia, Chuvasha, Tataria, and Bashkiria (Hitchings and Bird 1993).

According to Bunney (1992), the seeds are slightly poisonous and large doses should not be taken. However, this was the only claim of toxicity encountered for the species in preparing this text.

Nutrition

Nutritional advantages of consuming black cumin have not been identified.

Curiosities

• The generic name *Nigella* is a diminutive of *niger* (black) for the blackness of the seeds (Sorvig 1983).

• The seeds of black cumin are thought to be the "fitches" mentioned by Isaiah XXVIII: 25-27 in the King James Bible (Sorvig 1983), in 725 B.C. according to Morton (1976). The translation of the Hebrew word *ketyaeh* or *ketzach* as "fitches" i.e. vetches (species of *Vicia*) in the Authorized Version of the Bible led to confusion concerning the identity of the plant (Moldenke and Moldenke 1952).

• The Roman surgeon and herbalist Dioscorides (50-100 A.D.) thought that black cumin mixed with vinegar cured dog and crocodile bites (Hitchings and Bird 1993).

• Black cumin was popular in Arabic and Turkish cultures as an ingredient of foods designed to fatten women (Grieve 1931). As noted by Fox (1933), "even in Asia Minor it does not seem likely that any woman still wishes to be fat."

• Black cumin seeds are believed to be among the earliest of space-travelling herbs, accomplished during the voyage of Sputnik III in 1958 (Hitchings and Bird 1993).

Problems and Potential

Black cumin is a very minor condiment, much more popular in Asia and southern Europe than in North America. It is adapted to warmer regions than found in Canada and the northern U.S., and indeed its prospects as a crop in North America seem limited.

Selected References

Grieve (1931); Sorvig (1983); Hitchings and Bird (1993).

Ocimum

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

Ocimum is made up of 20-25 species of aromatic annual and perennial herbs and shrubs native to the Old World tropics, with about six native to the New World tropics (Paton, personal communication). In addition to the two species discussed in detail below, several other members of *Ocimum* are used as culinary herbs or as sources of particular chemicals useful in medicine and perfumes (Mansfeld 1986; Facciola 1990). The species readily obtainable in North America are noted below.

Ocimum Americanum L.

[There is confusion over what some authors call *O. americanum*; this may be *O. canum* Sims of some authors, while others may be using the name to designate a variety of *O. basilicum*, treated in detail below (Paton, personal communication). Paton (1992) discussed the species in some detail.]

Known as hoary basil, hairy basil and American basil, *O. americanum* is a herb that grows 30-60 cm tall. It occurs wild in tropical and subtropical Asia and tropical Africa, and is widely cultivated in tropical and warm temperate regions of the world, including Russia, Indonesia and Oceania (Morton 1981). It is a very fragrant plant, reminiscent of cinnamon, clove and lemon (Morton 1981). Despite the "American" in the scientific and one of the popular names, the species is not native to North or South America, although it has been introduced into parts of both. The leaves are eaten steamed, as a side-dish with rice, or added to curries. They are also used to season sea food, meats, poultry stuffing, salads, soups, and sauces (Morton 1976). Seeds soaked in water swell into a gelatinous mass, which is mixed with coconut milk and sugar to form a sweet, cooling beverage. The leaves are employed to treat parasitic skin diseases in Sudan and India, and a decoction of the foliage is used for curing dysentery and as a mouth-wash to relieve toothache in Nigeria and Ghana (Olowokudejo and Pereire-Sheteolu 1988). In Brazil the plant is used to treat rheumatism and kidney problems, and in Trinidad for coughs, indigestion, and diarrhea (Morton 1981). Distilled oil from the plant is added as a scent to soaps and other toilet products (Morton 1976). Seeds of this species are available through at least one North American herb catalog.

Fig. 262.
American basil *(Ocimum americanum)*,
from Curtis (1787-present; #2452).

Ocimum Gratissimum L.

This 1-3 m tall shrub is 'known as (African) tea bush, fever plant, tree basil, shrubby basil, and clove basil (and is listed as "East Indian basil" in one North American herb catalog). This species is rather variable, and is discussed in detail by Paton (1992). A native of tropical Africa and India, it is cultivated in southern Europe, Norah Africa, and Brazil. The species has often been grown in herb gardens in France as an annual. The lemon-flavored leaves

are used in salads and as a seasoning for soups, meats, and poultry stuffing. They are also brewed into a tea. The essential oil is insect-repellent and has antimicrobial activity (Olowokudejo and Pereire-Sheteolu 1988). The oil contain about 48% thymol according to Sainsbury and Sofowora (1971), 75% thymol according to Olowokudejo and Pereire-Sheteolu (1988). Morton (1981) and Charles and Simon (1993) note that the species is variable in chemical composition of the essential oil. Lawrence (1992) refers to it as Russian basil, and indicates that 55 t of essential oil are produced annually worldwide. The plant is grown around homes because mosquitoes avoid it (Morton 1976). Seeds and plants are difficult to obtain in North America, but are available through at least one North American herb catalog. The plant has been grown outdoors in Pennsylvania, where seeds may mature if the weather remains mild into October (Darrah 1978). Generally, however, it is best grown in northern North America as a potted plant that can be brought indoors to prolong its lifespan.

Ocimum Kilimandscharicum Gürke

This shrubby species, known as camphor basil, grows up to 3 m in height. It is native to east Africa and is cultivated in Africa and India. During World War II it was cultivated in Africa to prepare camphor (Ryding 1994). The leaves have a distinctive camphor-like fragrance and are occasionally used to brew tea. The oil is used for aroma in medicines. Seeds and plants are available through at least one North American herb catalog.

Ocimum Campechianum Mill. (O. Micranthum Willd.)

This strongly aromatic, annual bushy herb is about 50 cm, sometimes a meter tall. A native of the New World tropics, it is a common weed of waste places and cultivated ground in southern Florida, the Bahamas, West Indies, and from Mexico to Peru and Brazil (Morton 1981). Known as wild basil and pot margin, it is widely used in folk medicine in Middle America. Morton (1981) notes the following food uses: a decoction is consumed as a beverage in Jamaica; in Guatemala the leaves are used to flavor food; and the leaves are added to split-pea soup in Barbados and boiled with milk to create a refreshing beverage.

Some so-called "Basils"

"Basil" is mainly used to designate species of *Ocimum*. However, some other species sometimes used as culinary herbs also have "basil" in their names.

"Basil thyme" [*Acinos thymoides* (L.) Moench, also known as *A. arvensis* (Lam.) Dandy, *Calamintha acinos* (L.) Clairv. ex Gaud.-Beaup., and *Satureja acinos* (L.) Scheele],

Fig. 263.
Basil thyme *(Acinos thymoides)*,
from Oeder et al. (1761-1883).

is native from England and Scandinavia to the Caucasus and Asia Minor. It is also known as mother of thyme (mother-of-thyme), a name usually applied to *Thymus serpyllum* L. (discussed in *Thymus* genus notes). This annual has odor and aroma suggestive of thyme, and is sometimes used like the latter for culinary purposes. According to Morton (1976), it is milder and pleasanter than thyme. The flowering tops were used in old English cookery to season jugged hare (Morton 1976). The name jugged hare comes from the obsolete practice of seething a hare in a sealed jug placed in a receptacle of hot water [for a modem recipe with herbs, see Mazza (1976)]. The species is naturalized in parts of Canada and the U.S., and is grown as an ornamental in North America. Seeds can be obtained from some North American catalogs.

Fig. 264.
"Wild basil" *(Clinopodium vulgare)*,
from Hallier (1880-1888).

Clinopodium vulgate L. [*Calamintha clinopodium* (Benth.) Benth., *C. vulgaris* (L.) Halácsy, *Satureja vulgaris* (L.) Fritsch] is known as basil, wild basil, field basil, basilweed, and dog mint. This Eurasian perennial is naturalized in parts of the U.S, has been collected occasionally outside of cultivation in Canada, and is cultivated as an ornamental. Fresh or dried leaves are used to flavor tomato sauce, omelets, egg sandwiches, fish chowder, broiled fish, rice dishes, and other foods (Facciola 1990). Fresh leaves are sometimes used to brew a herbal tea. Recipes and serving suggestions are given by Michael (1980). Seeds can be ordered from some North American catalogs. Additional information on this species is in the genus notes for *Calamintha*.

Ocimum Basilicum L.

English Names

Sweet basil
Also: basil, common (sweet) basil, French basil, royal basil, royal herb

French Names

Family: Labiées, famille de la menthe
Basilic (m)
Also: basilic à feuilles bullées, basilic à feuilles de laitue, basilic aux sauces, basilic commun, basilic d'Amérique, basilic des cuisiniers, basilic des jardins, basilic grand (vert), basilic gros (vert), basilic ordinaire, basilic romain, basilique, grand basilic, herbe royale, orange(r) de(s) savetier(s), plante royale

Fig. 265.
Sweet basil *(Ocimum basilicum)*,
from Hallier (1880-1888).

Description, Taxonomy, and History

Basil is an annual or tender short-lived perennial, 30-60 (sometimes to 150) cm in height. The place of origin is unknown. Tropical Africa is perhaps most likely, as all close relatives of basil are African (Paton, personal communication). Tropical Asia, possibly India, has also been suggested as the area of origin (Morton 1981). Basil is a feral plant in many tropical parts of Asia and Africa. Several types differing in height, hairiness, stem and leaf color, flower color, odor and aroma have evolved in cultivation (Prakash 1990). The odor may be like anise, lemon, or lemongrass (Morton 1981). Rinzler (1990) notes several strains: opal basil with a peppery flavor; licorice-flavored anise basil; lemon basil; and cinnamon basil. Rather extensive classification systems have been devised [for example, see Bois (1934) for a categorization with 14 groups]. Some of the varieties that have been recognized include (Ryding 1994): var. *difforme* Benth. (with laciniate leaves), var. *crispum* (Thunberg) E.G. Camus (with thick crisped leaves), var. *thyrsiflorum* (L.) Benth. (with a densely branched inflorescence), and var. *purpurascens* Benth., (with a rather dense inflorescence and purplish bracts). A simple scheme is to recognize only two subspecies (Greenhalgh 1979; Mansfeld 1986): subsp. *basilicum*, the familiar culinary sweet basil of commerce, and subsp. *minimum* (L.) Danert ex Mansf., (known as dwarf basil, bush basil, and Greek basil), usually cultivated as an ornamental. Several strains of subspecies *basilicum* have been selected for varying flavors and odors (such as the cultivar Lemon, also known as lemon-scented basil, which was once regarded as a separate species, *O. citriodorum* Vis.). "French basil" is reputed to be an especially sweet and flavorful strain (Simon 1985). "Egyptian basil" (also known as Reunion or African basil) is somewhat camphoraceous, and generally less expensive (Simon 1985). *Ocimum basilicum* is not well understood taxonomically. There is a need to clarify the status of the many varieties that have been recognized, as well as which forms may have arisen as a result of hybridization with related species (Paton, personal communication).

Basil has been cultivated for nearly 3000 years in Asia (Mansfeld 1986). It seems to have been known in Egypt at the time of the pharoahs (Ryding 1994), and was grown by the ancient Greeks (le Strange 1977). The use of basil spread to Rome and southern Europe. Basil probably was not used in England until the 16th century (Garland 1979).

Uses

Basil is an important culinary herb. Dried sweet basil leaves are aromatic, fragrant, and sweet, with a warm clove-like flavor with pungent undertones. The fresh or

Fig. 266.
Sweet basil *(Ocimum basilicum)*, from
Lamarck and Poiret (1791-1823).

dehydrated leaves (sometimes also the flowering tops) are added to soups, meat pies, fish dishes, and certain cheeses. The leaves complement various vegetable dishes, including artichoke, broccoli, carrot, cabbage, eggplant, green beans, peas, squash, zucchini, and cooked cucumber. Many consider basil to be the best accompaniment to tomatoes (even a Bloody Mary), tomato cocktails, peppers, and eggplants (all belonging to the potato family). So good is it with tomatoes that Italian tomato paste cans often contain a leaf of basil (Duke 1985). Chopped basil leaves season lamb dishes, dressings, stuffings and pâtés. The green leaves are also used in salads and on pizza in addition to or instead of oregano. Dehydrated basil is very important in Italian cooking, notably in tomato sauce, pizza, spaghetti, macaroni, chicken cacciatore, and cheese casseroles. Rinzler (1990) states that basil goes well with fruits, and suggests sprinkling some on a baked apple. Fresh basil is essential for the famous Italian pesto sauce, an oil-and-herb mixture made by pounding the leaves to a pulp in a mortar and combining salt, garlic, olive oil, parmesan cheese and pine or walnuts. The French add basil to omelets and soups. It is also sometimes an ingredient of "bouquet garni" (a combined bunch of herbs popular in France, typically thyme, rosemary and laurel). Fresh leaves are best added towards the end of cooking tune to retain a desirable flavor and aroma. Small leaves are best used whole. Fresh leaves are much more flavorful than dried, and are to be preferred when available. Large leaves should

be torn rather than cut to preserve their flavor. However, Mességué and Peter (1982) recommend cutting basil into strips on a board, or with scissors, but not chopping it. Lemon basil can be used to make a flavorful tea.

The oil of basil is sometimes added as a flavoring for confectionary, candy, baked goods, and commercial condiments such as chile sauces, catsup, tomato paste, pickles, and specialty vinegars. It is an important ingredient in some types of sausages and spiced meats. The oil is sometimes a component of dental and oral products. It is also used occasionally in perfumes (Prakash 1990). A tincture of oil (combined with 20-60% ethanol) is employed as a flavor modifier for some liqueurs, such as Chartreuse (Greenhalgh 1979). An oleoresin is also obtained from basil but its commercial usage is negligible (Greenhalgh 1979).

In the Near East, basil seeds are consumed alone or in bread dough (Morton 1976). The mucilaginous coating of the seeds was once used to prepare a tonic drink (Morton 1976). Basil flowers are an attractive decoration on soups and salads (Leggatt 1987), and are said to be eaten in China (Duke 1985). Purple-leaved cultivars are Of ornamental value, but are as aromatic as regular green-leaved sweet basils (Simon and Reiss-Bubenheim 1987), and may be perfectly acceptable for culinary use.

Recipe Sources

Garland (1979) has recipes for Pesto (basil) sauce, Pesto soup, and Tomato and basil sauce. Kenyon (1979) gives recipes for Broiled chicken with basil, and Tomato and melon salad with basil. Mességué and Peter (1982) have recipes for Tomato and basil tart, and Mussels with basil. Belsinger and Dille (1984) present 17 basil recipes, including: Basil broiled lamb chops, Basil lime marmalade, Cucumber basil tea sandwiches, Basil almond devilled eggs, and Basil potato salad. Tolley and Mead (1985) have recipes for Peppers in basil oil and Tomato and basil sorbet. Hutson (1987) presents recipes for: Luscious lemon basil pesto, Basil cheese torta with red bell pepper strips and toasted pine nuts, Balkan basil and tomato sauce, Basil-garlic-Parmesan-butter, and Dark opal basil vinegar. Jeanneret (1987) gives recipes for Basil oil, Basil casserole, Zucchini with basil, and Beef patties with basil. Holt (1991) has recipes for Chilled avocado and basil soup with asparagus crackers and Tagliagelle with tomato and basil salsa. Richardson (1991) has 16 basil recipes, notably: Gaspacho summer soup; Tomato, basil and mozzarella salad; Pesto sauce; Sautéed sole with basil and parmesan; Soup au pistou; and Basil ice cream with bitter chocolate sauce. Barash (1993) has six basil flower recipes, including Basil corn chowder and Eastern basil chicken with couscous.

Fig. 267.
Sweet basil *(Ocimum basilicum)*, cultivar Lettuce-leaved, from Vilmorin-Andrieux et C^{ie} (1883).

Other recipes are: Eggplant with basil casserole (Rosengarten 1969); Basil tea (Muenscher 1978; Marcin 1983); Basil salt (Rose 1979); Salmon and basil loaf (Hemphill and Hemphill 1984); Beet pasta with grilled salmon and basil-cream sauce (Brennan et al. 1985); Basil & tomato salad (Thompson 1986); Hot buttered tagliatelle (pasta) with basil and dandelions (Leggatt 1987); Crêpes with basil stuffing (Bremness 1988); Scented basil jellies (Creasy 1988); Cherry tomatoes with basil cream (Holt 1989); Warm scallop salad with basil cream, topped with saffron croutons (Bittman 1992).

Importance

Basil is cultivated commercially in much of Europe and North Africa. In North America the principal area of cultivation is California. Much commercially-produced sweet basil herb, particularly in the Mediterranean area, India, and California, is used domestically, so that production statistics are limited. The U.S. is the world's largest importer, in 1988 importing 1776 t of crude basil herb valued at $2,417,600 and about 29 t of processed basil valued at $38,800 (Anon. 1989*a*). Values of basil imported to the U.S. (mostly from Egypt) averaged $3.3 million over the period 1990-94 (Buzzanell et al. 1995).

Verlet (1993) estimated the annual world value of basil essential oil to be $1,540,000 (U.S.). Lawrence (1992) states that annual world production of basil essential oil is about 42.5 t. He gives the following annual production information: India (15 t), Bulgaria (7 t), Bulgaria (7 t), Egypt (5 t), Pakistan (4.5 t), Comores (French islands off south east Africa) (4.5 t), Israel (2.0 t),Yugoslavia, U.S.A. and Madagascar (each 1.0 t).

Cultivation Notes

Soil

Basil grows well in light, well-drained, fertile soils. The best substrate is a sandy loam enriched with well-rotted manure (Garland 1979). According to Simon et al. (1994), "The plants have a relatively high nitrogen and water requirement. In contrast to some other herbs which thrive in less fertile soils, basil will grow best and look more elegant if provided with a fertile growing environment." A pH tolerance range of 4.3-8.4 has been reported (De Baggio 1987). Crockett and Tanner (1977) recommend a pH of 5.5-6.5.

Climate

Basil is susceptible to frost and cold temperatures, and is generally grown as a tender annual that is seeded or transplanted into the field in late spring after danger of frost (see below). In tropical and subtropical areas, basil can be cultivated as a short-lived perennial by continually removing the flowers and harvesting frequently (Simon et al. 1994). The seeds germinate well at temperatures between 13-25°C (Putievsky 1983). Growth occurs between 5 and 31°C, optimally at 19°C. Basil requires full sunlight. Maximum yields result after exposure to periods of daylight of 15 h or more (Sharma et al. 1987). The plants need considerable water but do poorly if the roots are in water-logged soil (Garland 1979). In commercial operations supplementary moisture is supplied by trickle or overhead irrigation (Simon 1985).

Propagation and Cultivation

Basil can be grown as a short-lived perennial in warm climates (U.S.D.A. climatic zone 10), but is normally grown as an annual from seeds started indoors. Seed longevity is good if refrigerated, the seeds lasting over a decade in cold storage (Wang et al. 1993). If artificial light is not available, the seeds should not be started in southern Canada and the northernmost parts of the U.S. until the natural light is strong, about May 1-10 (Lima 1986). Seeds should be planted at a depth of 6-13 mm (Wang et al. 1993). The soil should be kept moist until the seeds have germinated, requiring 8-14 days (Simon 1985; 5-10 days according to Wang et al. 1993). However, the seeds may rot in cold, damp soil (Wang et al. 1993). The tops of seedlings are often trimmed prior to transplanting, when they are 15 cm tall, to encourage lateral branching and growth. The seedlings are transplanted outdoors after frost danger; basil transplants readily. Black plastic mulch has been found to be effective in controlling weeds, significantly increasing yield of sweet basil over plants grown without mulch (Ricotta and Masiunas 1991). In the U.K., bird damage to young seedlings outdoors may be extensive (Paton, personal communication).

Propagation and cultivation of basil as an indoor house-plant is discussed by Crockett and Tanner (1977) and Shirley (1989). Spicy Globe, Minimum, and Green Bouquet are dwarf cultivars well-suited for window culture. Basil seeds are sown in small pots or flats, covered by less than 2.5 mm of soil (shallower than recommended above), and placed in a warm, well-lit location. Transfer clumps of 3-5 plants to 10 cm pots when the seedlings have the second pair of true leaves. The pots should be placed in full sunlight and kept at a temperature above 10°C.At least 5 hours of direct sunlight, or 12 hours of artificial light should be provided daily. Avoid overwatering. Pinch off flower spikes as they develop to maintain leaf production. Indoor basil may be fed monthly with an all-purpose liquid fertilizer used at half strength. The youngest shoots can be harvested for use.

Harvest and Storage

In commercial operations a mower with an adjustable cutting height is often used to harvest the plant (Simon 1985). Lewis (1984) reported yields of fresh basil vary between 5 and 20 t/ha. A yield of 7 t/ha of fresh herb has been reported from two cuttings in parts of Asia (Prakash 1990). In California, three to five harvests a year may yield up to 25 t/ha of fresh herb. In areas with a growing season of only 2-3 months, only one or two harvests are possible. The first harvest is taken on a dry day, just before plants are in full bloom. The plants are cut about 10-15 cm above the ground, allowing subsequent harvests to be taken every 15-20 days. Care must be exercised not to damage the root system during harvest to avoid decreasing yield.

Leaves destined for the spice market are dried artificially, just below 40°C, to preserve the flavor and green color. Although sun-drying is cheaper, the succulent, soft leaves do not dry as well, and tend to become brownish in color. Dried leaves are chopped to specific sizes by a series of machines and graded fine, medium, or coarse.

Lange and Cameron (1994) found that, with protection from water loss, basil can be stored for nearly 2 weeks at temperatures from 10 to 15°C. Storage at colder temperatures (which has sometimes been recommended) was quite harmful to shelf life, and produced chilling injuries. At temperatures of 20-25°C, about half of commercial-type packages of basil were judged acceptable after 1 week.

Crops destined for oil production are cut near the ground. The plants are partly dried, and the oil is extracted by steam distillation. In some countries oil is extracted

Fig. 268.
Sweet basil *(Ocimum basilicum)*, compact bush form, from Vilmorin-Andrieux et C^{ie} (1883).

separately from the flowers and the remainder of the plant. Studies in Australia have shown that yield of essential oil was higher when distilling basil plants that included long flower spikes (12-20 cm long) rather than with shorter spikes (Bonnardeaux 1992). A good yield in India is considered 13 kg/ha of sweet basil flower oil and 27 kg/ha of sweet basil leaf and stem oil. Yield of oil is about 0.15% of total fresh plant weight excluding roots (Rosengarten 1969; Farrell 1985).

In home gardens, the vegetative period of basil can be prolonged by pinching off the flower buds. The home gardener can use basil leaves fresh, or preserve them for later use by the following methods. The best way is to freeze the leaves after blanching. Batches of pesto sauce can be prepared and frozen for use over the winter months (Lima 1986). Basil leaves preserved Italian style in olive oil may blacken, but will retain their flavor for many months (Crockett and Tanner 1977). To dry leaves, cut the stem before the flowers open, strip the leaves from the stem, and dry in a dark, airy place. After drying, store in an airtight container.

Example Cultivars

Anise, Dark Opal, Genovese, Large Leaf, Large Leaf Italian, Lemon (also sold as Lemon-scented), Lettuce Leaf, Mammoth, Mrs. Bums Lemon, Licorice, Picollo, Purple Ruffles, Spicy Globe, Sweet Dani, Sweet Fine Green, Sweet Large Green.

There are more than 50 commercially available types of basil in North America (Simon et al. 1994). Facciola (1990) and Hampstead (1992) list basil cultivars encountered in the U.S. Field trials conducted in Indiana of several basil cultivars are discussed by Simon and Reiss-Bubenheim (1988). Culinary basil cultivars are often grown as ornamentals. In addition, some cultivars such as Green Ruffles and Purple Ruffles are grown specifically as ornamentals.

Additional Notes

Chemistry

Basil essential oil is sweet, anise-like, and floral in fragrance. The oil is obtained by about 4 hours of steam distillation of the flowers or the whole shoot. The essential oil obtained from basil flowers is considered to be of better quality than oil obtained from the leaves (Prakash 1990). Chemical constituents of the oil are rather varied as described below, the balance determining aroma and taste. Anethole contributes an anise taste; estragole a taste like tarragon; eucalyptol is spicy; eugenol is responsible for the oil of cloves odor and taste; and linalool smells like French lavender (Rinzler 1990).

An oleoresin is obtained primarily. from cultivars having a high methyl chavicol content. The extract is very dark green and viscous. One gram of oleoresin is equivalent in flavor and odor to 134 g of freshly ground basil (Prakash 1990).

Five chemical types of basil have been recognized. As exemplified by Lawrence (1992), these are: geraniol (40-50%) + eugenol (20-30%); eugenol (20-40%); camphor (10-15%); methyl cinnamate (60-65%); and geraniol (20-30%) + linaolool (30-35%) + eugenol (20-30%). Prakash (1990) extensively reviewed productivity of various compounds by different cultivars and growing regions of the world. The highest quality sweet basil oil is the so-called European type, produced in Europe and the U.S. It contains linalool and methyl chavicol as its main constituents, but does not contain camphor. Adulteration of high-quality oils with poorer grade oil apparently occurs, so that cultivar and country of origin are not the only determinants of quality. Sheen et al. (1991) found that methyl chavicol was the most desirable component and l-octen-3-ol the least desirable for aroma. The percentage content of linalool and methyl chavicol increases in the essential oil as water stress increases (Simon et al. 1992). The type of nitrogen fertilizer can also change essential oil composition (Adler et al. 1989). Morales et al. (1993) found that essential oil content of field-grown plants was greater than in greenhouse-grown plants, but chemical composition remained stable.

Medicine

Basil has been used in folk medicine to treat many conditions, including alcoholism, boredom, childbirth, cholera, colic, constipation, cough, cramps, deafness, delirium,

depression, diarrhea, dysentery, earache, epilepsy, fever, flu, frigidity, gastroenteritis, gonorrhea, gout, halitosis, headache, hiccup, hysteria, infection, inflammation, insanity, insect bites, labor, migraine, nausea, nerves, piles, paralysis, ringworm, snakebite, sores, sore throat, stings, toothache, tumors, urinary ailments, warts, whooping cough, and worms (Duke 1985). Among the more prominent usages of basil has been its employment for cases of gastrointestinal and oral problems, coughs, and ailments of the nose and ears, and for the fungal disorder ringworm. The plant is still used in homeopathic medicine (Prakash 1990). Basil leaves have been employed in China for stomach spasms, kidney ailments, and to improve blood circulation after giving birth (Sharma et al. 1987). Other ailments still treated with basil in China, include gout, halitosis, snakebite, warts, and worms (Duke and Ayensu 1985). The seed of sweet basil has been used to treat dysentery, diarrhea, and gonorrhea in Iraq and India (Olowokudejo and Pereire-Sheteolu 1988). In Vietnam basil is used to treat fever and malaria (Nguyêñ-Xuân-Duñg and Dõ-Tãt-Loi 1991). Perry and Metzger (1980) review the various ailments treated with sweet basil in other countries of Asia.

Some basil oils contain the carcinogens estragole and safrole, although such small amounts are in basil itself that it is not considered hazardous for human consumption (Rinzler 1990). Other components such as anethole, eucalyptol, eugenol and linalool are potential allergens that could cause contact dermatitis, as could prolonged contact with the plants (Rinzler 1990).

Nutrition

Duke (1977) characterized content of calcium, fiber, iron, potassium, riboflavin, and vitamin C as high, and content of vitamin C as very high. Ground basil has been reported to contain 14.4% protein (Duke 1985). Rinzler (1990) states that basil is a good source of beta-carotene, calcium, and vitamin C. She adds that leaves rich in vitamin C, such as those of basil, should not be cut or torn until just before use; upon tearing, the cells release the enzyme ascorbic acid oxidase which destroys vitamin C, reducing the nutritional value of the food.

Curiosities

• The name basil is derived from *basileus*, the Greek word for king, possibly suggesting its strong flavor, or for its widespread employment in Europe as the foremost herb for preserving cold meats and counteracting putrefaction (Sanecki 1974). Basil has been called "the king of herbs" (Mességué and Peter 1982).

Fig. 269.
Sweet basil *(Ocimum basilicum)*, from
Vilmorin-Andrieux et C^{ie} (1883).

• The Greek *basilica* (royal) appears to have been confused with the Latin *basiliscus* (a basilisk, a mythical lizard-like monster said to be able to kill simply by breathing upon or looking at someone). This led to the herb acquiring a rather evil reputation which lasted into the 18th century (le Strange 1977).

• In the Middle Ages spontaneous generation of living things from the inanimate world and from other living things was given considerable credence. Basil was commonly thought to transform into flies, worms and, especially, scorpions (Darrah 1980). Some physicians claimed that merely breathing the aroma of basil would cause scorpions to breed in the brain (Garland 1979).

• The Greek physician Dioscorides (40-90 A.D.) warned against eating too much basil "as it dulleth the eyesight, breedeth wind, provoketh urine, drieth up milk, and is difficult to digest." The ancient Greeks considered basil to be a symbol of hatred (Farrell 1985).

• In ancient Greece the planting of basil seeds was accompanied by shouts and curses, in the belief that this would insure its germination. This gave rise to the French phrase "*semer le basilic,*" meaning to slander or use abuse (Fox 1933; Garland 1979).

• Basil was believed to have grown on the grave of Christ. On Saint Basil's Day (New Year's Day) in Greece, women carry basil to church (Darrah 1972, 1980). [The association of basil and the Eastern Orthodox Catholic Church is curious, given the lack of mention of basil in the Bible (Darrah 1980). The association of basil and St. Basil appears to be fortuitous. Saint Basil the Great (328-379) lived about the time of St. Helen, who

reputedly discovered the Holy Cross with basil growing at its foot. The Feast of St. Basil (Jan. 1) and the association of basil with Christ perhaps contributed to the temporal association of basil and St. Basil. For more information, see discussion of the name holy basil for the next species examined, *O. tenuiflorum*.]

• Basil is commonly planted on graves in Moslem countries, and indeed the same is done with holy basil, treated below, in Hindu countries (Darrah 1980). As noted above, basil is also associated with the grave of Christ in Christian tradition. Such parallelism is astonishing, perhaps suggesting that somehow the tradition in the oldest religious culture (Hinduism) inspired the same in the more recent religions.

• As noted above, basil was confused historically with the dragon-like monster, the basilisk. In another curious parallelism between basil and holy basil, one of the common Indian names for the holy basil is "taghni," meaning that which slays monsters (Darrah 1980).

• The Roman scholar Pliny (23-79 A.D.) considered basil to be an aphrodisiac; it was given to horses and asses during the mating season (Farrell 1985). In succeeding centuries, the erotic or aphrodisiac reputation of basil steadily grew (Darrah 1972). In Haiti basil is associated with the pagan goddess of love, Erzulie (Lust 1974).

• The Italian author Giovanni Boccaccio (1313-75) authored a very popular collection of 100 tales called the *Decameron*. In one story, basil plants were nurtured by a young girl using the corpse of her dead lover, as well as her own tears, as fertilizer (Forsell 1990).

• Some early Italians who considered basil a sacred herb had rather sexist notions. Women were not allowed to pick it, and when using it in rituals, priests had to be kept well away from women "in a state of impurity" (i.e., menstruating) (Toussaint-Samat 1992).

• A more romantic notion of basil later evolved in Italy. Basil came to symbolize love - a pot of basil in the window of a lady was a signal to her lover that she was expecting him. Italian women wore a sprig of basil to engender sympathy (Farrell 1985). The common Italian name for the sweet basil, *bacia-nicola* ("kiss-me-Nicolas"), reflects the association with affection (Darrah 1972). The name in Tuscany, *amorino*, is in the same tradition (Darrah 1980).

• A rural New Mexican tradition by which a wife can keep her husband faithful involved dusting basil powder over his heart (Lust 1974).

• Basil leaves were dried, powdered, and used like snuff to dislodge maggots from nasal passages in India (Prakash 1990).

• In parts of the southwestern U.S. it was believed that carrying basil in one's pockets attracted money into them (Lust 1974). Shopkeepers in Haiti sprinkle basil water around their stores to bring prosperity (Castleman 1991).

• Basil seeds, when soaked in water, are mucilaginous. The resulting gelatinous substance has been used as a glue in some countries (Mansfeld 1986). Duke (1985) recommends the mucilaginous concoction formed by seeds in water, with parsley and savory, as a gruel.

• In France and Italy window pots of basil are used to keep insects away (Rosengarten 1969).

• Because of its insect repellent properties, basil was grown on unscreened windows in the Mediterranean region to repel flies (Duke 1985).

• Two compounds in basil, juvocimene 1 and juvocimene 2, seem to interfere with hormonal activity of some insects, preventing them from maturing and reproducing (Rinzler 1990).

Problems and Potential

Although, spice producers are willing to pay a considerable premium for high quality basil, the farm potential for domestic basil production is not high. For instance, in 1979 in the U.S. four growers satisfied an estimated 50-70% of the domestic market. It was predicted that international demand would increase about 10% per year, and about 15% per year in the U.S. (Greenhalgh 1979).

In Canada, there is some potential for greenhouse production of basil for the local fresh market. Basil has been successfully produced in greenhouses near Genoa, Italy for local markets. The plants are pulled when only 15 cm tall and then sold in bunches with the roots still attached (Stobart 1977). This may be considered as a specialty item near large cities in North America.

Selected References

Darrah (1972); Greenhalgh (1979); Darrah (1980); Simon and Craker (1984); Farrell (1985); Simon (1985); Prakash (1990).

Ocimum Tenuiflorum L.

Scientific (Latin) Synonym

O. sanctum L.

English Names

Holy basil
Also: East Indian basil, pagoda tulsi, purple-stalked basil, sacred basil, sacred herb, tulasi, tulsi, tulsi sacred basil

Fig. 270.
Holy basil *(Ocimum tenuiflorum)*, prepared by S. Rigby
(based on greenhouse plant grown from seed from Richters).

[N.B. "Holy basil" may mean different things to different people. The Holy Cross (on which Jesus died) was allegedly discovered in 318 A.D. by St. Helen. A basil plant is said to have grown at the foot of the Cross, and since then basil (*O. basilicum*) has been the holy herb of the Greek Orthodox Church (Jones 1961). According to Jacopin (1979) "On the third Sunday of Lent and on the feast of the Exaltation of the Precious Cross (Sept. 14) the holy cross is placed on a tray of basil leaves which are distributed to the faithful after the service." Additional use of *O. basilicum* in Christianity is noted in *O. basilicum* Curiosities, as well as the fortuitous association of St. Basil and basil. The association of basil with Christianity could lead to confusion with the "holy basil" discussed below, a different species, and one that is holy in a different religion, Hinduism. A previous discussion of this parallelism of religions and basils does not appear to have been published.]

French Names

Basilic sacré (m)

Description, Taxonomy, and History

Holy basil is a perennial, herbaceous, bushy, white-, pink-, or purple-flowered plant, 30-80 cm high. It develops into a subshrub, i.e., the base becomes woody. It probably originated in southern Asia. Morton (1976) stated that holy basil is native from western Asia to Australia. The species is widely distributed in predominantly Hindu areas from southern Arabia to Australia and Polynesia. It has also been introduced into South America and Africa (Mansfeld 1986). The aroma is like anise or clove, depending on variety (Morton 1981).

Holy basil has been grown for nearly 3000 years in Indian gardens, courtyards, and temples (Mansfeld 1986). It is the most celebrated of the basils in history and legend, and the most sacred plant in Hinduism. It is the important holy "Tulsi" (in hindi) or "Tulasi" (in Sanskrit), considered to be a reincarnation of the wife of Vishnu, and a symbol of fidelity or "pure divine love" (Darrah 1972). The plant is dedicated to the Hindu god Krishna (an incarnation of Vishnu), and is therefore planted in sacred places.

There appears to be some confusion about the status of certain forms of *Ocimum* called "holy basil." Morton (1976) noted that one form of basil has purple leaves and stems, and Morton (1981) notes that this has brown seeds without mucilage, while the all-green form has black seeds with a little mucilage. According to Richters (1994), "Much of what is sold as 'sacred' basil is actually spice basil. . . with strong spicy fragrance and flavor. . . possibly a natural hybrid between *O. canurn* [*O. americanum* L.] and *O. basilicum*. Although recognized as sacred by Hindus, this

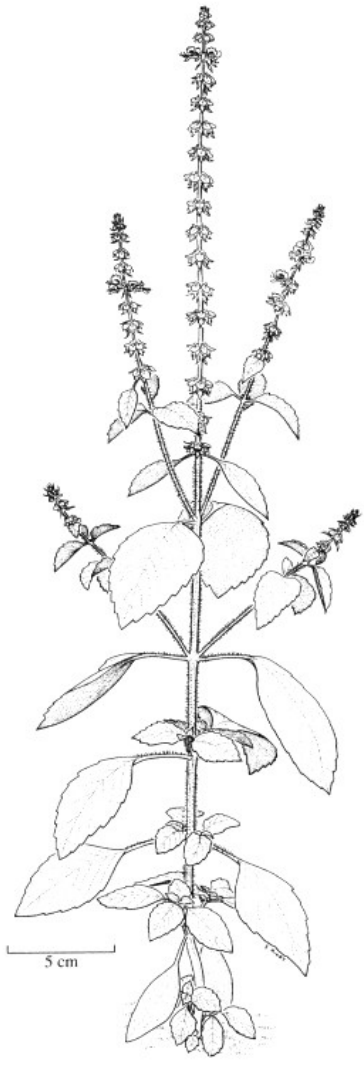


Fig. 271.
Spice basil *(Ocimum sp.)*, prepared by S. Rigby (based on greenhouse plant grown from seed from Richters).

variety is often confused with sacred or holy basil." Shimizu (1982) also notes that "in India. . .spice basil has been accepted as a holy basil." Although sometimes called *O. sanctum* [*O. tenuiflorum*], "any similarity to *O. sanctum* is superficial" (Darrah 1980). Ryding (1994) noted that there do indeed appear to be plants that are intermediate between *O. basilicum* and *O. americanum*, although he was unable to hybridize the two. According to Hutson (1987) "Thai basil (also called holy basil or Tulsi basil in India and sacred to the Hindus), has highly aromatic, slightly downy leaves with reddish-purple markings and small tight clusters of similarly colored seed stalks. The more sun this 3-foot-high shrubby plant gets in the garden, the redder its color. . . Sometimes a basil with sprawling branches and pale green hairy leaves and stems (attaining about 2 feet in height) is also called holy basil. Its lavender flowers bloom all summer and it is a rampant self-seeder. The sweet leaves remind me of overripe apples and often have a rank and pungent odor." The latter form could be "spice basil." However, Darrah (1980) notes that there are two forms of *O. tenuiflorum*: Purple or "Krishna tulsi," with purplish, hairy stems and leaves purple on the upper side; and Green or "Sri tulsi," with all-green leaves; the latter could be the green holy basil pointed out by Hutson. Clearly there is a need to improve identification guides to the basils.

Uses

The leaves are occasionally added as a seasoning to fruit dishes, and sweet yeast breads (Facciola 1990). The fresh leaves are added to salads to produce a sweet anise-like flavor (Shimizu 1982). Shimizu (1982) characterized holy basil's fragrance as similar to sweet cloves. She stated that the fresh or dried leaves and even the flower tops add tremendous taste to meats, especially chicken; and that holy basil blends well with hot, spicy foods, giving a cooling effect. Indeed, Thais use this herb in fish, chicken, and beef curries (Huston 1987). However, many consider sweet basil, *O. basilicum*, greatly superior as a culinary herb. Based on the taste of greenhouse plants grown in Ottawa, I have found that holy basil is more attractive as an ornamental than as a culinary plant. Huston (1987) recommends holy basil in herb vinegar, stir-fries, chicken salad, and in Szechuan sauce used with grilled chicken or fish. The mucilaginous seeds are sometimes consumed as are those of sweet basil (Morton 1976).

Holy basil is used for medicinal purposes and in snuff manufacture (Greenhalgh 1979). The distilled oil of holy basil is an effective antibiotic and insect repellent (Morton 1976).

Holy basil is mostly used in the religious symbolism of Hinduism. Devout hindus tend and water a basil plant in their homes, circumambulate (walk around) it every day, and offer leaves during special prayers and rituals (Darrah 1972). The leaves are laid on the breasts of the dead as a powerful protection. on their afterlife journey (Garland 1979; Lima 1986). The roots or tough stem bases are made into beads and worn around the arms and neck of the Vishnu-brahmans (Fox 1933).

Recipes Sources

No recipes were found. Serving suggestions are given above, and holy basil can be used with the recipes for regular basil, noted previously.

Importance

Holy basil is of the highest religious significance for Hindus. Its culinary significance is very limited, and indeed the culinary use of holy basil in North America is almost unknown.

Cultivation Notes

Soil

Holy basil can be grown in the same types of soil as sweet basil, as described above. A pH tolerance of 4.3-7.5 has been reported (Duke 1978).

Climate

According to Webster (1936), who grew holy basil in her New England garden, it "has a curious resistance to frost which by all rights it should not exhibit." Nevertheless, holy basil is too tender to grow outdoors as a perennial in northern North America, where it is best grown as a potted house plant. It can be grown as an annual for culinary purposes.

Propagation and Cultivation

Holy basil can be reproduced from seeds or by division. Seeds are not widely available, although listed in at least one North American garden catalog. Religious Hindu friends are a probable source.

Harvest and Storage

As with most herbs, the young foliage is tastiest, and the culinary quality of the foliage decreases if the plants are allowed to flower and fruit. Holy basil can be dried in the same way as basil.

Example Cultivars

Sacred Tulsi (available in North America)

Fig. 272.
Holy basil *(Ocimum tenuiflorum)*,
prepared by M. Jomphe (based on collection
"E. Small Sept. 4, 1992" at Agriculture and Agri-Food
Canada herbarium, Ottawa).

Additional Notes

Chemistry

Ocimum tenuiflorum contains 0.3-0.8% essential oil on a fresh-weight basis, with eugenol usually constituting 40-71% of the oil (Asthana and Gupta 1984). An analysis of the essential oil by Lawrence et al. (1972) revealed 37.7% methyl eugenol, 27.4% caryophyllene, 9.9% methyl chavicol, as well as other compounds. Morton (1981) notes that chemistry varies with population, some oil samples high in eugenol and methyl ether, others with methyl chavicol, cineole, and linalool. Pareek et al. (1980) studied a form with a high percentage of oil and eugenol. They noted that the oil content and the eugenol percentage in the oil fluctuated widely at different growth stages. The strong, pungent, clove-like odor of the oil is due to the high eugenol content (Simon et al. 1984). Eugenol is useful in pharmaceutical preparations, perfumes, soaps, dental creams, and as a flavoring agent in foods, meats, sausages, sauces, etc., and so the species has been considered to be a potential source of the chemical (Asthana and Gupta 1984). The essential oil of the leaves and stems also contains citral and methyl chavicol depending on the strain of the plant (Darrah 1974). The seed oil, which dries easily, contains about 66% linoleic acid (Mansfeld 1986).

Medicine

Holy basil was used medicinally in ancient India, Greece and Rome (Godhwani et al 1988). It has continued to be employed in traditional medicine in India, to treat conditions such as worms, infection, gastric problems, cancer, pain, and as a general tonic (Godhwani et al. 1987, 1988). In Vietnam it is used (like sweet basil) to treat fever and malaria (Nguyêñ-Xuân-Duñg and Dô-Tât-Loi 1991). Morton (1981) outlines folk medicinal uses in Middle America, including the treatment of fever, childbirth, stomach ache, and prickly heat. Recent studies have shown that it may be useful in cases of tuberculosis (Reddi et al. 1986), and that it seems to have an anti-stress effect in experimental animals (Sakina et al. 1990). Perry and Metzger (1980) review medicinal uses in other countries of Asia. Anti-fertility effects of the leaves have been reported in mice (Arneja et al. 1987), perhaps due to impairment of testicular function. An extrapolation of this observation to possible effects in humans does not seem to have been made.

Nutrition

Particular nutritional benefits from holy basil have not been noted, although ascorbic acid (vitamin C) is present (Mansfeld 1986).

Curiosities

• When the British colonized India, they allowed Hindus to swear in court on holy basil, because they had nothing equivalent to the Bible (Stobart 1977).

• In Curaçao (an island of the Netherlands Antilles in the south Caribbean), leaves of holy basil strewn on the bed or stuffed behind the ears are thought to induce a good night's sleep (Morton 1981).

Problems and Potential

Holy basil is a rare herb in North America, with a potential for a small ethnic market, and for sale as garden stock.

Selected References

Darrah (1980).

Fig. 273.
Marjoram *(Origanum majorana)*, from Hallier (1880-1888).

Origanum

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

Estimates of the number of species of *Origanum* vary, from about 20 to 40. The species are subshrubs or perennial herbs, native to the Mediterranean area and eastern Asia (Ietswaart 1980; Tucker and Rollins 1989). The genus is closely related to *Thymus*, which includes the thymes, also treated in this book. *Origanum* contains a number of widely cultivated horticultural forms. In the U.S. 16 species (some of hybrid origin) and several hybrids are cultivated (Tucker and Rollins 1989).

While the scientific name *Origanum* is unambiguous, the same cannot be said for the vernacular name origanum or its more popular counterpart, oregano. Perhaps 39 species of 16 genera from six plant families are colloquially called oregano, origanum, or some similar name (Lawrence 1984*c*). The name "oregano" is frequently used as a term for a certain spice flavor and aroma rather than for a particular plant species. The flavor is often determined by the relative concentrations of carvacrol and thymol in the essential oil of the plants, the former primarily responsible for the distinctive "oregano" taste. About half of the "oregano" used in the U.S. is obtained from Mexico and is derived from the dried leaves and flowers of *Lippia graveolens* of the Verbenaceae (discussed elsewhere in this book). The rest generally comes from several species of *Origanum*.

So-called Spanish oregano oil is derived from *Thymus capitatus* (L.) Hoffm. & Link. (= *Coridothymus capitatus* (L.) Reichenb. f.). Spanish oregano oil is used in soaps, cosmetics, lotions, and perfumes, to flavor soft drinks, desserts, and candies, as an antiseptic for pharmaceutical and dental products, and to produce an inferior oregano spice (Roecklein and Leung 1987). For additional information on this species, see *Thymus* genus notes.

"Marjoram" can be as ambiguous as "oregano." This common name is applied both to several plant species and to a class of condiments. Indeed, the commercial "oil of wild marjoram" is distilled from *Thymus mastichina* L., known as mastic thyme or Spanish marjoram. As if this weren't sufficiently confusing, oregano is sometimes marketed as "marjoram" when the latter is in short supply, and vice versa.

Marjoram (*Origanum majorana*) has often (but erroneously) been considered to be the cultivated form of oregano (*Origanum vulgare*), and the latter is sometimes called wild marjoram. This has led to considerable confusion between the two.

Origanum Majorana L.

Scientific (Latin) Names

Majorana hortensis Moench

English Names

Marjoram
Also: amaracus, annual marjoram [the species is a perennial grown as an annual in northern North America], knotted marjoram [so-named because the flower buds form tight overlapping "knots" (plaited bracts) from which the flowers emerge], sweet marjoram
[Morton (1981) lists wild marjoram as one of the common names; this is traditionally applied to the next species examined, *O. vulgare*.]

French Names

Family: Labiées, famille de la menthe
Marjolaine (f)
Also: amaracus, amarique, faux origan, grand origan, marjolaine à coquille, marjolaine à gros épis, marjolaine commune, marjolaine des jardins, marjolaine sauvage, marjolaine ordinaire, marjolaine vivace, marjolaine vulgaire, petite marjolaine sauvage [marjolaine sauvage is *O. vulgare*]

Description, Taxonomy, and History

Marjoram is a perennial subshrub, usually 30-60 cm high, with purplish stems and small, white to pink flowers in clusters. The species is thought to be native to North Africa, the Middle East, and part of India (Stuart 1979). It is cultivated as a culinary herb and as a medicinal plant in many countries in Europe, Asia, and the Americas, where it has escaped from gardens and grows wild in warm climates. Some cultivars are grown as annuals or biennials, and have a less compact habit than the perennial forms (Ietswaart 1980). No taxonomic distinction is made between the wild and cultivated forms of marjoram.

Marjoram was grown in Egypt over 3000 years ago (Mansfeld 1986). It was used medicinally by the ancient Greeks (le Strange 1977). It has been cultivated for at least 2 centuries in western Europe.

Under cultivation, *Origanum majorana* has hybridized with *O. vulgare* subsp. *vulgate* to form *O. applii* (Domin) Borosa, a hybrid long known from gardens in west and central Europe. *Origanum majoricum*, discussed below, is also of hybrid origin.

Uses

Marjoram enhances most dishes, so much so that many herb enthusiasts have the motto "when in doubt, use marjoram" (Hutson 1987). "In American kitchens the heartier and more assertive oregano outshines the more demure marjoram. Too often forgotten, marjoram never overpowers; it simply complements foods with elegance" (Hutson 1987). Nevertheless, marjoram is deceptively potent and care should be exercised not to use too much; six servings of meat, fish or eggs need only 1.2-2.5 mL (1/4 to 1/2 teaspoon) (Farrell 1985).

The leaves, flowers, and tender stems are employed for flavoring syrups, stews, dressings, liqueurs, sauces, vinegars, soups, omelets, sausages, stuffings, poultry, meats and seafoods (Morton 1976; Farrell 1985; Facciola 1990). The importance of marjoram in flavoring meat in Germany is reflected by the name *Wurstkraut*, meaning sausage herb (Stuart 1979). Marjoram can be added to highly spiced foods such as pizza. It is also combined with salads, mushrooms, and various vegetables including carrot, cauliflower, peas, spinach, summer squash, and tomatoes. Fresh or dried leaves are sometimes brewed into a sweet tea, considered superior to oregano tea (Marcin 1983). Marjoram leaves should be used sparingly in food dishes. In cooked dishes it usually should be added only in the last 10 minutes of cooking (Stuart 1979). Commercial marjoram is available either whole or ground (Prakash 1990). Marjoram and oregano (the latter discussed next) can be mutually substituted, keeping in mind the following: 1½ parts fresh marjoram leaves equals 1 part fresh oregano leaves; two parts dried marjoram leaves equals 1 part dried oregano leaves (Rinzler 1990).

The aromatic seeds are used to flavor candy, beverages, condiments, and meat products.

The thymol-free essential oil distilled from leaves and flowering shoots is used to flavor meat sauces, preserves, soups and sausages, and as an ingredient in perfumes, soaps, and hairdressings (Lewis 1984; Mansfeld 1986; Morton 1986).

Recipe Sources

Rosengarten (1969) presents recipes for Marjoram tuna casserole, and Marjoram meat loaf. Muenscher (1978) has recipes for Marjoram biscuits, and Turnips with marjoram. Owen (1978) gives recipes for Chicken corn soup marjoram, and Lamb roasted with marjoram. Gilbertie (1988) has recipes for Sweet marjoram blueberry tartlets, Grilled corn cakes with sweet marjoram-red pepper marmalade, and Rack of lamb with sweet marjoram and lemon. Richardson (1991) gives the following recipes: Quick ham pâté with marjoram, Freezer tomato sauce with marjoram, Marjoram herbed brown rice with shallots, Marjoram pasta sauce with tomatoes and cheese, and Mediterranean clam soup with marjoram.

Other recipes are: Marjoram tea (Marcin 1983); Marjoram corn bread (Belsinger and Dille 1984); Salmon and marjoram pie (Hemphill and Hemphill 1984); Pork tenderloin medallions with fresh marjoram (Hutson 1987); Marjoram, spicy stuffed flower turkey (Leggatt 1987); Goats' cheese grilled in vine leaves with marjoram and thyme flowers (Holt 1991); Roast chicken with marjoram (Barash 1993).

Importance

Marjoram is one of the western world's most important culinary herbs. It is commercially cultivated in France, Germany, Granada, Great Britain, Hungary, Italy, Morocco, Portugal, Spain, South America, Tunisia, and the U.S. (Farrell 1985). Egypt produces 90% of the world's supply (Verlet 1990). France and Germany are the largest international markets for marjoram. Germany may consume up to 1000 t per year (Greenhalgh 1979). In 1988, the U.S. imported about 380 t of unprocessed (bulk dried shoots) of marjoram valued at $481,400.00, and an additional 1.8 t of processed marjoram valued at $5,100.00. Of the above totals, Canada exported nearly 12 t of unprocessed marjoram valued at $11,960.00 and supplied all of the processed marjoram to the U.S. in 1988 (Anon. 1989*a*). About 3 t of marjoram essential oil are produced annually worldwide (Lawrence 1992). Verlet (1993) estimated the annual world value of "marjoram" essential oil to be $2,100,000.00 (U.S.) (but as discussed in Genus notes, some or much of this may be *Thymus mastichina*).

Fig. 274.
Marjoram *(Origanum majorana)*,
from Vilmorin-Andrieux et C^{ie} (1883).

Cultivation Notes

Soil

Marjoram performs best on a rich, light, well-drained soil (Rosengarten 1969), although a range of soil types will be accepted. A pH tolerance range of 4.9-8.7 has been reported (De Baggio 1987). Crockett and Tanner (1977) recommend a pH of 6.0-8.0.

Climate

Marjoram grows at temperatures between 3 and 30°C, optimally about 17°C. This species grows best in full sunlight, but slight shade will be tolerated. It is too cold-sensitive to be grown as a perennial in northern climates. Because it is cultivated as an annual, it can be grown widely in North America.

Propagation and Cultivation

Propagation is by seeds. Germination is slow, but seedlings will usually emerge in 8-15 days according to Wang et al. (1993). Seeds should be planted at a depth of 3 mm or less according to Crockett and Tanner (1977), 6 mm or less according to Wang et al. (1993). The sod must be kept evenly moist. In field plantings careful weeding is necessary until the seedlings have become established (Rosengarten 1969). In the home garden, pinching back the tops encourages branching and bushy growth. Rarely, marjoram is propagated by stem cuttings. To grow marjoram as a house plant, follow the instructions given below for dittany of Crete.

Harvest and Storage

The plants are harvested by cutting them close to the ground. The leaves and tender shoots are thoroughly dried, cleaned and stored. The method of drying depends on the local climate and the size of the crop. The cut plants may be tied in bunches and dried in the open; or spread on wire trays in ventilated rooms and dried by controlled, circulating, warm air (Prakash 1990). Drying away from the path of sunlight preserves the green color and aroma (Simon et al. 1984). Unlike many herbs, marjoram's flavor becomes more intense when it dries, and many prefer the flavor of the dried herb (Hutson 1987). According to Crockett and Tanner (1977), the most desirable time to harvest sweet marajoram is when the flavor is best, just after the flower buds form, and just before flowering. The home gardener can dry the leaves of marjoram in a warm, dry, shaded place, and store them in an airtight container.

Example Cultivars

Golden (= Golden marjoram, creeping gold marjoram, Aurea), Variegated (described by Facciola 1990).

Additional Notes

Chemistry

The essential oil is obtained by steam distillation. The yield is very low, often less than 1% of the fresh material. The oil is yellowish, with a spicy, aromatic quality, reminiscent of lavender. The taste is sharp and spicy. The main components of the essential oil are *cis*-sabinine hydrate and terpinen-r-ol (Fischer et al. 1987). The oil also contains linalool, - and -terpinene, and other constituents (Lawrence 1984c, Fischer et al. 1987). The oleoresin is dark-green and viscous. About one part of the oleoresin is equal to 40 parts of freshly ground marjoram in flavor and odor (Farrell 1985). A review of the various chemicals found in the volatile oil appears in Prakash (1990).

"Oil of wild marjoram" is obtained from *Thymus mastichina*, discussed in the genus notes for *Thymus*.

Medicine

In herbal form, marjoram has been used in folk medicine as a remedy for asthma, indigestion, headache, rheumatism, and toothache (Simon et al. 1984). Several varied folk uses of marjoram in Middle America are outlined by Morton (1981), for such conditions as hysteria, epilepsy, muscular pain, pain of childbirth, flatulence, and ear problems. As noted by Morton, many of these uses were common in Europe and were introduced into the New World by the Spaniards. The herb has formed part of sneezing powders (Grieve 1931). The oil of marjoram has been used much like that of oregano (*O. vulgare*) in traditional medicine. The volatile oil has been employed to treat flatulence, colic, and rheumatism (Prakash 1990). It has also been applied externally as a liniment for sprains and bruises, used as a stimulant and tonic, and employed to alleviate tooth aches by placing a few drops On cotton placed on the tooth. Marjoram oil was used to promote perspiration in those suffering from measles, and was also regarded as a treatment for spasms. There are no important modem medicinal uses for marjoram.

Curiosities

• The genus name *Origanum* is derived from the Greek *oras*, mountain, and *ganos*, joy, thus "joy of the mountain," a reference to the attractive color and scent of the flowers and leaves, and the hills from which the plants originated (le Strange 1977).

• The classical Greeks and Romans crowned young married couples with marjoram, and in ancient Sicily it was said to possess the gift of banishing sadness (Fox 1933).

• According to Greek legend Aphrodite, the goddess of love, first cultivated marjoram, and its sweet scent came from her touch. Because of this association the ancient

Greeks wore wreaths of marjoram at weddings (Lust 1974); and it was believed that if a lady put marjoram in her bed, she would be visited by Aphrodite in her dreams, who would reveal her future spouse's identity (Castleman 1991). The Roman version of the legend is that Venus (essentially equivalent to Aphrodite) left the perfume of marjoram to remind mortals of her beauty (Belsinger and Dille 1984).

• The ancient Greeks used marjoram as an antidote for snakebite. If the patient died, and with admirable persistence that the plant had some value, they planted marjoram on the grave, thinking it would help the dead sleep peacefully (Lust 1974).

• During the Middle Ages, marjoram was employed as an air freshener, love potion, and as a magic charm against witches (Rosengarten 1969; Belsinger and Dille 1984).

Problems and Potential

Marjoram is one of the herbs most frequently found in short supply (Greenhalgh 1979). There is potential for a few growers to produce it in the warmest parts of Canada and the northern U.S. However, as with most herbs, new producers should exercise caution. Established exporting countries, such as Egypt, have shown quick response to periodic short supplies of marjoram. Also the growth of demand for marjoram is increasing quite slowly.

Selected References

Rosengarten (1969); Greenhalgh (1979); Ietswaart (1980); Tucker and Rollins (1989); Prakash (1990).

Origanum Vulgare L.

English Names

Oregano
Also: European oregano, mountain mint (better reserved for *Pycnanthemum*, discussed in this book), organy, pizza herb, wild marjoram, winter marjoram, wintersweet (Other common names attributable to the various subspecies are found below.)

French Names

Origan (m)
Also: marjolaine bâtarde, marjolaine d'Angleterre, marjolaine sauvage, marjolaine vivace, origan commun, origan vulgaire, pelevoué (Switzerland), thé rouge, thym de berger
[Wijk (1911) provides an extensive list of obsolete French names.]

Fig. 275.
Oregano *(Origanum vulgare)*, from Hallier (1880-1888).

Description, Taxonomy, and History

This species is an extremely variable, woody, perennial plant, up to a meter in height, usually producing purple flowers, sometimes pink or white flowers. Oregano grows wild from the Azores, Madeira, and Canary Islands in the eastern Atlantic Ocean, through Europe, west and central Asia, to east Asia and Taiwan (Ietswaart 1980). It has escaped from cultivation in North America. Wild-growing plants have been collected as far north as southwestern British Columbia, southern and eastern Ontario, southwestern Quebec, Prince Edward Island, and Nova Scotia (Scoggan 1978-79). Oregano is naturalized in the northeastern U.S. (Morton 1976). It is an abundant weed in parts of the U.S., especially in the Catskill Mountains (le Strange 1977).

Oregano has been used medicinally since the times of classical Greece (see Medicine). It has been cultivated in England at least since the 13th century (le Strange 1977).

Many names have been given at and below the species level to variants of oregano (Ietswaart 1980; Mansfeld 1986; Tucker and Rollins 1989; Rollins 1989). A brief description of the kinds that have been recognized, including forms of horticultural importance, follows.

Subspecies *glandulosum* (Desf.) Ietswaart

This wild subspecies is found in mountainous regions of Algeria and Tunisia in northern Africa (Ietswaart 1980).

Subspecies *gracile* (K. Koch) Ietswaart

Known as Russian, Kirghiz, or Turkestan oregano, variants of this subspecies are found from eastern Turkey and northern Iraq to northern Afghanistan and the central Asian part of Russia. It is uncertain whether cultivated forms have been selected. However, there are chemically different strains (readily identified by chefs and horticulturists by distinctiveness of flavor) that have sometimes been recognized under the separate species names *O. tytthanthum* Gontscharov and *O. kopetdaghense* Borissova (Rollins 1989). The so-called *O. tytthanthum* has a distinct pungency and an excellent culinary flavor (Facciola 1990).

Subspecies *hirtum* (Link) Ietswaart

[=*O. heracleoticum* of some authors, but not equivalent to *O. heracleoticum* L., which is part of subsp. *viride* (Ietswaart 1980); see Tucker and Maciarello (1994) for additional taxonomic information.]

This subspecies is known as Greek oregano (also Turkish oregano, winter marjoram, and winter sweet marjoram). In northwestern Turkey, this is called "black oregano" (Tucker and Maciarello 1994). According to Simon et al. (1984) this is also sometimes known as pot marjoram, a name best reserved for *Origanum onites*, discussed below. Wild forms of this eastern Mediterranean subspecies are found mainly from the Balkan Peninsula to Turkey. Cultivated forms have been selected. Economically, this is the most important oregano, providing most of the European oregano on the American market (Morton 1976; Tucker and Maciarello 1994). About 7.8 t of Greek oregano essential oil are produced annually worldwide (Lawrence 1992). According to Barash (1993), Greek oregano prefers a richer soil than other forms of oregano.

Subspecies *virens* (Hoffmans. & Link) Ietswaart

This subspecies is found on the Azores, Madeira, and Canary Islands (likely introduced by man), in locations in the eastern Atlantic Ocean, and in the Iberian Peninsula and North Africa. It has been introduced to Argentina where it has escaped from gardens. It is uncertain if any cultivated forms have been selected.

Subspecies *viride* (Boiss.) Hayek

(= *O. heracleoticum* L. (Ietswaart 1980))

This grows wild from the island of Corsica in the Mediterranean to eastern China. Cultivated and wild plants are indistinguishable. The subspecies is occasionally cultivated in the U.S.

Subspecies *vulgare*

Known as wild marjoram (also common marjoram and wild oregano) this subspecies grows wild from England to Asia and Taiwan, although rare in southern east Asia. It was introduced into North America during early European colonization. Several cultivars have been selected.

Fig. 276.
Oregano (Origanum vulgare),
from Syme et al. (1863-1886).

Uses

Oregano in its various forms has become indispensable in the preparation of many Italian, Spanish, Mediterranean, and Latin American dishes. Generally a small amount is sufficient. The leaves should be crushed and added to the food being prepared just before the end of cooking and should not be exposed to high heat for more than 10 minutes. Oregano is combined with omelets, Italian sauces, tomato dishes, vegetable casseroles, and pizza. It is often sprinkled on various meat dishes including hamburgers, pork, beef, lamb, veal, and poultry, and on some seafood dishes. Oregano is often a constituent of soups, broths, cheese spreads, and salads. It goes well with such vegetables as broccoli, cabbage, eggplant, onions, and tomatoes (Farrell 1985). Wild marjoram (subsp. *vulgare*) has also been used as a dye, imparting a brown or red shade to wool. However the tint is neither brilliant nor durable (Grieve 1931; Mansfeld 1986).

Recipe Sources

Belsinger and Dille (1984) have recipes for Oregano hot sauce, and Stuffed mushrooms with oregano. Hutson (1987) gives recipes for Oregano pesto, Oregano pesto torta with roasted chile strips and toasted pine nuts, Pollo picado (shredded chicken dish), Greek salad (shredded chicken dish), and Ancho-oregano-pecan-butter. Richardson (1991) presents the following recipes: Oregano, shallot and mushroom salad; Noël's eggplant casserole; Oregano oil; Vine leaves stuffed with rice and oregano; Baked cod with feta cheese and oregano; Spaghetti with clams and oregano; and Oregano chicken baked in foil. Barash (1993) provides two recipes with oregano flowers, including Veal cutlet with oregano flowers.

Other recipes are: Beef stew, Mexican style (Rosengarten 1969); Oregano salt sticks (Garland 1979); Tomato soup oregano (McCormick 1979); Avocado salad with oregano (Boxer and Back 1980); Oregano tea (Marcin 1983); Oregano cheese pie (Bremness 1988); Zucchini with oregano (Creasy 1988); Red mullet with tomatoes and oregano (Holt 1989).

Importance

Oregano's popularity in North America is increasing, reflecting an expanding market for pizza, both from pizza parlors and frozen product outlets (Buzzanell et al. 1995). European forms of oregano (species of *Origanum*) are considered superior to Mexican oregano (*Lippia graveolens*) and often command a price almost three times higher on the world market. The best European oregano is harvested from the wild in Greece by shepherds (Fleischer and Sneer 1982). Oregano is grown. in the U.S. for production of the dried herb. The U.S. is the world's leading importer of oregano, followed by Italy. The U.S. imports most of its oregano from Turkey, Mexico, and Indonesia (Buzzanell et al. 1995). Much oregano from Mexico represents so-called Mexican oregano (*Lippia*), which is treated elsewhere in this book. Imports of "oregano" averaged $12.1 million (U.S.) over the period 1990-1994 (Buzzanell et al. 1995). Canada also imports Mexican oregano from Mexico. Canada occasionally exports processed oregano herb to the U.S., for example, in 1987, 18 t valued at $9,450.00 (Anon. 1989*a*). In 1988, the U.S. imported about 6.8 t of "origanum" essential oil valued at $259,200.00 (Anon. 1989*b*). This came mainly from Spain, representing the so-called Spanish oregano oil, used as a flavoring in North America. It is actually distilled in Europe from *Coridothymus capitatus* and likely represents some or all of the oil mentioned above.

Fig. 277.
Oregano *(Origanum vulgare)*,
from Bulliard (1784).

Cultivation Notes

Soil

A light, rich, well-drained soil is best (Simon 1990). A pH tolerance range of 4.5-8.7 has been reported (De Baggio 1987). Crockett and Tanner (1977) recommend a pH of 6.0-8.0.

Climate

A warm, sheltered situation in full sunlight is essential. Growth occurs between 4 and 32°C, optimally at 23°C.

Propagation and Cultivation

It is recommended that most strains of this and other species of *Origanum* be propagated vegetatively to obtain plants with the desired flavor and aroma characteristics of their parents. Some hybrids do not develop seeds (Rosengarten 1969). When oregano is grown as a perennial in hot climates, the roots become rather tangled and should be divided every 2 or 3 years to renew their vigor (Crockett and Tanner 1977). However, older plants become less flavorful. To grow oregano as a house plant, follow the instructions given below for dittany of Crete.

Harvest and Storage

The first harvest of the leaves and tender tops occurs just as flowering commences. The plants are cut 6-10 cm from the ground. In many regions of the world 2-6 cuts can be made over a single year (Simon 1990). Where commercially grown, oregano plantings are productive for 4-5 years. The leaves are thoroughly dried, cleaned, and stored as soon as possible (Rosengarten 1969). Typically, yields of 1.5-3.0 t/ha of dried herb are obtained. Once harvested for the fresh market, oregano should be kept at 0°C to maximize shelf-life (Simon 1990).

The home gardener can dry the leaves of oregano in a warm, dry, shaded place, and keep them in an airtight container.

Example Cultivars

Subspecies gracile
This subspecies is available in North America under the name "Turkestan oregano."

Subspecies hirtum

This is available in North America as "Greek oregano." Kalitera (which means "the best" in Greek), is likely a cultivar of subsp. *hirtum*. It is grown commercially in Greece for the oregano market and is known for its quality and high oil content. This is also available in North America.

Subspecies vulgate

Aureum (golden oregano, with mild oregano flavor), Humile (compact plant, poor flavor, more commonly an ornamental).

Facciola (1990) describes cultivars of *O. vulgare* available in the U.S. Huxley et al. (1992) describe additional cultivars.

Additional Notes

Chemistry

A high carvacrol content in the essential oil is the key to the "oregano" flavor. The carvacrol content has been found to vary so much in subsp. *hirtum* that in one study, to the trained nose the oils were variously thought to be marjoram, thyme, or oregano (Fleisher and Sneer 1982). The marjoram type. had high quantities of terpinen-4-ol, and little thymol or carvacrol. The thyme type was predominately composed of thymol while the oregano type mainly had carvacrol. Commercial essential oil predominantly contains carvacrol, reflecting preference for the latter.

There are differences in the oil obtained from the various subspecies, and indeed cultivars of *O. vulgare*. Greek oregano (subsp. *hirtum*) is the major source of commercial oregano oil. It contains 60-80% carvacrol (Lawrence 1984*c*). Subspecies *viride* is considerably higher in its concentration of thymol, up to 50% (Prakash 1990).

Medicine

Oregano has a long history as a medicinal plant. It was used by the ancient Greeks both internally and externally as a remedy for narcotic poisons, convulsions, and dropsy (Grieve 1931). Oregano has been used as a folk remedy against colic, coughs, headaches, irregular menstruation, nervousness, and toothaches (Simon et al. 1984). Oregano is still used in medicine in China (Duke and Ayensu 1985). The essential oil has been found to completely inhibit the growth of foodborne fungi and bacteria (Paster et al. 1990). There are indications that this oil might be an alternative to food preservatives currently in use.

Nutrition

Ground oregano contains about 11% protein and 10% fat (Duke and Ayensu 1985), but is not notable for nutrient content.

Curiosities

• Among the ancient Greeks, oregano growing on a grave indicated the happiness of the departed (Grieve 1931).

Fig. 278.
Oregano *(Origanum vulgare)*, from
Vilmorin-Andrieux et C^{ie} (1883).

• Aristotle (384-322 B.C.) stated that tortoises that swallowed a snake would immediately eat oregano to prevent death, and consequently it was taken as an antidote to poisoning (Bremness 1988).

• In classic Greek and Roman times, it was the custom to crown young couples with oregano (Grieve 1931).

• In England, before the introduction of various foreign perfumes, powders and washing "waters" were made with oregano (Grieve 1931).

• In England, furniture was once scoured with the leaves of oregano to impart an aromatic scent (Grieve 1931).

• Before the introduction of hops (*Humulus lupulus* L.), oregano was in demand as a flavor for beer-brewing (Grieve 1931).

• In England, it was once thought that placing oregano beside milk in a dairy prevented curdling during thunder storms (Grieve 1931).

• Oregano was in little demand in North America before World War II. Although the first pizzeria in the U.S. apparently dates from 1895 in New York, Italian food remained of minor interest in North America (Tucker and Maciarello 1994). American troops become fond of pizza while fighting in Italy and, after returning home, were responsible for a pizza craze in the U.S. The result was a 6000% increase in demand for oregano over the next 20 years, with only a minor growth in the use of marjoram (Rosengarten 1969).

• One ounce (28.4 g) of oregano will properly season 432 slices of pizza (Meares 1987).

• An analysis of foods that were liked and disliked during pregnancy showed a tendency to dislike sauces flavored with oregano [foods craved included ice cream, sweets (particularly chocolate), fruits, and fish] (Hook 1978).

• The ancient Greek philosopher and naturalist, Theophrastus (ca. 371-287 B.C.), observed that the younger seeds of aromatic plants often germinate more slowly than the older seeds, unless the former have been soaked in water or milk. An explanation of these phenomena has been advanced by Thanos et al. (1995). They discovered that seeds of some aromatic plants, including those of *O. vulgare* subsp. *hirtum*, have a curious dormancy mechanism which delays germination until sufficient moisture is available. The calyx which covers the seed contains essential oils, which inhibit germination until leached away by rain. Older seeds, even if protected from rain, seem to germinate more readily than younger seeds, apparently because the inhibiting oils have volatilized.

Problems and Potential

Oregano is a plant better adapted to hotter climates than occur in all but the warmest parts of Canada and the adjacent U.S., where there is likely little potential for commercial production. Home gardeners in relatively cool regions may successfully grow oregano as a perennial as long as the plants are kept indoors during the winter.

Selected References

Rosengarten (1969); Ietswaart (1980); Tucker and Rollins (1989); Prakash (1990).

Origanum Onites L.

English Names

Pot marjoram
Also: Cretan oregano, Turkish oregano
[In the Izmir-Bodrum-Marmaris-Antalya region of Turkey this is called "balls oregano" (Tucker and Maciarello 1994). In Crete it is named "rhigani" (Tucker 1990).]

French Names

Origan de Chypre (m)
Also: marjolaine de Criète

This species is a perennial subshrub native to southern Greece, Crete, Sicily, and southern and western Turkey (Ietswaart 1980). Unlike other species of *Origanum* the plants develop two types of leaves, small ones during the summer droughts common to Crete, and large ones during the wetter winter months.

Pot marjoram was introduced to England where it was grown at least by the 16th century (le Strange 1977). It was cultivated there and in Germany as a garden plant.

Fig. 279.
Pot marjoram *(Origanum onites)*,
prepared by M. Jomphe.

This species was not introduced into North America until 1975 (Rollins 1989). It is grown in somewhat cool climates, where marjoram does not grow well. Pot marjoram's flavor is considered inferior to that of marjoram (Stuart 1979). It is propagated by seeds (germination may be irregular), cuttings, or by root division. True to its name, it is often grown in pots. Pot marjoram is tolerant of various conditions, but prefers light, well-drained soil and full sun. It is reported to tolerate soil ranging in pH from 5.8-7.3 (Duke 1979). The herb is used fresh or dried in salads, for flavoring meat dishes, and in tea (Facciola 1990). It has a delightful, peppery flavor and thymelike aroma.

In Turkey, leaves and floral shoots are distilled to make a volatile oil consisting of 50-85% carvacrol. The yield of the volatile oil ranges from 1.8 to 4.4% of the plant material (Vokou et al. 1988). Several reports of the chemistry of the oil from *O. onites* are reviewed in Tucker and Maciarello (1994).

Pot marjoram is offered in North American garden catalogs (sometimes listed as Cretan oregano, a name that is easily confused with the following species). It is too tender to grow outdoors in northern North America, but can be grown as an edible house plant.

Fig. 280.
Dittany of Crete *(Origanum dictamnus)*,
from Curtis (1787-present; # 298).

Origanum Dictamnus L.

Scientific (Latin) Synonyms

Amaracus dictamnus (L.) Benth.

English Names

Dittany of Crete
Also: Crete dittany, dictamnus, dittany, hop marjoram, Spanish hops

[Dittany of Crete should not be confused with American dittany, *Cunila origanoides* (L.) Britt. (*C. mariana* L.) of the eastern U.S., the leaves of which are used to make a minty folk medicinal tea (Foster and Duke 1990). Early settlers used American dittany as an oregano substitute, and today the plant makes an attractive ornamental that will grown under the difficult conditions of dry shade (Adams 1996).]

French Names

Dictame de Crète (m)
Also: dictame, dictame vrai, origan dictame
[The spelling according to Bois (1934) is dictamne de Crète.]

This perennial subshrub is native only on the island of Crete and southern Greece, where it forms mats or cushions on calcareous rocks, often in shady places (Ietswaart 1980). Unfortunately its beauty and alleged healing powers have led to it being ruthlessly picked. Combined with excessive grazing, the species is in danger of extinction (Jones 1973). Dittany of Crete is a low-growing shrub, 25-40 cm tall, with thick, gray, wooly, round leaves and flowers ranging from pink to purple. Its overlapping floral bracts form hop-like clusters. It was known in antiquity, and was pictured in a fresco unearthed in Crete dating back to 1500 B.C. (Jones 1973; Gambee 1985). Dittany of Crete has been grown in England for use as a pot herb and an ornamental, at least since the 16th century (le Strange 1977).

Dittany of Crete was cultivated in Italy during the Middle Ages as a medicinal plant, and was thought to be especially useful for treating wounds (Grieve 1931). The leaves have also been used in folk medicine to ease childbirth, the root has been used in a salve to treat sciatica, and the juice was consumed in wine to cure snake-bite (Jones 1973). The species has also been used to treat pain, stomach ailments and rheumatism (Simon et al. 1984).

The aromatic foliage of dittany of Crete is used for flavoring salads. Dried leaves and extracts are employed to flavor vermouths, bitters, and other liqueurs, and occasionally baked goods (Furia and Bellanca 1975). The main component of the essential oil is carvacrol (Schaden and Hesse 1976). In Saxon kitchens it was an ingredient of a sauce to be used with fish (Jones 1973). Combined with parsley, garlic, thyme, salt and pepper, it added a pleasant flavor. Its beautiful chartreuse and pink flowers are still used in Crete to make tea (Mansfeld 1986). This species is available through some North American garden catalogs. It can be rooted easily from cuttings and is also grown from seeds. The plant has survived winters outdoors in Pennsylvania (Jones 1973). However, this unique species is too frost-tender to be grown without protection in most of northern North America, and is most appropriately grown as an edible houseplant. It is best propagated using semi-ripe cuttings in late summer (Paton 1994). Freshly rooted cuttings should be kept in shade until established, and thereafter provided with as much sun as possible. Dittany of Crete requires at least 5 hours of direct sunlight daily (Crockett and Tanner 1977), although Rollins (1995) notes that in its native Crete it has been observed growing in shady places. The plant should be grown in dry, free-draining, sandy soil. It should be watered well, and then allowed to dry between waterings. Flower buds should be pinched off to stimulate leaf growth; if not done, the plant may flower and die (Crockett and Tanner 1977). In the summer the plant may be kept outdoors when night temperatures remain above 7°C (Crockett and Tanner 1977). During the rest period in winter, indoor plants should be watered sparingly, but not allowed to dry out.

Curiosities

• The epithet *dictamnus* in the name *O. dictamnus* is derived from the mountain Dicte on the island. of Crete, one of the mountains on the island where dittany of Crete grows (Bois 1934). "Dittany" in the common name is also derived from this.

• In ancient times dittany of Crete was famous for its alleged property of expelling weapons inbedded in soldiers. Wild goats were reputed to seek out the plant after being struck by arrows; the goats were thought to eat the plant, and the arrows would fall out immediately. In the ancient tale of the Trojan wars by the Roman poet Virgil (= Vergil; 70 B.C.-19 B.C.), the hero Aeneas was severely wounded by a deeply imbedded arrow that could not be extricated. His mother Venus went to Mount Ida on the island of Crete and retrieved some dittany of Crete, which was applied to the wound, causing the arrow to drop out and the wound to cure immediately (Gambee 1985). Virgil's version

Fig. 281.
Gas plant (dittany) *(Dictamnus albus)*,
from Lamarck and Poiret (1791-1823).

of the event in *Aeneid*, Book XII, was translated by the English poet John Dryden (1631-1700) as follows (Brown 1935):

> A branch of healing Dittany she brought
> Which in the Cretan fields with care she sought.
> Rough is the stem, which wooly leaves surround.
> The leaves with flowers; the flowers with purple crowned.
> Well known to goats; a sure relief
> To draw the pointed steel and ease the grief.

• In ancient times it was believed that a snake would allow itself to be burned to death rather than cross the path of dittany of Crete (Jones 1973).

• For many years the alleged medicinal virtues of dittany of Crete were (because of the similarity of name) erroneously ascribed to a species called the gas plant, burning plant (burning bush), and dittany [*Dictamnus albus* L. (= *D. fraxinella* Pers.)]. When the error was realized, the gas plant was called the "bastard dittany" or "false dittany" (Jones 1973; cf. "bastard saffron" in saffron Curiosities). The gas plant is a pleasantly fragrant (lemon or vanilla-and-almond scented) culinary herb, the dried leaves of which are used to make a herb tea. The roots have been used in flavoring "wine-based apertitifs and, where permitted, non-alcoholic beverages and pastry" (Furia and Bellanca 1975). The rhizome has been used medicinally, but the active alkaloid present, dictamine, is toxic in strong doses (Bunney 1992). The species is called "gas plant" because while in bloom it emits a volatile oil that can be ignited with a match when the air is dry and still (Morton 1976). This flash of fire does not hurt the plant (Crockett and Tanner 1977). If this stimulates you to acquire this plant, keep in mind that contact with the seedpods and subsequent exposure to sunlight may result in dermatitis. Also, according to Shih-Chen et al. (1973) the root has "a strong odor which resembles that of the goat." The plant is difficult to propagate, and seeds may not germinate for months. (Muenscher and Rice 1955).

Selected References

Jones (1973); Paton (1994).

Origanum Microphyllum (Benth.) Boiss.

English Names

Small-leaved oregano
[No common names were found and the name given has been coined for this book by translating the Latin name.]

French Names

Origan à petites feuilles (m)
[Name coined for this book.]

This perennial subshrub has small leaves and a trailing habit. It is native to Crete, where it grows in rocky soils and in crevices. Seeds of this plant are offered in some North American garden catalogs (sometimes listed as "microphylla oregano"). The species is notable for its strong spicy flavor. It is too frost-tender to be grown in most of northern North America, but can be grown as an edible houseplant.

Fig. 282.
Small-leaved oregano *(Origanum microphyllum)*, prepared by S. Rigby. (Based on greenhouse plant from Richters.)

Origanum Syriacum L.

Scientific (Latin) Synonyms

O. maru L.

English Names

Syrian oregano
Also: Egyptian marjoram, Egyptian oregano, Lebanese oregano, white oregano
[Oregano from *O. syriacum* collected from the Taurus Mountains - Adena region of Turkey is often called "white oregano" (Tucker and Maciarello 1994).]

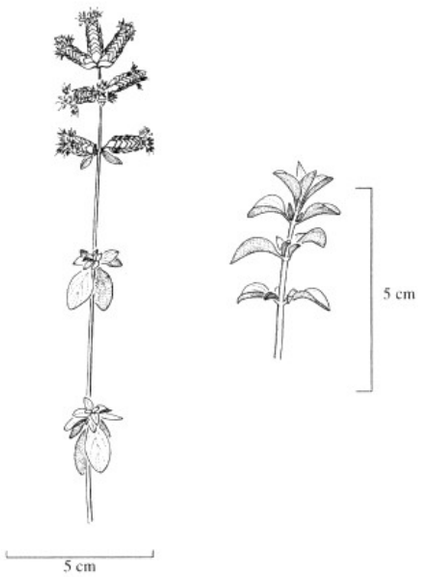


Fig. 283.
Syrian oregano *(Origanum syriacum)*, prepared by S. Rigby.
(Based on greenhouse plant from Richters.)

French Names

Origan d'Égypte (m)
Also: marjolaine à coquille(s)

This perennial subshrub is native to the Middle East. It grows on rocky, often limestone soils (Ietswaart 1980). Three varieties are known of which var. *bevanii* (Holmes) Ietswaart seems to be cultivated as a condiment in the Mediterranean region.

Syrian oregano is the ancient "hyssop" of the Bible and was the "za'atar" that is still a popular condiment in the Holy Land (Fleisher and Fleischer 1988, where it is identified as *Majorana syriaca* (L.) Raf.). The plant was used to treat heart ailments, coughs, and toothaches (Gardner 1989). It was also an ancient symbol of modesty. Syrian oregano was an important part of ancient Jewish purification rites. It was a valued potted plant in British gardens as far back as the 17th century; gardeners of the time observed that care had to be taken to protect it from two dangers: the cold climate, and cats (le Strange 1977).

Two chemotypes of Syrian oregano have been found; the strain predominantly containing the chemical carvacrol in the essential oil is preferred to that containing mostly thymol (Fleisher and Fleisher 1988). In Israel, about 300 tons of this plant are commercially processed annually. The species is harvested during the dry season and is left in the field for 48 hours to dry after cutting. A combine harvester is used to separate the leaves from the stems and the leaves are then piled on thick plastic and left in the field to cure (Gardner 1989).

The leaves and flowering tops are used as a seasoning. The flavor is reminiscent of a blend of thyme, marjoram, and oregano, although sharper than these. In the Middle East, the dried herb is mixed with elm-leaved sumac (*Rhus coriaria* L.) and sesame seeds to form the spice blend *za'atar*, which is used, along with olive oil, as a topping for breads. Za'atar is sold in Israel and Jordan in shakers and is sprinkled on salads, gourmet cheeses, and barbecued steaks. According to Gardner (1989), a sample of za'atar imported from Lebanon Was inferior to that sold in Israel. It apparently contained thyme (*Thymus* spp.) instead of Syrian oregano. Talbert (1994) gives a recipe for za'atar. Bedouins grind the dried leaves, add salt, and eat the dry mixture on bread (Facciola 1990).

Live plants of Syrian oregano are available through some North American garden catalogs. The species is too frost-tender to be grown in most of northern North America, but can be grown as an edible houseplant.

Origanum × Majoricum Cambess.

Scientific (Latin) Synonyms

Origanum majorana L. *O. vulgare* L.

English Names

Italian oregano
Also: cooking oregano, culinary oregano, hardy marjoram

French Names

Marjolaine d'Italie (f)
[A French name was not found. The above name was suggested by H.S. MacKee (personal communication).]

This is probably a hybrid between *O. majorana* and *O. vulgare* subsp. *virens* (Tucker and Rollins 1989). It seems to combine the hardiness of oregano and the flavor of

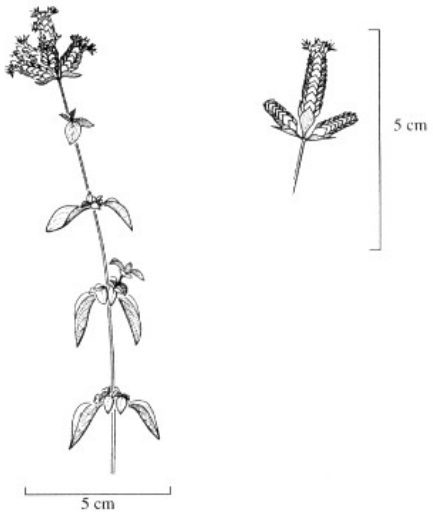


Fig. 284.
Italian oregano *(Origanum × majoricum)* prepared
by S. Rigby. (Based on greenhouse plant from Richters.)

marjoram (Facciola 1990). It is noted for its strong flavor. Italian oregano is known from several natural sites on the Balearic Islands as well as in Spain and Portugal (Ietswaart 1980). For many years it was grown in California gardens, misidentified as a strain of marjoram. A cultivar, Well-Sweep (from Well Sweep Herb Farm) is spattered with gold (Tucker 1990). Italian oregano is a much sturdier perennial than marjoram, forming a woody rootstock with flowering shoots that grow to 0.6 m tall. In California, plants have successfully survived-9°C (Rollins 1989).

Live plants of Italian oregano are offered through several North American garden catalogs, including a New Jersey strain called "variegated oregano," which has yellow-streaked leaves. Italian oregano might survive outside as far north as the warmest parts of Canada. Otherwise, in cold areas it should be treated as an indoor plant that can be placed outside during the warmer months.

Fig. 285.
Dwarf ginseng *(Panax trifolius)*,
from Engler and Prantl (1898).

Panax

Family: Araliaceae (ginseng family)

Genus Notes

Panax is a genus of perennial herbs, with two species in eastern North America and a very uncertain number, perhaps four or five, in Asia. The species are mostly in the temperate zone, but a southern form that has been called "*Panax vietnamensis* Ha & Grushv." occurs in central Vietnam (at latitude 15°N, altitude 1700-2000 m) (Nguyen 1994). In most plants of *Panax*, the unbranched, erect stems arise from a short rhizome and an elongated tuberous root. One-year-old plants usually have one leaf (with three leaflets), 2-year-old plants usually have two leaves, and thereafter the plants generally have three or more leaves, each made up of three to five (occasionally seven) leaflets. Mature plants of "*Panax notoginseng,*" discussed below, usually have a leaf with seven leaflets. *Prong* is an American ginseng grower's term for leaf. Plants may not flower for the first several years of growth. The subglobose, red or yellow, few-seeded fruit is usually referred to as a "berry." Technically it is a *drupe*, a type of fruit subtly distinguished from a berry. (In development, the fruit wall of a berry is entirely fleshy, while the inner fruit wall of a drupe is very hard.) All species of *Panax* are best adapted to the shade of hardwood forests. Clearcutting of virgin forests and overharvesting has drastically reduced the size of wild populations of the species.

In addition to *P. quinquefolius* discussed in detail below, *P. trifolius* L., is native to North America. This is called dwarf ginseng or dwarf American ginseng, a reference to its small size, usually under 20 cm in height. It is also known as ground nut, a reference to its subterranean root (other species, including the peanut, are also called ground nut or groundnut). Dwarf ginseng is distributed along the mountains from Quebec to Nova Scotia, and south into Tennessee, North Carolina, and northern Georgia. It does not appear to have the properties of herbal ginseng, and is not harvested or cultivated as is American ginseng. Proctor and Bailey (1987) note that it may have potential in a breeding program to improve American ginseng, since it has greater cold tolerance, light tolerance, and ability to grow in wetter soils, by comparison with its more famous cultivated cousin. That dwarf ginseng differs from all other species of ginseng is undisputed. As explained in the discussion of Asian ginseng, there is controversy about. the separability of all other "species" of ginseng.

In North America, wild sarsaparilla (*Aralia nudicaulis* L.) is a common woodland plant, distributed in much the same areas as the North American ginsengs mentioned above, that may be mistaken for the ginsengs. The American *Aralia* species that grow in the same region as the American species of *Panax* have their leaves borne alternately on the stem, not in a whorl as in *Panax*.

Siberian or Russian ginseng [also called eleuthero ginseng or just eleuthero, taiga root, Devil's bush (devil's bush), Devil's shrub, Russian root, spiny ginseng, touch-me-not, prickly eleutherococc, and eleutherococc] is *Eleutherococcus senticosus* (Rupr. & Maxim.) Maxim. [*Acanthopanax senticosus* (Rupr. & Maxim.) Harms] (Soejarto and Farnsworth 1978). Baranov (1979) coined the name "Ussurian thorny pepperbush," which has not attracted much attention. This species is native to eastern Siberia, Sakhalin Island, South Korea, Manchuria, and the Shansi (Shanxi) and Hopei (Hebei) Provinces of China. It is another member of the ginseng family (Araliaceae) alleged to have some properties similar to those of ginseng. Siberian ginseng is a prickly shrub up to 6 m tall, found in forests (forms without prickly spines also exist). Its roots and, less commonly its leaves, are used medicinally in China, Russia, and elsewhere. It was described as the mystery herb taken by Soviet athletes that allowed them to win the 1980 Olympics (Fulder 1980). It has also been purportedly taken by Russian cosmonauts during their space trips (Duke 1989). The alleged medicinal properties of the plant have been ascribed to compounds in the root called eleutherosides, which are aromatic glycosides (Farnsworth et al. 1985; Chandler 1988). Millions of Russians have consumed Russian ginseng in one or another form in the belief that it has desirable medicinal effects (Duke 1989). Siberian ginseng is available in North America as an imported herbal product, and the possibility of growing it in North America has been considered. Although not nearly as popular as ginseng; Siberian ginseng can be produced much more cheaply, has developed its own mystique of medical value, and therefore offers some competition for ginseng. Tyler (1994) concluded that "on the basis of existing evidence, its consumption as a tonic/adaptogen cannot now be recommended."

Siberian ginseng is the subject of the so-called "hairy baby" story (Farnsworth 1993).A 30-year-old woman self-medicated daily with "Siberian ginseng" capsules for 18

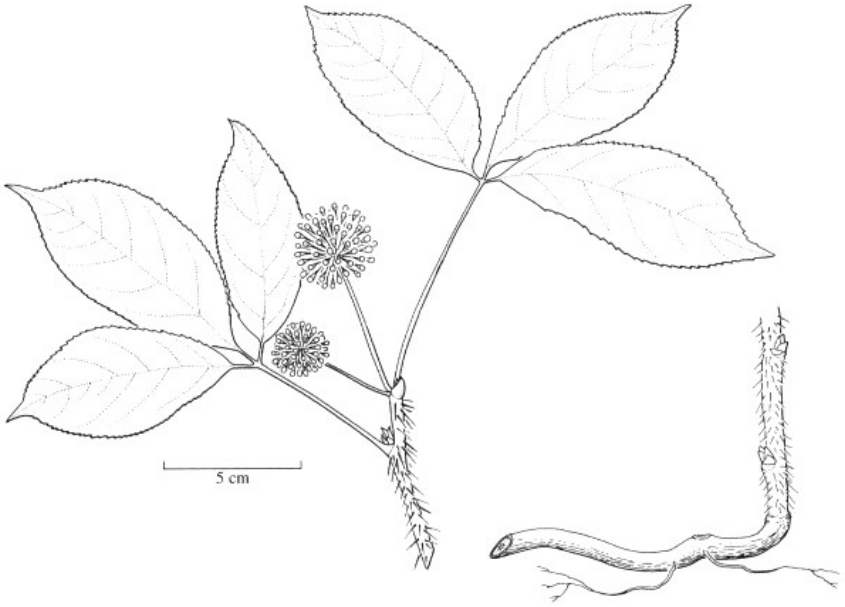


Fig. 286.
Russian ginseng *(Eleutherococcus senticosus)*,
flowering branch and portion of root with attached spiny stem, prepared by S. Rigby.
(Based on M. Johns & N. Taylor 7130 at Agriculture and Agri-Food Canada herbarium, Ottawa.)

months, including the 9 months of pregnancy. She gave birth to a baby boy with thick black pubic hair over the entire forehead, and with other symptoms suggestive of excessive male hormone production. However, it was subsequently determined that the tablets taken contained not Siberian ginseng, but another plant. As noted below for the "ginseng abuse syndrome," ginseng too has been falsely accused of toxic properties.

The term ginseng has been associated with at least 22 species, most of these fraudulently represented as ginseng to cheat customers (Hu 1976; Siegel 1979). One of these is canaigre, the root of *Rumex hymenosepalus* Tort., which has been deceptively marketed as "wild red American ginseng" and "wild red desert ginseng" (Tyler 1993*a*). In China, "woman's ginseng" (*dong quai*) is derived from the root of *Angelica sinensis* (Oliver) Diels, and is esteemed for regulating menstruation and expelling afterbirth (Schofield 1989).

The enormous literature on ginseng prompted Tyler (1993*a*) to comment "That too much has been written about ginseng is a gross understatement." Bae (1975) lists 1191 publications produced between 1687 and 1975, and since then the rate of ginseng publication increased dramatically. However, the emphasis has been on pharmacology and agriculture. It is certainly not true that too much has been written about the basic botany of the ginsengs. As noted below, there is abysmal ignorance at present of how many species should be recognized.

Warnings

(1) It has been suggested that those suffering from the following conditions should not consume ginseng: asthma, blood clotting problems, diabetes, cardiac arrythmia, emphysema, hayfever, and hypertension (see Medicine for other possible counter-indications). (2) Harvesting wild

ginseng in Canada and most localities in the U.S. is governed by legislation. Generally, wild ginseng in North America is endangered, and in most locations it is immoral, if not illegal to pick it.

Panax Quinquefolius L.

[Graham (1966) has pointed out that many authors treat the genus name *Panax* as neuter (so that the final of the two words in the binomial name, the specific epithet, ends in "um"), as did the Father of biological nomenclature, Linnaeus (1707-78). Lewis and Zenger (1982) argued that the International Code of Botanical Nomenclature (current at the time) made it mandatory to treat *Panax* as a neuter name (so that the binomial ends in "um"). However, the name is masculine in both Greek and Latin, and the specific epithet should agree [Article 62 of the present Code of Nomenclature (Greuter et al. 1994)].Thus *P. quinquefolius*, not *P. quinquefolium*, is correct.]

English Names

American ginseng
Also: Canadian ginseng, five-fingers (for the five leaflets), ginseng, man's health, North American ginseng, occidental ginseng, red-berry (red berry), sang (contraction or corruption of ginseng), seng, sheng, strawberry ginseng, ninsin (bastardization of the Japanese name for ginseng)
[Pronounce the "gin" in ginseng as in gin, the alcoholic beverage. See Curiosities for derivation of some of the above names.]

French Names

Family: Araliacées, famille de l'aralie
Ginseng (m)
Also: ginseng à cinq folioles

Description, Taxonomy and History

Panax quinquefolius has been collected in Canada from southern Ontario and southwestern Quebec as far west as Manitoba (Anderson et al. 1993). In the U.S., it is distributed from Maine to Minnesota to South Dakota, south to Oklahoma, Louisiana and northern Florida. McManus (1979) stated that American ginseng is known to have occurred in 32 states. The species is especially abundant in the Cumberland Gap area of southern Appalachia. It usually occurs in colonies. Once a seedling of American ginseng has become established, its life expectancy is greater than 20 years (Charron and Gagnon 1991). American ginseng is found in rich, shady, deciduous forests, in deep leaf litter, generally on damp but well-drained, sweet soils, frequently on northern or northeastern, cool, rocky slopes. The plants are 20-70 cm tall, with a whorl of three or four long-stalked leaves, each generally with five large leaflets, of which the upper three are larger than the two lower ones. In mid-summer, 6-20 small, yellowish flowers are borne on a short stalk. The fruits mature to a deep red color in the fall. Reproduction is entirely by seed. In nature, dispersal of seeds is by animals (including birds), and gravity. Stockberger (1953) states that the berries of northern plants have fewer seeds than those of southern plants, with southern plants often producing more than 300 seeds per plant, and usually showing three seeds in each fruits, while northern plants rarely develop more than 100 seeds, and usually have less than three seeds (commonly one) in each fruit. According to Emboden (1974), northern plants have green stems and produce buds very quickly on breaking above ground in the spring, whereas southern plants produce purple-green stalks, and develop buds only after the foliage is fully expanded. Also, western plants are relatively slender, with comparatively narrow leaflets.

The roots of ginseng have been likened to gnarled, shrivelled parsnips. The principal portion of the root of American ginseng is 1-3 cm thick, and 5-10 cm long (sometimes much longer), spindle-shaped, and often forked. The roots of older plants become branched and acquire prominent circular wrinkles. American ginseng may live as long as 50 or 60 years. Ginseng roots are slightly aromatic, and have a sweetish, somewhat bitter taste. According to Williams (1973), western plants usually have long, thin roots with undesirable qualities, while plants from northern areas, particularly Wisconsin and New York, have roots of good size, weight and shape, and provide the best breeding stock; Bailey (personal communication) disagrees with this assessment. Cultivated roots are usually heavier and more uniform than wild roots, but are less valuable in commerce (Williams and Duke 1978).

Wild American ginseng was apparently used by many Indian tribes for increasing the fertility of women, as a tonic to increase mental powers, and to treat headache, cramps, fevers, rheumatism, and cough (Goldstein 1975; Staba and Chen 1979). However, as pointed out by Lewis (1986), Amerindian use of ginseng is controversial. According to Duke (1989) it is certain that Amerindians used ginseng in pre-Columbean times, but unclear which uses were acquired from visiting Europeans.

The commercial significance of American ginseng was not discovered until after knowledge of Asian ginseng was disseminated to the West. Asian ginseng was fast described in western literature in 1714 by Père Jartoux, a missionary

Fig. 287.
American ginseng *(Panax quinquefolius)*, prepared by B. Brookes.

in China. Jartoux conjectured that ginseng would be found in similar habitats in North America, and this information was transmitted by the Jesuits in Pads to their Canadian outposts. In 1704, Michael Sarrazin (or Sarrasin), the King's Physician to Canada, discovered American ginseng in Quebec, and brought some roots to Pads. However, not until Father Lafiteau, a Jesuit priest and missionary among the Iroquois in Quebec, read Jartoux's paper, and discovered American ginseng near Montreal in 1716, did trade in the New World species begin. By 1718 the Jesuits were shipping dried roots to China. In the early 1700's, ginseng became second only to fur as a trading commodity between New France and China. During the middle of the 18th century, after serious depletion of local ginseng populations, very inferior material was shipped from Canada to China, resulting in a bad reputation for Canadian exports, and cessation of Canadian trade with China. The problem was that roots were dug out of season, hastily harvested, and improperly dried rapidly in ovens, rather than by the time-honored method of air drying. The Canadian trade was replaced by roots obtained in the U.S. The years 1858-1896 have been described as a "green gold rash," as Americans took advantage of the Chinese interest in American ginseng (Williams 1972). In 1860 alone, over 270,000 kg of dried roots was exported from the New World. The practice of harvesting wild ginseng in North America has continued to the present, especially by rural people in southern Appalachia, who gather the roots for shipment to Asia and Europe. Overcollection has made *P. quinquefolius* rare as a native wild plant.

Attempts to grow ginseng in Wisconsin in the late 1870's failed because of disease (Harrison et al. 1992). Ginseng was first successfully cultivated in the U.S. in 1880, in New York (S.-K. Hong 1978). Ginseng farms increased rapidly from 1900 to 1920, particularly in Wisconsin, Michigan, Ohio, and Minnesota (S.-K. Hong 1978). American ginseng was first cultivated in Canada about 1890, in Ontario (Proctor 1984), but only commonly since the 1930's. Cultivation in British Columbia started in 1982 and the province has rapidly become a dominant centre of ginseng production in North America (Proctor 1992). North American plantations were generally abandoned during the Second World War, but have resumed vigorously since 1965. Until recently, ginseng products in North America mostly contained imported Asian ginseng, but North American-grown American ginseng is rapidly becoming popular as well in North America. American ginseng has recently begun to be grown extensively in China (Ye et al. 1991).

Appendix II of the Convention on International Trade in Endangered Species (CITES) requires countries to show that exporting indigenous ginseng will not endanger its survival. In 1988, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed ginseng as "threatened." At the time, wild ginseng from Canada was only being collected and exported from Ontario. In 1989 export of wild ginseng was officially discontinued from Canada pending evaluation of the magnitude of the threat to wild ginseng's survival (Haber 1994). In the U.S., collection and sale of wild ginseng are subject to registration, permits, and an official season. In areas of the central and southern Appalachian Mountains and the Ozark Plateau in the U.S., American ginseng continues to be collected from the wild (Lewis 1986). Overharvesting in the mid-1970's led to ginseng being defined as an endangered species, and by

Fig. 288.
American ginseng *(Panax quinquefolius)*,
from Curtis (1787-present; # 1333).

1992 18 states required licences for its exportation (Harrison et al. 1992). In accord with CITES regulations, all states are required to monitor all ginseng gathered wild or cultivated for export within their borders (Persons 1994).

Uses

Although employed for culinary purposes, American ginseng is used mainly in Asian countries and by Asian immigrants to Western countries in the belief that it has medicinal properties. It is commonly believed that ginseng has amazing healing properties, provides energy, lowers blood pressure, retards the aging process, cures neurological disorders, speeds recovery from sickness, and is an aphrodisiac. The reputation of ginseng as a health herb has also been the main reason for non-Asians to take up the regular use of ginseng. Ginseng itself is somewhat bitter, although an acquired taste for it often develops. Duke (1989) described how out of curiosity he ate some chunks of freshly dug American ginseng that he had boiled for tea. He found that the pieces that didn't have the bitter peel attached tasted a little like new potatoes.

Ginseng is employed orally in capsules (rarely pills), as a tea, broth, powder, or masticatory (gum), and topically as a tincture and ointment. It is also often used simply as dried strips or slices of root. Ginseng is sometimes incorporated in such consumer goods as soft drinks, candy, jams, hair tonic, shampoos, and facial creams.

Chinese herbal medicine is based on the concept of *yin* and *yang* forces of Daoist herbal theory (Hsu 1979). Yang represents masculinity, strength, and heat, and yin by contrast is feminine, mild, and cold. Ginseng is generally considered yang food. However, American ginseng is "yin of the yang," and is considered good for the respiratory or digestive system to "reduce heat." The "cooler" American ginseng also is considered more desirable in hot climates. American ginseng supposedly also has more aphrodisiac effect.

Recipe Sources

Durden (1992) and Lee (1992) provide culinary recipes for ginseng. Also see recipes for Asian ginseng, discussed below.

Importance

Statistics on ginseng production and value are relatively difficult to obtain, and estimates provided by various sources often differ. Ference et al. (1988) estimated word production of ginseng at 5,132 t, worth $443 million (CAN) in 1987, with China producing 2,520 t in 1987 (about one-half of world ginseng production), followed by South Korea with about 1,639 t. Ginseng is the world's most widely used medicine, a consequence of its popularity in Asian, especially Chinese medicine. The market for ginseng extends throughout Asia, and there is minor usage as well in western nations. Five to six million people in the U.S. alone use (mostly imported) ginseng regularly (Chandler 1988); ginseng sales are greater than $40 million per year in the U.S. alone (Bailey, personal communication); perhaps 20 million people in Western nations have used ginseng (Duke 1989).

Historically, ginseng (mostly Asian) has fetched absurdly inflated prices - on occasion, thousands of dollars a kilogram. A supposedly 600-year-old root found by a farmer near Beijing in 1993 reportedly sold for $282,000.00 (Schreiner 1994). Hong Kong is the exchange center of international commerce in American ginseng (But and But 1984), and substantial profits are made there. American ginseng obtains a higher price than Asian, older material a higher price than younger, and wild roots a higher price than cultivated. For wild roots, those that are man-shaped are especially desired in eastern culture. Ginseng brokers and graders are expert in distinguishing the value of different kinds of root.

The major centres of cultivation of American ginseng today are in southern Ontario, British Columbia, and Wisconsin [mostly Marathon County, where more than 90% of U.S. ginseng is grown (Harrison et al. 1992)]. In Canada, ginseng is also raised in Quebec, Nova Scotia, New Brunswick, Prince Edward Island, and Newfoundland (Wallis and Dickieson 1996). In the U.S., ginseng is also grown in Kentucky, North Carolina, Tennessee and other states (English 1985). About 545 t were produced in 1991 in Wisconsin (Proctor 1992) and, according to Wallis and Dickison (1996), the 1995 crop was almost as large as Ontario's (see below). In recent years, dried wild roots from Canada have sold for as much as $200.00(CAN)/kg, while cultivated roots have sold for about $50.00 (Haber 1994). In 1991, about 295 t were raised in Ontario (Proctor 1992), worth an estimated $35,000,000.00(CAN). The center of ginseng culture in Ontario is in Brant and Norfolk counties (Cronin 1982). Wallis and Dickieson (1996) reported that in Ontario 380 growers using over 2,000 ha harvested about 1 million kg with a farm-gate value of $80 million - amounts notably more than reported for all of Canada in previous years (see below). Recent estimates of tonnage produced by Ontario are: 1992: 340, 1993: 414, 1994: 544, 1995:743 (N. Charest, personal communication). In British Columbia in 1992, about 109 t of root worth about $13,000,000.00 were produced, as well as about 25 t of seeds, worth about $5,000,000.00 (BCMAFF 1993). According to Schreiner (1994), the 1993 British Columbia harvest was expected to have a net value to growers of

$28,000,000.00(CAN), and the crop could have a value of $60,000,000.00 by 1998. Recent estimates of tonnage produced by B.C. are: 1993: 242, 1994: 320, 1995:442 (N. Charest, personal communication). Wallis and Dickieson (1996) estimated the B.C. industry as amounting to about 1200 ha and 130 growers. About three-quarters of recent production has been shipped to Hong Kong. Canadian production is decidedly on the increase. Canadian ginseng exports, which represent 85-90% of production, have been reported as follows (Fisher 1994):

Canadian Annual Ginseng Production Statistics.

Year	Quantity kg	Value $ Canadian
1988	141,149	14,805,000
1989	122,392	11,994,000
1990	212,123	20,827,000
1991	128,335	14,132,000
1992	323,681	33,837,000
1993	346,992	31,930,000

The amount of ginseng imported to the U.S. about equals the amount of American ginseng exported (Harrison et al. 1992). Exports are as follows (Dull 1994b, 1995):

American Annual Ginseng Production Statistics.

	Cultivated		Wild	
Year	Quantity kg	Value $ U.S.	Quantity kg	Value $ U.S.
1988	384,299	38,299,800	63,965	11,666,900
1989	1,070,267	54,299,600	92,280	18,876,000
1990	997,661	69,755,800	67,592	12,114,500
1991	585,945	62,059,900	60,672	13,583,600
1992	755,105	80,102,300	100,272	24,452,400
1993	714,991	57,426,800	69,639	21,770,100

b

Hsu (1979) presented the following information as to why American ginseng is often preferred in the Asian market in comparison with Asian ginseng. American ginseng has a sweeter taste, preferred by the Chinese, as well as a pleasant aroma.

Imported American ginseng also has acquired a reputation for high quality. According to Bailey (personal communication), relative preference for American and Asian ginseng varies according to locale.

Fig. 289.
American ginseng *(Panax quinquefolius)*,
from Lamarck and Poiret (1791-1823).

Persons (1994) notes that American ginseng is being experimentally cultivated in Germany, Switzerland, Sweden, Italy, Belgium, Australia, New Zealand, and Chile, and that about 200 ha are under cultivation in China. China produced an estimated 80-100 t of American ginseng dried roots in 1995 (N. Charest, personal communication).

Cultivation Notes

Soil

In nature, ginseng grows best in well-drained, porous soils with a topsoil rich in humus formed from hardwood and other leaf litter. In cultivation as well, ginseng develops best in well-drained loam rich in organic matter. Clay loams and sandy loams are suitable for ginseng (Thompson .1987), although soils high in clay tend to remain wet, which could lead to fungal problems. Very sandy soils tend to result in hard, inferior roots (Williams 1973). In commercial .practice, well-tilled raised beds of soil are prepared, allowing room for machinery (particularly sprayers and diggers) and walkways between the beds. Soil pH is best in the range of 5.5 to 6.6 according to Thompson (1987); 5.0-6.0 according to Castleman (1991); near 5.5 according to Harrison et al. (1992). In western North America (British Columbia, Washington, Oregon), much more alkaline soils are used to grow ginseng than in eastern North America (Bailey, personal communication). Soils in which American ginseng has been collected in Kentucky have ranged from

a pH of 4.5 to 7.4 (Proctor and Bailey 1987). Anderson et al. (1993) collected ginseng in Illinois on soils ranging in pH from 4.4 to 7.3. According to Duke (1989), the nutrients that ginseng needs are available in the pH range 5.0-6.7. Fertilization of ginseng is somewhat controversial. The traditional view is to minimize mineral fertilization, in order to grow hardy roots that resemble wild-grown material. However, calcium may be important for production, and boron may be necessary to prevent "rusty root" disorder (English 1985). Fertilization with phosphorus, potassium, magnesium, and sulfur may also be important, and low annual addition of nitrate can benefit plant growth (Thompson 1987). Well-composted manure is often added to soil a year before it is used to grow ginseng. A good discussion of fertilization requirements is found in Harrison et al. (1992).

Climate

According to Harrison et al. (1992), ginseng thrives in a climate with 100-125 cm of annual precipitation and an average temperature of 10°C. Ginseng is adapted to a cool growing environment, and winter chilling is required to break dormancy of the overwintering bud produced at the apex of the rhizome (Konsler 1987). American ginseng seeds survive a temperature of-15°C, while roots will tolerate temperatures as low as -10°C (Proctor 1984). A mulch of about 15 cm greatly helps ginseng to survive winter cold.

Depending on solar irradiance regime, American ginseng thrives in 3/4 shade [even more in relatively southern regions, according to Williams and Duke (1978)]. The deep shade requirement usually necessitates provision of special shade gardens. Both panels of wood slat and synthetic fabric, commonly black polypropylene shade fabric, have been used to provide shade. Williams and Duke (1978) recommended against burlap or muslin, which interfere with air circulation (so does polypropylene), and burlap and muslin are rarely used today. Williams and Duke (1978) advocated that lath should run north to south to provide alternating sun and shade to the plants. Shade housing needs to be erected early in the season, and taken down in the fall. Commercial synthetic fabric systems have a major advantage over traditional wooden lath in that they can easily be put up in the spring and removed in the fall. Excess sun bums leaves, reduces yields, and eventually kills the plants (English 1985).

Propagation and Cultivation

American ginseng has often been grown directly in shady woodlots, using woods to provide a natural canopy of shade. Although ginseng will survive under coniferous trees, in general deciduous, hardwood woodlots are preferred (Duke 1989). Konsler (1987) advises that shallow-rooted trees like maples offer serious competition for soil moisture and nutrients, and should be avoided. Williams and Duke (1978) recommended a site with tall trees but little undergrowth. Increasingly, culture under artificial shade is being adopted commercially on a world-wide basis (Proctor and Bailey 1987). When cultivated, the attempt is made to simulate the natural habitat of the plant; for example, mulch is used to emulate natural leaf litter; and sloping fields or, more commonly, raised beds are used to provide good drainage, promoted in nature by sloping soils and the drying, aerating effect of tree roots. Shade, a soil rich in organic matter, mulch, and a cool, moist environment are provided. Fields in which ginseng has previously been grown, or where root knot nematode infestations have occurred, are avoided.

The "mature" seeds of ginseng contain undeveloped embryos, which require a year of moist storage, including cold-stratification (3-4 months of exposure to cold temperature), to mature (after-ripening can be hastened somewhat by using gibberellic acid or other plant hormones). Ginseng seeds seem to have a "double dormancy," first requiring maturation of the embryos, and second requiring exposure to cold temperature in the winter following planting (Thompson 1987). This means that unless gibberellin treatment is used to overcome dormancy, 18 to 22 months are required from the time seeds are harvested to the time they germinate [i.e., if stratified and planted immediately after harvest, they will germinate in the second subsequent spring; but see Duke (1989) for discussion of techniques for achieving germination in 6 months]. Seeds of ginseng must never be allowed to become dry, as they quickly lose viability. Usually in commercial practice, berries are harvested in year 3 and subsequently (when seed prices are high, berries are often harvested in year 2). Seeds are commonly removed from the berries by either of two methods. First, a burlap bag of berries may be kept moist, allowing the berries to ferment for 5-10 days (sometimes longer), after which the fermented pulp easily separates from the seed. Second, seeds can also be separated using a depulping machine. The seeds are cleaned and mixed with sand, and buried for a year before planting. Seeds are preferable to root cuttings for propagation because the latter are often diseased. Generally following stratification, seeds are sown in the fall for spring germination.

Ginseng is subject to several fungal diseases, including *Altenaria* leaf and stem blight, *Phytophthora* root rot and foliar blight, seedling damping-off caused by *Pythium* and *Rhizoctonia*, and rusty root (Harrison et al. 1992). To avoid these, the seeds may be disinfected in a solution of one

part chlorine bleach and nine parts water for 10 minutes (Castleman 1991). Commercial growers now use a variety of chemical treatments to disinfect seed. Good air circulation is considered crucial to minimize diseases (Harrison et al. 1992).

Seeds are planted 1.5-2.5 cm deep. In cold areas, the soil covering planted seed should be protected with straw mulch. The crop may be directly seeded, or 1-year-old plants may be transplanted from a nursery bed. The roots are usually harvested during the third or fourth years, this time required to produce marketable roots because of the extremely slow growth, not surprising in view of the fact that the plant thrives in deep shade. Roots grow more rapidly when plants are not permitted to set seed.

Transplantation is very rare in North American commercial production. Roots can be transplanted in the fall, after the tops of the .plants have begun to die back, but before the ground becomes frozen. Harrison et al. (1992) recommend planting the roots at an angle of 39-45° from the vertical, with the crown of the roots buried under 2-2.5 cm of soil, followed by a straw mulch of up to 13 cm in cold climates to prevent frost heaving.

Nematodes may need to be eliminated from soil before planting using short-lived pesticides. White grubs and wireworms may also attack the roots. Once planted, use of pesticides to control diseases is problematical in view of the possibility of leaving residues; nevertheless, use of common insecticides occurs, and in any event insects are usually not a major problem in ginseng. Voles and field mice sometimes feed on ginseng roots. Weeding is generally done by hand, to avoid the use of herbicides [Harrison et al. (1992) note the use of Fusilade 2000 as a herbicide in the U.S.]. Hand weeding is slow and expensive, but herbicides generally kill the ginseng. Fungal diseases can be treated with a limited number of fungicides (local regulations need to be consulted). Only a few chemicals are registered for use on ginseng in Canada and the U.S. (Proctor et al. 1990; Fisher 1994.).

As a rule, ginseng is rarely replanted in the same soil. Ginseng grown on the same land tends to die off in 2 or 3 years. The pathogens responsible have not been clearly identified (Roy and Reeleder 1994). The "replant problem" is a mystery and receives little attention (Bailey, personal communication). Wallis and Dickieson (1996) reported that about 30% of the crop is lost to disease even when ginseng is not replanted in the same soil.

Curran (1983) and Curran and Curran (1985) provide detailed information important to the growing of ginseng. Duke (1989) also furnishes considerable information. Provincial and state extension services and ginseng production and marketing organizations where ginseng is cultivated also can furnish useful, updated information. Oliver et al. (1990) is an outstanding guide to the cultivation of ginseng in British Columbia. Harrison et al. (1992) is an excellent guide to cultivating ginseng in Wisconsin and adjacent areas.

Harvest and Storage

Roots are dug up in the fall, after the tops have died down, anywhere from the third to the seventh year, depending on market conditions and growth achieved. Roots must be excavated carefully, with their natural branches intact. In commercial practice, modified potato diggers are often used. Williams and Duke (1978) stated that the best quality roots break with a somewhat soft and waxy fracture, while (depending on drying technology) young or undersized roots may dry to become hard and glassy, and therefore less marketable. The roots need to be washed and handled carefully, because natural coloring, markings, and branching affect price. Roots should not be scraped or scrubbed. Lewis (1987) found that when roots were air-dried a reduction in weight of 72% occurred due to loss of water. A well-documented rule of thumb that ginseng growers use is that the dry weight of the crop will be about 1/3 of the fresh weight. Commercial drying of ginseng is today usually carded out using well-engineered dryers specifically designed for the purpose. Generally, drying temperature is about 39°C, with a maximum drying time of 14-16 days (Bailey, personal communication). Dried roots are stored in cardboard barrels in a dry, airy, rodent-proof location.

Yield of dried 6-year-old root from beds may be of the order of 3 kg/m^2 (Williams 1973).At harvest, well-managed plantations average about 2.24t/ha dried roots at harvest (Williams 1973), or 1.80-3.05 t/ha (English 1985). Some experienced growers have obtained exceptional yields of 4.26 t/ha (Thompson 1987). There are about 330-550 dry roots in a kg, the average root weighing about 2.3 g (English 1985). About 170-280 kg/ha of seeds may be produced annually [English 1985; much higher yields are typical in British Columbia (Bailey, personal communication)].

Example Cultivars

"There are no cultivars of [American] ginseng" (Proctor and Bailey 1987). "No improved varieties have been developed" (Harrison et al. 1992).

Additional Notes

Chemistry

Ginseng's alleged virtues are believed to be due to a large variety of root triterpene saponins called ginsenosides, panaxosides, or panaquilins (Lewis 1986). These occur in the aerial portions of both American and

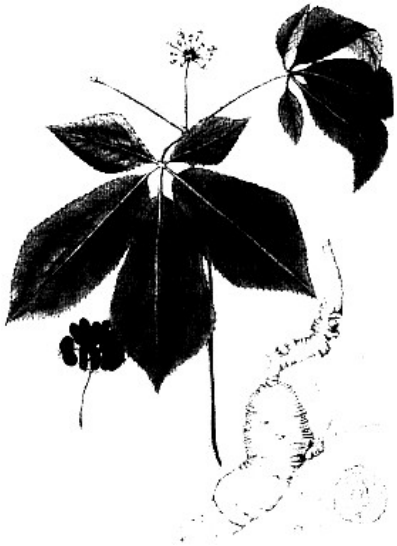


Fig. 290.
American ginseng *(Panax quinquefolius)*,
from Millspaugh (1884-1887).

Asian ginseng, as well as in the roots, although by tradition only the roots are used in commerce (Lewis 1986). The nomenclature of these chemicals can be confusing since some of the compounds were independently isolated in American and Asian ginseng by different groups of investigators, who gave the same compound different names (Tyler 1993*a*). The ginsenosides of American ginseng were recently studied by Li et al. (1996).

Medicine

The therapeutic value of ginseng (both American and Asian) has been a subject of continuing controversy, with western scientists generally rejecting the claims of Asian medicine that ginseng has manifest benefits in the treatment of numerous illnesses. The widespread use of ginseng as an aphrodisiac, and the historical folk-medicine tradition with which ginseng has been employed, have contributed heavily to the lack of respect for this herb by western medicine. However, as with acupuncture, there seems to be an increasing interest in the western world in assessing the medicinal potential of this ancient treatment. In the U.S., ginseng is classified by the Food and Drug Administration as a "generally recognized as safe" (GRAS) food (Harrison et al. 1992).

A wide variety of physiologically active compounds occur in ginseng root, and many reputable scientists have come to believe that at least some of the physiological effects may be beneficial in some circumstances. Ginseng has been said to enhance digestion; stimulate blood circulation; relieve fatigue, nervous disorders, and blood diseases; and in general have a stimulating tonic effect. Such results could conceivably derive from one or more of the active principles of ginseng, which have specific effects on the human body. Panaxin is a brain and cardiovascular stimulant. Panoxic acid affects metabolism and aids heart and blood vessels. Panaquilon stimulates endocrine secretion and raises blood hormone levels. Panacen kills pain and tranquillises the central nervous system. Ginseng lowers sugar content of blood, and there is some evidence that it may be employed to treat anaemia, diabetes, insomnia, neurasthenia, gastritis, and various other debilities.

Additional medicinal information furnished below for Asian ginseng is for the most part likely also applicable to American ginseng, although the different chemistry of ginsengs may be related to different medical properties.

Nutrition

Duke (1985, 1989) provides an analysis of American ginseng root nutrients. Included are small amounts of most common vitamins and minerals, but not in sufficient quantities that ginseng can be considered a good source of these nutrients.

Curiosities

• The genus name *Panax* comes from the Greek *pas*, all, and *akos*, cure; or *panakes*, all healing, referring to the medicinal properties of the ginseng plant (Chandler 1988). Panacea was a goddess in Greek mythology who could heal all diseases, and who found a remedy for maintaining good health (Chandler 1988).

• The name ginseng, first applied to Asian ginseng (*P. ginseng*) is derived from the Chinese *ren-shen* (in standard Chinese piryin) [also rendered *jen-sheng, jin-hsien, shen seng,* and *shinseng* (Chandler 1988)]. This is usually translated as (1) "man-shaped root," but according to Hu (in Baranov 1966) is better rendered as "man-essence;" the name originates from (a) the fancied resemblance of ginseng root to the human form, or (b) from the belief that the root represents the essence of the earth crystallized in a human form. Interestingly, an American Indian name for *P. quinquefolius, garantoquen*, also means man-like (Grieve 1931).

• The name seng (= 'seng) is the romanized version of a Chinese word for "essence." The word seng is used by

Chinese medicinal plant diggers for the fleshy underground portion of many plant species (Hu 1976).

• The Pawnee used the roots of American ginseng, along with other plant substances, as a love charm (Wilson 1963).

• The Jesuits realized in the early 18th century that trade in American ginseng with China was extremely lucrative, and so they attempted to keep this trade secret. However, just why the celibate fathers were taking such an unusual interest in a certain low-growing herb rumored to be an aphrodisiac attracted attention, and eventually the secret leaked out (Castleman 1991).

• Ginseng has a "contractile root" - a kind of root possessed by many perennial herbaceous species, which is designed to pull the root down into the ground. This is necessary to maintain the growing tip, which regenerates the stem each year, at ground level, where it is protected. Were it not for the contractile root, each season the growing rhizome would extend the growing tip higher into the air. To counteract the vertical growth of the rhizome, the ginseng roots contracts yearly at the same rate at which the rhizome grows upward, pulling the plant downward (Emboden 1974).

• In 1788 Daniel Boone (1734-1820) collected about 13.6 t of ginseng roots in what, is now West Virginia and Kentucky to sell in Philadelphia (Emboden 1974). At a typical 18th century price of 10 cents/pound, this would have fetched about $3,000.00, an enormous sum of money in the 1780's (Kimmens 1975). Unfortunately while transporting the ginseng in a boat, the ginseng was damaged by flooding, and had to be redried. Adding to Colonel Boone's woes, during the delay required to dry the ginseng again the price of ginseng in Philadelphia fell (Kimmens 1975).

• In 1908, Mr. L.J. Wilson of Pennington Gap, Virginia became totally exasparated at the prospect that the thieves who had robbed his ginseng garden the previous 2 years would return. He set up a series of shotguns with fine trip wires in his garden, with the result that a thief was shot to death and his companion wounded. A coroner's jury exonerated him from criminal blame (Hardacre 1974).

• The largest wild ginseng root collected was found in woods near Benzonia, Michigan by Custer Higgins; it weighed 1.2 kg (Hardacre 1974).

• The fable is told about the man who was arrested for selling a ginseng preparation allegedly adding years to one's life. The charlatan, it was found, had been arrested for the same offence before - in 1870, 1910, 1949, and 1975 (Cronin 1982).

• Duke (1985) recorded the curious situation of the U.S. Food and Drug Administration approving the addition of water to ginseng, but not ginseng to water. The latter would technically make ginseng a food additive or drug, uses that were not approved.

• John Latta, a Vancouver real estate developer who started the lucrative cultivation of ginseng in British Columbia in 1982, was inspired to do so while on a trip to Wisconsin. There, he observed "a bunch of farmers, each farming an acre or two, and all driving Mercedes" (Schreiner 1994).

Problems and Potential

Ginseng farming has been extravagantly advertised as a "gold mine." Ginseng itself has been described as "green gold" by one author (Persons 1986), and by another as "worth its weight in sterling silver" (Paseador y Barrios 1901). While large profits are possible given the reliable oriental market, there are many difficulties in raising ginseng. According to Proctor (1984), the limiting factor in ginseng cultivation is root rot. The slow growth, demanding cultural conditions, fungal diseases, rodent predation, and growing competition make ginseng farming a challenging occupation. Ginseng requires considerable capital investment, and a high commitment of time and labor for successful commercial production. According to Harrison et al. (1992), ginseng growers typically invest $50,000.00 (U.S.)/ha and 1500 hours of labor and get no return on their investment until the third or fourth year, and sometimes do not break even for 10 years. Depending on supply and demand, prices that growers receive fluctuate from year to year. Ginseng is a risky crop to grow, and the rapid growth of the industry in North America in recent years could lead to a drop in prices as supply increases.

Growing ginseng involves planting, weeding, mulching, collecting of seeds, harvesting of roots, erection of lath in the spring, and storing of the lath during the winter. A large plantation can employ 25-125 people at peak times (Lindsay and Cruice 1975). This labor intensive industry is useful in addressing the problem of unemployment (labor shortages are very common in the industry - Bailey, personal communication).

There has been speculation that the U.S. and Canada are close to saturating the ginseng market in China (English 1985). This hasn't happened yet, but it seems to be the case that crops that prove to be attractive are inevitably grown up to and beyond the point of market saturation.

Selected References

Duke (1981); Evans (1985); Konsler (1987); Proctor and Bailey (1987); Duke (1989); Oliver et al. (1990); Harrison et al. (1992); Bailey et al. (1995); Li (1995).

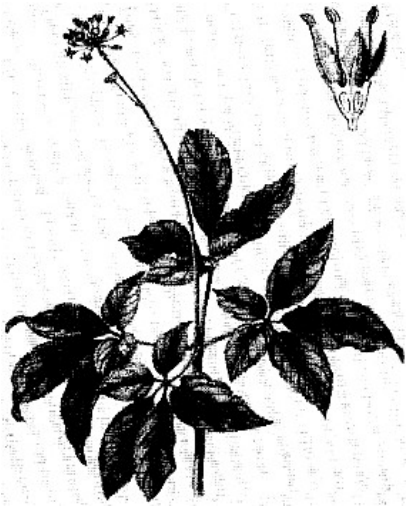


Fig. 291.
Asian ginseng *(Panax ginseng)*,
from Engler and Prantl (1898).

Panax Ginseng C.A. Mey.

Scientific (Latin) Synonyms

P. schinseng Nees

English Names

Ginseng, Asian ginseng, Oriental ginseng
Also: Asiatic ginseng, Chinese ginseng, heal-all, Kirin ginseng, Korean ginseng, life root, man root, red ginseng, root of immortality, Tartary ginseng, Tartary root, white ginseng
[In Hong Kong, the center of ginseng commerce, ginseng from North America is called American ginseng, while commercial ginsengs from China, Korea, and Japan are simply called ginseng. However, Chinese use the name Chinese ginseng, while in Korea ginseng is commonly called Korean ginseng. These names are reminiscent of such phrases as "British Columbia apples" or "Oregon apples," but are often used as if they reflected quite distinct kinds.]

French Names

Ginseng (m)
Also: ginseng de Tartarie

Description, Taxonomy, and History

Asian species of *Panax* are found over a large area, from longitude 85°E in Nepal to 140° in Japan, and from latitude 22°N in Vietnam to 48° in eastern Siberia (Hu 1978; as pointed out above, "*Panax vietnamensis* Ha & Grushv." occurs in central Vietnam, at a latitude of 15°N). The Asian species of *Panax* are poorly delimited and require study. There is no single character that can be reliably used to separate any of the Asian species that have been recognized (Hara 1970). Indeed, all of these could conceivably be combined into one polymorphic species, whose name would be *P. pseudoginseng* Wallich. [The word *pseudoginseng* in the species name *P. pseudoginseng* was coined by Wallich in the mistaken belief that he had found a new ("false") species of ginseng. The name is considered offensive in Asia (Bailey, personal communication), but its usage is determined by the Code of Botanical Nomenclature.] In fact, many authors have used this name to refer to all of the cultivated Asian ginseng (e.g., Bailey and Bailey 1976). However, most botanists follow Hara (1970) in assigning the bulk of Old World commercial ginseng plants to *P. ginseng*, as well as most wild plants of North Korea and northeastern Asia (southern and eastern Manchuria, and Ussuri), as is done in this discussion. The name *P. pseudoginseng* is commonly used to refer to a very variable species, often called san-ch'i or tienchi ginseng, found in different areas of Asia (but see comments on sanchi ginseng, below). Wallich (1831) first described *P. pseudoginseng* as "*P. pseudo-ginseng,*" and this hyphenated form of the name is widely encountered. However, the rules of botanical nomenclature require deletion of hyphens in specific epithets unless the two words so joined normally are independent, such as in *Aster novae-angliae* L., the *New England* aster. Wallich illustrated his new species, and his figure is reproduced here as Fig. 292. Wallich's species differs subtly in rhizome and leaf characters from *P. ginseng*. Sometimes Japanese ginseng, *P. japonicum* C.A. Meyer, is included as a subspecies of *P. pseudoginseng* [as *P. pseudoginseng* subsp. *japonicus* (Nees) Hara]. *Panax ginseng* and *P. pseudoginseng* allegedly differ in kinds of ginsenoside present (Ham 1970; Yang 1981). The Japanese subspecies of *P. pseudoginseng* (subsp. *japonicus*) has been said to possess a distinct group of saponins called chikusetsusaponins (Chandler 1988). It is unclear to what extent *P pseudoginseng* and other Asian "species" besides *P. ginseng* are grown for commercial ginseng, since it is unclear how to define these species. Since the Asian species are controversially separated from each other, and indeed from American ginseng, it is difficult to interpret studies showing different chemistry for some Asian forms of ginseng. While there do seem to be geographical

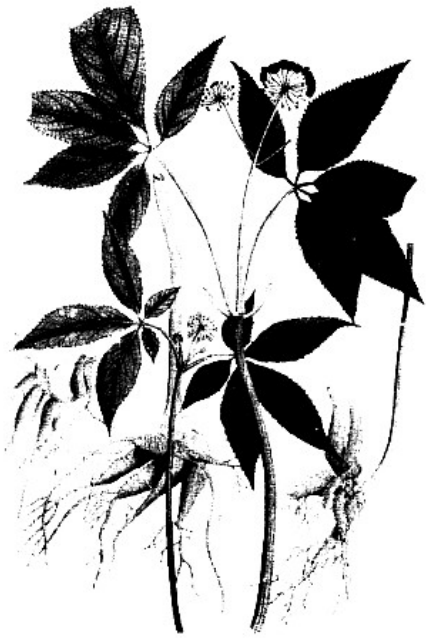


Fig. 292.
Panax pseudoginseng, from Wallich 1831.

differences in chemistry, taxonomic studies of this variation is too limited at present to associate these differences with given "species."

According to Hu (1976), there are several species of Asian ginseng, including *P. pseudoginseng* discussed below, that are called *san-ch'i* (often rendered *sanchi*, best called *sangi*), literally "three-seven," a name that arises from possession of three (or four) leaves each with seven leaflets. (Most leaves of mature ginseng plants have five leaflets. Asian forms that usually have seven leaflets exist, but their status requires study.) Other Chinese names for sanchi ginseng are *tianchi* (more properly *tiangi*) and *jin bu huan* (Bailey, personal communication). The roots have been used in Chinese medicine. Duke (1985) refers to sanchi ginseng as *P. notoginseng* (Burkill) Hoo &Tseng. (= *P. wangianus* Sun; as noted above, the name *P. pseudoginseng* is considered to be an offensive terminology when applied to *P. notoginseng*.). "*Panax notoginseng*" is widely avaiable in Southeast Asia, Japan, Korea, and elsewhere in Asia. In China, it is commonly known as South China ginseng. Duke (1985) notes that it has been introduced into Chinese medicinal shop in the U.S. and Europe. It has a higher content (7-10.8%) of crude saponins (the chemicals of interest in ginseng) than the normal ca. 4% found in Asian ginseng (Tyler 1993*a*). A recommended form of internal consumption has been in chicken soup, and it also distributed and consumed as a tea, powder, capsules, drinks, and extracts. It is expensive, and Duke (1985) suggests that chicken soup alone may be as valuable medicinally. Large amounts of "*P. notoginseng*" are cultivated in Yunnan Province of China (Bailey, personal communication).

Panax ginseng occurs in northeastern China and in Korea. It has been exterminated in the Chinese provinces of Shansi (Shanxi) and Shensi. In northeastern China the species is found in high-mountain, mixed forests of deciduous and coniferous trees. *Panax ginseng* is not only difficult to distinguish from other Asian species of *Panax*, it is also extremely similar in appearance to *P. quinquefolius* (American ginseng), although attempts to date to hybridize the two species seem to have been unsuccessful (Duke 1989).According to Bailey and Bailey (1976), the fruit of American ginseng is about 6 mm long, while that of Asian ginseng is about 12 mm in length. Graham (1966) reported that the species can be distinguished by the slope of the base of the leaflets and the degree of persistence of the fleshy or membranaceous scales at the base of the stem. According to Emboden (1974),Asian ginseng is most characteristically distinguished from American ginseng by the corrugated seeds, fleshy scales at the base of the stem which persist into maturity, and leaves that have double serration and nerves above covered with white hairlike bristles. Duke (1989) suggests that the most reliable difference between American and Asian ginseng is that the leaflets of the seedlings of the latter tend to have edges that have more irregular and less conspicuous teeth than those of former. However, Duke also suggests that no one has established that there are reliable differences between the two species, and accordingly much of the research on ginseng conducted to date suffers from questionable identification of the experimental material.

The roots of Asian ginseng have sometimes been reported to be more pungent than those of American ginseng, but this could simply be a matter of how they have been prepared. According to Kim (1978), cultivated 6-year-old roots weigh about 76 g (fresh weight), and occasionally some weigh 300 g. Grushvitskii (1959) noted that while wild specimens sometimes achieve a weight of over 400 g, the growth of wild ginseng roots is much slower than that of cultivated plants, the wild roots generally increasing in weight only between I and 2 g/year.

Ginseng is found in two forms in world trade - white ginseng (dried, raw) and red ginseng (boiled or steamed and then dried). Red ginseng may cost twice as much as white ginseng. Asian ginseng is processed by boiling, steaming or sugaring.

Asian ginseng has been used in oriental medicine for perhaps 5000 years, although good documentation of use as a drug extends back perhaps only 2000 years (M.-W. Hong 1978). Persons (1994) suggests that thousands of years ago, in the mountainous areas of Manchuria, ginseng was probably first used for food. The fast Chinese *materia medica* (medical book), the *Shen-nung psents'ao-ching*, written over 2000 year ago, recorded uses for ginseng (Chandler 1988). Ginseng has been prized by the Chinese throughout recorded history. In the T'ang Dynasty (618-905) it was presented to royalty as an article of tribute; in the Sung Dynasty (960-1126), ginseng was equated with silver in value (Chandler 1988). Decimation of the native population, and destruction of habitat with advancing civilization, made it necessary to establish plantations. Like American ginseng, Asian ginseng is protected worldwide by the Convention on International Trade in Endangered Species, and only a little ginseng is still collected from native stands or cultivated under forest canopies (Proctor et al. 1990). Although the species has been cultivated for millennia, there is little evidence of the selection of domesticated races or cultivars.

Very little Asian ginseng has been grown to date in North America (small amounts have been cultivated in British Columbia, Ontario, and Wisconsin), and such cultivation is a sensitive issue. Many North American growers are opposed to introduction of Asian ginseng, fearing that this might result in new diseases and insects, and that cross-pollination of species might devalue the commercial worth of ginseng.

Uses

Asian ginseng is a medicinal herb, primarily consumed by the people of China, Korea, Japan, and other areas of Asia. However, in China and Korea, ginseng is also used in dietary therapy as a health-giving vegetable (Tanaka 1994). It is used in chicken-ginseng soup, and a slice of fresh ginseng with honey may be served to a special guest as an hors d'oeuvre (Tanaka 1994). Ginseng may be encountered as crystals, extract, powder, and whole root. Ginseng is made into many culinary products, including extracts, tea, tablets, capsules, tinctures, syrups, drinks, wine, and candy (Song 1978; Proctor et al. 1990). It is also used in cosmetics, toothpaste, soap, and skin care products (Song 1978; Harrison et al. 1992). Still other products listed in

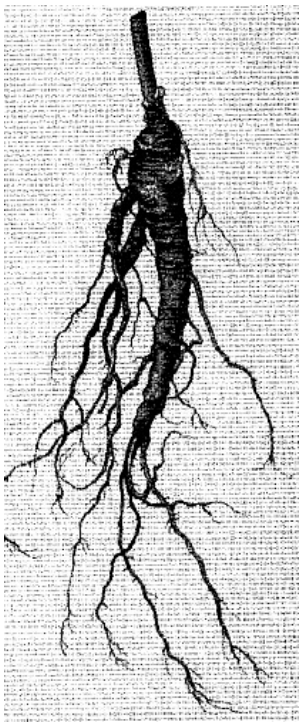


Fig. 293.
Root of Asian ginseng *(Panax ginseng)*,
from Engler and Prantl (1898).

Duke (1989) include chewing gum, chicken essence, hair tonic, jam, marmalade, liqueurs, feminine hygiene products, and cigarettes.

Recipe Sources

Hu (1977) gives many medicinal recipes, of which the following may also be considered culinary: Revitalizing ginseng tea, Four gentlemen soup, and Stop hunger feeling. For those interested, another recipe given has the title "Stop vomiting," which might also have culinary relevance.

Importance

Asian ginseng has long been the most important plant in Chinese medicine. It is grown in China, Korea, Japan, Russia, and the Ukraine. In Asia, ginseng is a major item of agricultural commerce. In China, plantations are located in the three northeastern provinces of Kirin (Jilin), Liao-ning (Liaoning), and Hei-lung-kiang (Heilongjiang) (Hu 1977). Recent reliable statistics for Asian production of ginseng are very difficult to obtain. China cultivates an estimated 2000 ha of Asian ginseng and 100 ha of American ginseng annually (Proctor et al. 1988). Li (1995) stated that China produced 3350 t of Asian ginseng in 1990. China produced an estimated 6000 t of dried roots of Asian ginseng in 1995 (N. Charest, personal communication). Outside China, Asian ginseng is grown in large quantities in Korea and Japan. Korea produces about 3000 t annually, with 1985 domestic sales of $64,400,000 and exports of $27,800,000 (Proctor et al. 1990). The major exporters of Asian ginseng are South Korea and Japan.

Cultivation Notes

Soil

S.K. Hong (1978) described suitable soil conditions for Asian ginseng cultivation in Asia. A well-cultivated sandy loam or clay-loam is best. Soils with sandy loam in the upper layer and clay in the deep layer have proven suitable. If the soil is too sandy, many small branches may be produced, of little market value. Soils should have a large amount of available potassium, and benefit from a high content of humus derived from deciduous trees. Soils heavily treated with chemical fertilizers and concentrated manures are undesirable. The pH should be 5.5-6.0 [Li (1995) gives the limits of pH as 5.0-6.5). Good drainage is essential, and may be provided either by well-drained level land or by northern or northeastern slopes of 8-15°. Soils that have grown ginseng should not be used again for this purpose for 10-15 years.

Climate

As noted earlier, the Asian ginsengs are distributed over a vast territory, and over a considerable range of latitude, so that there is likely considerable genetic variation in cold tolerance and adaptation to other aspects of seasonal variation in climatic factors. Length of cold stratification needed for seeds to germinate is much longer in Russia (ca. 5 weeks) than in Japan (ca. 2 days) (Li 1995). In the chapter "Climatic zones where herbs can be grown," the information presented (based on published information) indicates that Asian ginseng is much less cold-tolerant than American ginseng, but this is not necessarily so. Asian ginseng has been experimentally cultivated near Moscow in Russia (S.-K. Hong 1978). It is also grown in Jilin and Heilongjiong in China, which have very harsh winters (Bailey, personal communication). The following information is from S.-K. Hong (1978). Light levels should be 1/8-1/13 normal sunlight. Mean summer temperatures should be 20-25° C, mean winter temperatures 0.0-13.8°C. Summer temperatures above 35°C may produce physiological disorders.

Propagation and Cultivation

Cultivation practices for Asian ginseng are significantly different than for American ginseng. Detailed instructions for cultivation of Asian ginseng as it is grown in the Orient are found in Hu (1977), S.K. Hong (1978), and Li (1995). Asian ginseng, is generally established in a seed garden for 1-2 years, and transplanted to a production garden for 2-6 years (Bailey, personal communication). Because of dormancy, cold stratification is also required as for American ginseng (Proctor et al. 1990). Seeds should not be treated with fungicides, because this is believed to decrease subsequent germination (Proctor et al. 1990).

Harvest and Storage

In the Orient, Asian ginseng is generally harvested at 4-6 years of age, with high quality roots generally harvested at 6 years, occasionally longer. Cultivated Asian ginseng roots typically achieve fresh weights of 60-100 g after 7 years. Asian yields are about 565 kg/ha (dry weight, Korea), with seed yields (4-year-old plants) of 400 kg/ha (Duke 1989).

Example Cultivars

Cultivars of Asian ginseng are known in Japan, Korea, and China (Bailey, personal communication). Li (1995) refers to 'Big Round Rhizome' and 'Medium Round Rhizome' as cultivars, but Li (1992*b*) refers to these simply as categories. It is altogether unclear that "cultivars" in the usual horticultural sense exist (i.e., genetically distinct cultivated types that have established non-scientific names), but given that Asian ginseng has been cultivated for probably thousands of years it seems likely that genetically distinctive strains have been selected in cultivation.

Additional Notes

Chemistry

The ginsenosides of Asian ginseng have been found to differ, at least in relative amounts, from those of American ginseng. There are more ginsenosides of the protopanaxatriol type in Asian ginseng compared to the American species (Chandler 1988). Physiological reactions seem to differ according to the kind of ginsenosides present (Chandler 1988).

Medicine

Ginseng is widely used routinely, more so than any other plant, by healthy individuals for stimulation, added energy, and a sense of well-being (Lewis 1979). Ginseng "has the reputation of being the ultimate elixir of life, a symbol of strength and long life, the source of happiness, a tonic and an aphrodisiac" (Chandler 1988). An extremely impressive number of ginseng recipes are employed in Asian medicine to treat various ailments. Particularly in Asia, ginseng preparations are used medicinally to treat hypotension, hypertension, stress, insomnia, fatigue, depression, arthritis, diabetes, high cholesterol levels, bronchitis, some cancers, anaemia, impotence, and premature aging (see Duke 1985 for an extensive list of other conditions treated). Despite extensive traditional uses and a huge number of scientific studies, evidence of the benefits of ginseng are controversial (Chandler 1988).

The virtues ascribed to ginseng could be explained by a unifying concept of ginseng as an *adaptogen* [Chandler 1988; see Duke (1989) for an extended discussion of this concept.] This is defined as a substance that is: "innocuous, causing minimal physiological disorder; non-specific in action, increasing resistance to the adverse influences of a wide range of physical, chemical and biological factors; and capable of a normalizing action irrespective of the direction of the' pathological change" (Chandler 1988). While one may question whether such an "explanation" really explains anything, studies have found that ginseng has favorable effects in the face of stress from changes in temperature, diet, restraint, exercise, and similar factors (Chandler 1988). There have also been useful pharmacological effects demonstrated for such conditions as anaemia, atherosclerosis, depression, diabetes, edema, hypertension, radiation sickness, and ulcers (Chandler 1988). It has been postulated that these diverse effects could be due to alteration of the levels of pituitary, gonadal, or adrenal hormones (Chandler 1988).

The potential use of ginseng as an aphrodisiac has attracted considerable research, but once again rather ambiguous and contradictory conclusions (Chandler 1988). Some experiments with animals have produced changes in hormone balance and have indeed increased sexual activity; however, it is unclear what these effects in rats, rabbits, frogs and hens have to do with human behavior (Chandler 1988). Some studies have shown increased sperm production in humans with low levels of production, and even improvement in impotence, but the design of these experiments was not definitive (Chandler 1988).

Much of ginseng medical research is supported by those with commercial motives, and the design of experiments has often allowed researchers to draw whatever conclusions they wished. "Only one well-controlled experiment with ginseng in human beings has ever been reported" (P. Barna, cited in Tyler 1993*a*; however there have been many recent experiments testing ginseng in humans, and the quotation exaggerates the lack of adequate controls). Lewis (1986) and Duke (1989) have expressed the opinion that there is simply no proof, despite the thousands of pharmacological and medical studies that have been conducted, that ginseng is medically useful in any respect. Many millions are nevertheless convinced that ginseng is the healthiest of health-giving herbs.

The incidence of adverse reactions to ginseng is very low, the toxic dose estimated to be 1000 times the normally effective dose (Chandler 1988). Nevertheless, a "ginseng abuse syndrome" has been alleged to exist, with such adverse effects as morning diarrhea, skin eruptions, sleeplessness, nervousness, and hypertension; or, rather opposite to some of these: hypotension, a tranquillising effect, and an inability to concentrate (Siegel 1979; Chandler 1988). These findings have not been adequately explored; they could be due to adulterants that are commonly encountered in commercially marketed ginseng preparations, or to different ginsenosides or other ginseng constituents. Moreover, the phrase *ginseng abuse syndrome* has fallen into disrepute as the study in which it was coined (Siegel 1979) "has now been thoroughly discredited" (Tyler 1993*a*). An estrogen-like effect in women has been suggested, with such results as production of mammary nodes and induction of vaginal bleeding (Chandler 1988). Castleman (1991) recommends that anyone with hayfever, asthma, emphysema, high blood pressure, cardiac arrhythmia, or blood clotting problems should avoid ginseng consumption. He also recommends that pregnant women should err on the side of caution and not use it, although there is no evidence for birth defects.

"The prolonged or excessive use of ginseng is associated with a low risk . . . Taken in moderation it probably does have a mildly stimulant effect and, for this reason, can be a useful, although expensive, alternative to tea and coffee" (Chandler 1988). Given the health concerns that have been expressed about the widespread use of tea and coffee, it is difficult to find fault with the comparatively innocuous ginseng on the basis of present knowledge.

Duke (1989) contends that the health benefits of ginseng conceivably might match that of an equal amount of carrot, although the latter is about 1/600th of the cost. However, as noted above the Western world has not yet acquired the respect for ginseng that evolved naturally in Asia through perhaps 5000 years of experience. As pointed out for many of the herbs. discussed in this book, mankind has often discovered health benefits of plants long before

Fig. 294.
Ginseng plant, redrawn by B. Brookes from Li Shih-Chen's
1885 Pharmacopoeia (see Li and Li 1973).
The root has been exaggerated to take on the form of a man.
The above-ground parts are not accurately depicted,
particularly the leaf arrangement.

modem medical research confirmed the findings. Probably hundreds of millions of Asians from historical times to today came to believe that there are considerable health benefits in consuming ginseng. Could so many be wrong?

Nutrition

Duke (1985) provides an analysis of Asian ginseng root nutrients. The root has small amounts of most common vitamins and minerals. Duke (1989) presents an extensive discussion of nutritional aspects of ginseng, which does not appear to offer any constituents of particular direct nutritional interest.

Curiosities

• Many ancient cultures advocated a "doctrine of signatures" for plants, whereby resemblances of portions of plants to human parts of the body were interpreted as a "signature" or sign of healing or beneficial qualities for the part resembled. In the case of ginseng, the roots often are forked (especially as a consequence of transplanting), and mimic the lower half of the human body. This appears to have given rise to the interpretation that the root has erotic value as an aphrodisiac, and indeed ginseng is still widely considered today to be a powerful sexual stimulant (Chandler 1988).

• One Chinese legend relates that ginseng was discovered during the reign of Wenti, of the Sui dynasty (581-601), at Shangtang in Shensi (presumably the province of Shaanxi). Each night the imploring voice of a man was heard at the back of a house. After a search, the voice was discovered to be coming from a remarkable ginseng plant, which was dug up. It was as tall as, and in the shape of a man, with perfect arms and legs. Thereafter, ginseng was known as "spirit of the ground" (Li et al. 1973).

• According to another ancient Chinese legend, ginseng was collected by a special guild of ginseng hunters who searched for the plants at night with tiny bows and arrows. They could locate the plants by a faint light that the plants were said to emit. Because the plants moved around at night, even after they were hit with an arrow, the hunters were able to retrieve the roots only if they attached string to the arrows (Weiss and Weiss 1985).

• According to a Korean legend, a 15-year-old boy named Kim prayed every day to the mountain spirit for a cure for his dying father. One day Kim fell asleep while praying, and the mountain spirit guided him to a place where ginseng grew. Directed by the spirit, he prepared a drink using the root of the ginseng, and gave it to his father, who recovered (Mercatante 1988).

• Another Asian legend deals with a man who tried to sell ginseng at an exorbitant price. Arrested and brought to trial, the man tried to destroy the evidence by eating the ginseng. The ginseng made him so strong that he was able to kill his guards and escape (Mercatante 1988).

• In Korea, ginseng has been fed to race horses to enhance their performance on the track (Harrison et al. 1992).

• Manchurian wild ginseng has been considered so valuable that it has fetched as much as 250 times its weight in silver. Almost all herbarium (plant museum) specimens of Manchurian wild ginseng, therefore, are lacking their roots (Li et al. 1973).

• In Korea, red ginseng (i.e., ginseng steamed to a reddish-brown) is classified into five grades, colorfully labelled "Heaven" (1st, "Earth" (2nd), "Good" (3rd), "Cut" (4th), and "Tails" (5th) (Proctor et al. 1990).

• Each season an aerial shoot is produced, a scar is left on the rhizome, generally on different sides of it, producing a zig-zag pattern. By counting these one can determine the age of the plant. (Each season, a "wrinkle" tends to be left on the root by its contraction, but this does not seem to be as reliable as the rhizome scars for ascertaining the age of plants.) By this method, some Asian ginseng plants have been alleged to live for about 400 years (Baranov 1966).

• Asian and American ginseng exhibit a well-known classical phytogeographical distribution pattern, with one species in eastern Asia, and a closely related species in eastern North America. There are numerous counterparts among other plant species (Li 1952; Reznicek 1988; cf. *Cryptotaenia* and *Agastache* Curiosities).

Problems and Potential

Asian ginseng is a well-established agricultural and trade commodity in Asia. Only limited attempts to grow it in North America have been undertaken, and some ginseng farmers have been opposed to introduction of Asian ginseng into North American farming for fear of genetic and pest contamination. However, the cultivation of American ginseng in Asia has been undertaken in recent years, in order to meet the Asian demand for it, without the same fears of contamination being expressed. While it is difficult to predict future trends, there would seem to be some prospect for increased cultivation of Asian ginseng in North America, especially if the market for exports of American ginseng decreases. Finally, it is of interest to mention the possibility of hybrids between Asian and American ginseng, perhaps generated by new techniques of genetic engineering. While tradition has dominated the kinds of ginseng that have been accepted in the marketplace, it is possible that new kinds of ginseng could be of commercial interest.

Selected References

Bae (1978); Chandler (1988); Duke (1989); Bailey et al. (1994); Bailey et al. (1995); Li (1995).

Papaver

Family: Papaveraceae (poppy family)

Genus Notes

Papaver has about 100 species of annual, biennial, and perennial herbs and some subshrubs, native mostly to temperate regions of the Northern Hemisphere, with one species indigenous to southern Africa (Goldblatt 1974). Many of the species are grown as ornamentals, and a few are used in folk medicine and in modem medicine. *Papaver orientale* L. (Oriental poppy), widely cultivated as an ornamental, is said to have seeds as tasty as those of *P. somniferum* (Duke 1973). Poppies are best known for the opium poppy, *P. somniferum*, discussed in detail in the following. It is not the only species to contain narcotic alkaloids, as shown below (after Duke 1973; Goldblatt 1974; thebaine is not considered narcotic), but is the only one that is used as a source of narcotics. (See Chemistry for information on the principal alkaloids.)

Papaver Somniferum L.

English Names

Opium poppy
Also: common poppy, garden poppy, mawseed, oil poppy, poppy, white poppy

French Names

Family: Papavéracées, famille du pavot
Pavot somnifère (m)
Also: oeillette (variété oléagineuse), pavot, pavot à oeillette, pavot à opium, pavot blanc (variété à graines blanches), pavot cultivé, pavot des jardins, pavot d'opium, pavot noir (variété à graines noires), pavot oeillette, pavot officinal, pavot pourpre

Warning

Culture of the opium poppy is strictly prohibited in the U.S. and Canada. Opium and the drugs derived from opium are addictive and potentially toxic, and should only be taken under qualified medical supervision.

Description, Taxonomy, and History

Papaver somniferum is an annual, growing to as much as 2 m in height, with attractive white, pink, red, bluish or purple flowers (doubled in some garden forms) to 10 cm across. The species is believed to grow wild in the Mediterranean region, from the Canary Isles eastwards. It is found as an escape from cultivation in fields, roadsides, and waste places in scattered localities throughout the U.S. and Canada (Kiger 1975). *Papaver somniferum* has been treated taxonomically in different ways. According to a popular interpretation (Mowat and Walters 1964; Kadereit 1986), the cultivated phase is placed in subspecies *somniferum* while the wild plants are assigned to subsp. *setigerum* (DC.) Corb. (= *P. setigerum* DC.). Others divide the cultivated phase itself into various subspecies. For example, Zohary and Hopf (1993) place the opium forms in subsp. *somniferum* and the oilseed varieties in subsp. *hortensis* (Hussenot) Corb. The economic part of the plant for culinary purposes is the seed. The kidney-shaped seeds range through white and yellow to slate-blue or black, and are small, 1.25-1.5 mm long, about 400 000 in a kilogram. They and the oil expressed from them have essentially no narcotic properties (but see below). In mature wild plants the wind shakes the seeds out of the fruit through pores at the apex. The opium poppy has been selected to produce three kinds of plants: narcotic cultivars, oilseed/condiment cultivars, and ornamentals.

Principal Alkaloids of some Species of *Papaver*.

Species of *Papaver*	**Alkaloid**				
	morphine	**papaverine**	**codeine**	**narcotine**	**thebaine**
somniferum	X	X	X	X	X
bracteatum Lindl.	X		X		X
orientale L.					
dubium L.	X				
hybridum L.	X				
rhoeas L.	X			X	X
commutatum Fisch.&Mey.		X			

Fig. 295.
Opium poppy *(Papaver somniferum)*, from Köhler (1883-1898).

The history of the poppy as a narcotic has been well documented (see for example Merlin 1984). The narcotic effects may have been known to the ancient Sumerians, ca. 4000 B.C., as they had a symbol for it that has been translated as "joy plant" (U.S. Dept. Justice 1992). The opium poppy was well established in classical times. It was well known to ancient Egyptian, Greek and Roman civilizations, and seems to have been used effectively as a therapeutic drug (Rosengarten 1969). However, by the time of Mohammed (A.D. 570-632) the narcotic qualities were also appreciated in Arabia. Islamic traders and missionaries spread the cultivation of the opium poppy to Persia, India, China, and Southeast Asia, where it was used to relieve pain, but also began to be used excessively as a habit-forming, destructive narcotic, first in India, then in China. The drug was first eaten in the Orient, but began to be smoked in the 17th century in China, which resulted in a tremendous upsurge of use and production. Crude opium has a disagreeable smell and a hot biting taste. The Swiss alchemist Paracelsus (1493-1541) overcame these objectionable features by making up a solution of opium in alcohol (le Strange 1977). This deadly mixture, known as tincture of opium or laudanum, enslaved numerous people during the following centuries. Portuguese, Dutch and British merchants trafficked extensively in opium. In the 19th century, the British brought about the Opium Wars of 1840 and 1855 to prevent the Chinese from outlawing the opium trade. It has been estimated that in 1886 about a fourth of the Chinese (approximately 15 million people) were addicted to opium (Anderson 1993). During Victorian times in England, tincture of opium was readily available, and was often administered to teething or upset babies to make then sleep (le Strange 1977). In the U.S. opium preparations became widely available in the 19th century, and morphine was used so widely as a painkiller for wounded soldiers during the American Civil War that opium addiction became known as "the army disease" and "soldier's disease" (U.S. Dept. Justice 1992).

The culinary use of the opium poppy is also ancient. Many seeds have been found at the sites of Neolithic domiciles, including Swiss Lake Dwellings of Neolithic Age (at least 4000 years ago) (Andrews 1951; Morton 1976; U.S. Dept. Justice 1992). In the second millennium B.C. the Egyptians cultivated poppy to obtain the edible oil in the seeds. The Classical Greeks also used poppy seeds as a food. Both the ancient Greeks and Romans added the seeds to cakes and bread as a flavoring (le Strange 1977). By the Middle Ages, the use of poppy seeds as a condiment on bread was well established.

By United Nations conventions, the opium poppy can only be cultivated for export of opium in a restricted number of countries (Singh 1982). In Canada, opium poppy is governed by the Narcotic Control Act, and can only be cultivated under licence. Opium poppy seed, however, is specifically exempted, and can be imported and possessed without difficulty. Cultivation and possession of plants are subject to severe penalties. The opium poppy was widely grown as an ornamental plant and to some extent as a seed crop in the U.S. until possession of it was declared illegal in the Opium Poppy Control Act of 1942 (U.S. Dept. Justice 1992). In the U.S., federal law 1568 makes it illegal without a licence to obtain, transport, or grow *P. somniferum*, or even to permit it to be grown on one's land (Kingsbury 1964). Opium poppy persists in old gardens and around abandoned homesteads in North America, and is occasionally planted, innocently or not (see last Curiosity).

Uses

The ripe seeds of *P. somniferum* (sometimes called maw seed) are eaten or pressed for poppy oil. The seeds have a mildly spicy, oily, agreeably nutty flavor, and are used as a condiment on baked goods, rolls, and pastry. The pleasantly nutty flavor and crunchy texture are brought out by toasting or baking. Poppy seeds are used as a topping on

Fig. 296.
Opium poppy *(Papaver somniferum)*, ornamental double-flowered form, from Vilmorin-Andrieux et C^{ie} (1884).

rolls, breads, cookies, cakes, and other baked goods, or as a garnish. The seeds can also be used in a variety of cooked vegetable dishes and stews. Crushed seeds are mixed with other ingredients and used as a filling for cakes and pastries, cream cheese, and sour cream dips. Poppy seeds are used to flavor butter and various food preparations. If whole seeds are available, they may be crushed by wrapping them in a kitchen towel and hammering them with a wooden mallet or rolling pin; a special mill, if available, may be used (Rinzler 1990).

Since poppy seed is a widespread culinary item, but is obtained from a dangerously narcotic plant, there has been interest in establishing whether or not the seeds contain any of the alkaloids found in opium that are considered to be narcotic. The statement is frequently recorded that the seeds contain no narcotic properties. Duke (1973) reviewed evidence showing that minute quantifies of narcotic alkaloids have been found in the embryos and endosperm (nutritive tissue) of the seeds. However, these trace amounts are generally considered insignificant.

Poppy leaves have been eaten in salads in China and young plants consumed like lettuce or as a potherb in Iran and elsewhere in Asia (Duke 1973), but generally the foliage of opium poppy is not eaten. Poppy seedlings are cooked and eaten as greens or in soup in India and Iran (Morton 1977).

Opium poppy is well known as the source of raw opium. Crude opium is the hardened milky sap of the unripe fruit. Dried latex is obtained from unripe capsules, and is used medicinally as well as for illicit narcotics. The drug opium is a mixture of many constituents, including the alkaloids morphine and codeine. It has traditionally been obtained by making incisions into the nearly ripe poppy capsules 10-20 days after flowering. In cooler climates incisions do not seem to result in good exudation of latex, and mature capsules are simply collected for chemical extraction. Morphine is often extracted from the capsules of oilseed cultivars after the seeds have been harvested, although narcotic cultivars are more productive. Heroin is manufactured from morphine. Growing poppies for pharmaceuticals in Noah America is possible only under license.

Opium poppy is also commonly grown as a source of oil. Forty to 60% of the seed weight is a pale yellow, fixed, tasteless, oil, useful as a salad oil as it is less liable to become rancid than olive oil. The oil is also used to make margarine, salad dressing, and as a cooking oil. Artists also use poppy seed oil as a drying oil, useful in paints and varnishes. The oil is also a component of some soaps. As an animal feed, poppy seed is commonly used as birdfeed, and after oil has been expressed from seeds the oil cake has been fed to cattle (Duke 1973).

Opium poppy is also extensively grown as an ornamental, despite its illegality in many nations. Duke (1985) notes that it is widely grown in the U.S. as the peony flowered poppy, although it is illegal to do so. Ornamental strains often have double or fringed petals.

Recipe Sources

Day and Stuckey (1964) provide recipes for: Poppy seed egg braid, Poppy seed kringle, Hamantaschen with poppy seed filling, Poppy seed whole wheat rolls, Poppy seed tea bread, Poppy seed biscuits, Poppy seed French toast, Poppy seed. honey toast, Bohemian poppy seed cake, Poppy seed cheese cake, Poppy seed coconut bars, Poppy seed and apple strudel, Ham and poppy seed noodle casserole, Poppy seed and almond noodles, Poppy and sesame noodles, Graham cracker poppy seed pie crust, Poppy seed cheese dream, Poppy seed potatoes, and Turnips with poppy seed butter. Rosengarten (1969) presents recipes for: Frosting, Poppy seed crescents, Poppy seed falling (three recipes), Poppy seed French dressing, Poppy seed coffee roll, Poppy seed cake, and Quick poppy seed snails. Crowhurt (1973) has recipes for Poppy seed log and Poppy wine.

Other recipes are: Poppy seed cake (Day and Stuckey 1964; Forsyth 1986); Noodles with poppy seeds (Garland 1979); Poppy seed dressing (McCormick 1979); Poppy seed sauce (Stuart 1979); Poppy seed muffins (Forsyth 1986); Spinach, orange & onion salad with poppy-seed dressing (Thompson 1986); Rose and poppy seed pasta (Leggatt 1987); Poppy seed ice cream (Norman 1990).

Importance

Poppy seed is produced in the Netherlands, Poland, Romania, the Czech Republic, the former Yugoslavia, Russia, India, Iran, Turkey, Argentina, and many Asian and Central and South American countries (Simon et al. 1984). In southern Europe poppy seed oil is not competitive with olive oil, and so is not produced there. Imports of poppy seed to the U.S. averaged $4.9 million (U.S.) over the interval 1990-94 (Buzzanell et al. 1995). Australia and the Netherlands accounted for over 90% of American imports during this period.

The opium poppy is best known as the source of illicit opium, produced chiefly in Asia. The major illegal growing areas are: in the highlands of mainland Southeast Asia (especially Burma, Laos, Thailand, and adjacent southern China and northwestern Vietnam); in Southwest Asia (notably Pakistan, Iran, and Afghanistan); in Mexico; and to a lesser extent in Lebanon, Guatemala and Columbia (U.S. Dept. Justice 1992). Rather detailed analyses of hectares of opium poppy illicitly cultivated and tonnages

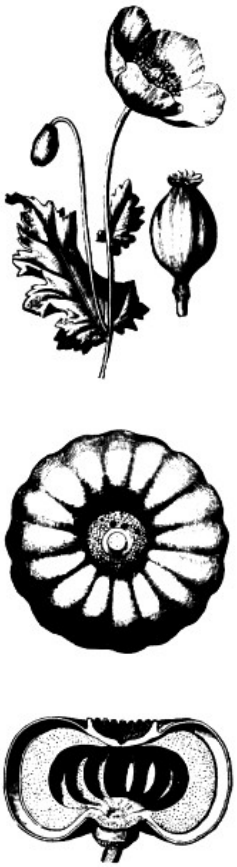


Fig. 297.
Opium poppy *(Papaver somniferum)*,
from Hatter (1988).

produced in various countries are available in U.S. Dept. Justice (1994). Limited authorized pharmaceutical production occurs, largely in Europe. Much of the poppy grown for the extraction of opium for medicinal purposes is cultivated in government-regulated farms in India, Turkey, and Tasmania (Australia) (U.S. Dept. Justice 1992). The opium poppy has been described as "the most important medicinal crop of India" (Doshi and Thakore 1995), and it probably holds a similar status in other countries. The importance of opium poppy derivatives is indicated by the fact that codeine is a constituent of over 22% of analgesic preparations in the U.S.

Cultivation Notes

Soil

Commercial production of poppyseed requires well-manured soil. Poppy has a high fertilizer requirement for nitrogen (especially), for phosphorus, and for boron. Light, warm soils have produced good results, while wet and badly aerated soils are unsuitable for growing poppy (Lööf 1966). The pH tolerance range is 4.5-8.3 (Duke and Hurst 1975). Singh (1982) recommends a pH of about 7.

Climate

Early sowing of seeds in Europe is considered desirable, although the seedlings are not particularly frost-resistant (Lööf 1966). Wet, cool weather after sowing seeds is desirable, as hot, dry conditions can dry out the seedlings. Once the root systems are well established, poppies prefer hot, dry weather, especially towards maturity. This applies both for production of oil in the seeds and opium in the fruits. When grown for opium, cool conditions and dull cloudy or rainy weather are quite deleterious to yield (Singh 1982). Opium poppy grows between 4 and 26°C, optimally about 15°C. Full sunlight is necessary for commercial production of poppyseed, although garden plants tolerate slight shade. The opium poppy is a "long day" photo-responsive plant, requiring long days and short nights to develop flowers (U.S. Dept. Justice 1992).

Propagation and Cultivation

For production of seeds in southern Europe, seeds are planted early in the spring for harvest in late summer, or in midsummer for harvest in the fall. Seeds are sown by drills so that the mature plants will be about 30 cm apart. Poppy seedlings emerge slowly and seeds need to be placed near the soil surface. Because the plants are mostly self-pollinating, there is no need to supply bees in order to bring about fruit and seed production.

Harvest and Storage

Fruits should not be allowed to become overripe or wet, as they become susceptible to birds, which are very strongly attracted to the seeds. Harvesting begins when the fruits turn yellowish-brown. Entire plants are picked and spread out to dry. The poppy fruits may also be cut off and spread out to dry. Yields in India are 220-275 kg seeds/ha (Pandey 1990). Under European conditions, yields of 1200-1800 kg/ha are typical, and up to 3000 kg/ha has been obtained (Lööf 1966).

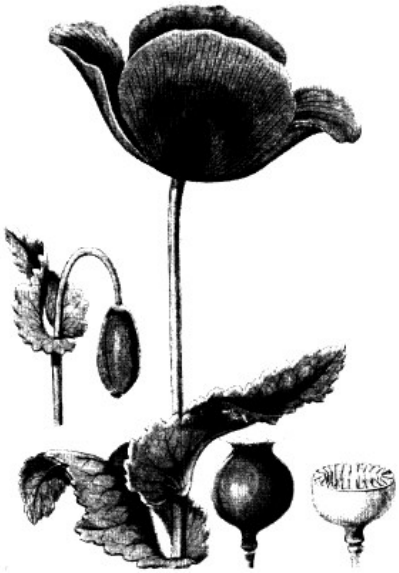


Fig. 298.
Opium poppy *(Papaver somniferum)*,
from Bulliard (1784).

When poppy fruits are collected for pharmaceutical extraction, they are harvested earlier than for seed, as content of morphine is highest before the seed is completely ripe (Lööf 1966). In India, yields of raw opium on average are about 60 kg/ha, with good yields ranging up to 100 kg/ha (Singh 1982).

Example Cultivars

Lööf (1966) and Singh (1982) give information on a number of cultivars and cultivated forms.

Additional Notes

Chemistry

Pandey (1990) provided a chemical analysis of the composition of the seeds. Singh et al. (1995) noted that the seeds are very rich in oleic and linoleic acids. The principal alkaloids in the plants are discussed below.

Medicine

Opium poppy has been used as a tranquillizer and analgesic for millennia. It has also been employed as an aphrodisiac, and to treat numerous medical conditions, and continues to be used in China for a variety of medicinal purposes (Duke and Ayensu 1985). Centuries of abuse of the drug as a recreational inebriant, and the well known misery that has resulted, suggest that the opium poppy has been more of a curse on humanity than a blessing. As noted below, however, constituents of the plant are invaluable in medicine. Opium poppy is one of the most important medicinal plants.

Alkaloids from poppy fruits are widely used in pharmacology, as narcotic analgesics, sedatives, sleep-inducing agents, and to counteract diarrhea, spasms, and cough (Simon et al. 1984). The biochemical sequence producing morphine in the plant is theabaine-codeine-morphine (Duke 1973). Opium may contain 3-23% morphine, 0.1-2% papaverine, 0.1-4% codeine, 1-11% narcotine, and 0.1-4% thebaine. Morphine is a very strong analgesic, narcotic, and stimulant. Papaverine has little narcotic or analgesic action, but is a muscle relaxant of smooth muscles, used for treating angina pectoris. Codeine produces similar effects to morphine but is less narcotic, euphoric, and constipating. Narcotine is a very mild narcotic and spinal stimulant. Theabaine is convulsant, not narcotic, and is used as an antagonist to curb heroin addiction.

Nutrition

Poppy seeds are considered nutritious and a good source of energy (Duke 1985). About 23% of the seeds is made up of protein (Pandey 1990), which has almost all essential amino acids except tryptophan (Duke 1973). Poppy-seed oil has a very high content of unsaturated fatty acids, especially linoleic acid, which is considered valuable nutritionally (Lööf 1966). Poppy seeds are also rich in carbohydrates and calcium (Duke 1973).

Curiosities

• The botanical eipthet *somniferum*, from the Greek for "sleep-bearing" refers to the plant's narcotic qualities. "Opium" comes from *opion*, a diminutive of *opos*, the Greek word for juice. "Morphine," a constituent of opium, is derived from the Greek god of dreams, Morpheus (Rosengarten 1969).

• According to a legend, to keep from falling asleep, Buddha cut off his eyelids, and where they fell upon the earth opium poppies sprouted (Bianchini and Corbetta 1977).

• The Akha tribe of Northern Thailand have a legend about the origin of opium (Anderson 1993). One day the seven lovers of a beautiful woman all arrived at her house at the same time. Even though she knew it would kill her, she decided to make love with all of them, rather

than risk offending any of the men. She asked that people care for her grave, and promised to send up a beautiful flower, opium, that would grow from her heart.

• The classical Greeks represented the God of sleep, Hypnos, with his head wreathed in poppies, or with poppies in his hand; the Gods of Death and Night were similarly shown (Fox 1933).

• The competitors in the Olympic Games in ancient Greece ate poppy seeds mixed with wine and honey (Fox 1933).

• Avicenna, a celebrated Arab philosopher and physician, died of opium intoxication in 1037 (Bianchini and Corbetta 1977).

• An allusion to spilled blood, the red poppy flower has been the symbol of fallen warriors in many countries since ancient times. Following World War I, the red poppies of Flanders' Fields (*P. rhoeas* L.) were widely adopted as a commemorative emblem (Rosengarten 1969). For example, it is the emblem of the American Legion (Duke 1973). John McCrae's (1915) poem (cited in Lehner and Lenher 1962) reads:

In Flanders fields the poppies blow

Between the crosses, row on row,

That mark our place, and in the sky,

The larks, still bravely singing, fly

Scarce heard among the guns below.

• Three categories are often used to describe the relative safety of herbs: GRAF - generally recognized as food, GRAS - generally recognized as safe, and GRAP - generally recognized as poisonous. Opium poppy falls into all three categories (Duke 1992*b*): the widely eaten poppy seeds are GRAF and usually also considered GRAS, and poppy alkaloids are GRAP.

• Workers in opium poppy fields assigned the task of incising the capsules with a knife to induce flow of latex have suffered "narcosis" from the fumes. Sometimes masks are worn to prevent excessive inhalation if there is insufficient wind to carry the fumes away (Morton 1977).

• "Lettuce opium" or lactucarium is a drug from the dried milky juice of wild and cultivated lettuce species, and is known to have been used by the ancient Egyptians. It enjoyed popularity in North America as a sedative and painkiller in the 19th century, and again as a legal, allegedly mind-altering drug in the mid-1970's. Although lettuce opium has been found to have some sedative components, it is not thought to have any efficacy as a drug (Tyler 1993).

• Poppy seeds are exceptionally small, about 20 million in 1 kg (Rinzler 1990).

• Many plants and fungi disperse their propagules by a ballistic mechanism. *Papaver somniferum* appears to be the champion of the plant world, throwing its seeds up to 15 m (Ellner and Schmida 1981).

• The first alkaloid ever isolated chemically was morphine, the basic alkaloid from opium. This was carried out in 1803 by F.W.A. Sertürner (1793-1841), a pharmacist's assistant in the German town of Paderborn (Starý and Jirásek 1973).

• Shepard's (1979) recipe for the Japanese dish *Togarashi* (hot pepper condiment) is unusual in using seeds of two of the chief narcotic plants of the world, opium poppy and hemp (*Cannabis sativa* L.).

• Minute quantities of morphine have apparently been found in lettuce, hay, cow's milk, and human milk (Hazum et al. 1981). The finding in lettuce is interesting in view of the uses of lettuce opium, but the concentration is too low to result in any effect. The same is true for milk and hay.

• According to Rinzler (1990) "poppy seeds that have been contaminated with even infinitesimal traces of the latex may produce a false-positive result on a urine test for drugs, suggesting that you have used morphine or heroin, a derivative of morphine, when in fact you have not."

• The 1997 Thompson & Morgan seed catalog (page 149) offers North Americans *Papaver somniferum* cultivar Hens & Chickens, doubtless innocently, as distributing seeds for the purpose of cultivating any form of this narcotic plant is illegal in Canada and the U.S.

Problems and Potential

Considerable poppyseed is imported into the U.S. and Canada. There is obvious potential for growing a crop in Canada and the U.S. (Kiehn and Reimer 1993), but this seems impossible at present because of the legal proscriptions against it, resulting from concern about narcotic use. Singh et al. (1995) concluded that the opium poppy is suitable for development as a high-linoleic-acid seed crop.

Selected References

Lööf (1966); Rosengarten (1969); Duke (1973); Duke et al. (1973); Morton (1977); Merlin (1984); Simon et al. (1984); Kapoor (1995).

Fig. 299.
Peppermint geranium *(Pelargonium tomentosum)*,
from Curtis (1787-present; #518).

Pelargonium

Family: Geraniaceae (geranium family)

Genus Notes

Pelargonium has about 300 species of annual and perennial herbs and shrubs native mainly to South Africa. Species of the genus *Pelargonium* have the common name "geranium." However, there is also a related genus *Geranium*, also with about 300 species, many of which are also garden ornamentals. This regularly results in confusion, which could be avoid by using the vernacular name pelargonium for species of the genus *Pelargonium*. Unfortunately the vernacular name geranium is now rather entrenched in North America for species of *Pelargonium*. In England, New Zealand, Australia and South Africa, geraniums are often correctly referred to as pelargoniums (Peddie et al. 1991).

In 1847 the French recognized the potential of geraniums in perfumery (Stuart 1979). By the middle of the 19th century geraniums were cultivated by the French perfume industry for rose geranium oil, which is almost indistinguishable from the more expensive oil of roses (Stobart 1977). Oil of geranium is considered an essential ingredient of certain perfumes for men (Stuart 1979). *Pelargonium graveolens* L'Hérit. ex Ait. is generally identified as the source of commercial geranium oil, but will also frequently be encountered as a potential source of culinary material. Most plants used for geranium oil in fact resemble *P. graveolens* to some extent, but are hybrids with this species (Vorster, personal communication). The plants grown on Réunion are a hybrid between *P. graveolens* and *P. capitatum* (L.) L'Hérit. ex Ait. (Demarne and van der Wait 1989).

Geraniums were introduced to England from Cape Province in 1632, and became well known as garden ornamentals. They are now grown as ornamentals around the world, principally in temperate climates. *Pelargonium* cultivars are classified as "zonals," "ivys" and "regals." "Zonals" include the ill-defined *P. hortorum* L.H. Bailey, which is widely used as a bedding plant. Zonal geraniums have a horseshoe-shaped pigmented area on the leaves. This "species" (actually a group of hybrids) is derived from *P. zonale* (L.) L'Hérit. and *P. inquinans* (L.) L'Hérit. "Ivys" are derived from *P. peltatum* (L.) L'Hérit. The ivy-leaved geranium is a trailing plant with shiny leaves, frequently grown in hanging baskets. "Regals" are derived from *P. cucullatum* L'Hérit. ex Ait. and perhaps a few other species, including *P. graveolens* (Vorster, personal communication).

There is a very wide range of scents, shapes, sizes, and floral colors among geraniums, including those mentioned below. Plants that lack an appetizing aroma should not be used as culinary herbs, but an attractive odor does not guarantee an attractive taste.

Pelargonium "Fragrant-Leaved Group"

English Names

Geranium
Also: pelargonium, storksbill, stork's bill, sweet scented geranium
["East Indian geranium" and "Turkish geranium" are names for the grass *Cymbopogon martinii*, discussed in the genus notes for *Cymbopogon*.]

French Names

Family: Géraniacées, famille du géranium
Géranium (m)
Also: bec-de-cigogne, bec-de-grue, becs-de-grue, pélargon, pelargonie, pelargonium, pélargonium [Rose geranium = géranium rosat.]

Description, Taxonomy, and History

All *Pelargonium* species have glandular hairs producing essential oils, some much more than others (Vorster, personal communication). The fragrant-leaved geraniums are a heterogenous group of species, notably including the following and hybrids involving these species, according to Bailey and Bailey (1976) and Morton (1976):

P. abrotanifolium (L.f.) Jacq. (southernwood geranium)

P. capitatum (L.) L'Hérit. (rose-scented geranium)

P. citronellum J.J.A.v.d. Walt (cultivars Mabel Grey & Lemon; difficult to propagate and often misidentified in the marketplace - Peddie, personal communication)

P. crispum L'Hérit. (lemon geranium)

P. cucullatum L'Hérit. (*P. acerifolium* L'Hérit., *P. citriodorum* (Car.) Mart.) (maple-leaved geranium, Spanish Lavender)

P. denticulatum Jacq. (pine geranium)

P. fragrans Willd. (nutmeg geranium; a hybrid of the pennyroyal-scented *P. exstipulatum* (Cav.) L'Hérit. and apple geranium)

P. graveolens L'Hérit. (rose geranium, sweet-scented geranium)

P. grossularioides (L.) L'Hérit. (gooseberry geranium, coconut geranium; "not noticeably fragrant" - Vorster, personal communicaton)

P. limoneum Sweet (English finger-bowl geranium; a hybrid derived partly from lemon geranium)

P. odoratissimum (L.) L'Hérit. (apple geranium)

P. quercifolium (L.f.) L'Hérit. (oak-leaved geranium; "rather unpleasant odor" - Vorster, personal communication; *P. panduriforme* Eckl. & Zeyh. is also called oak-leaved geranium, and the two species may be confused)

P. radens H.E. Moore [crowfoot geranium; "rather unpleasant odor" - Vorster, personal communication; the cultivar Cinnamon Rose is commonly assigned to this species, but this nomenclature may be inaccurate (Peddie et al. (1991).]

P. scabrum (L.) L'Hérit. (apricot geranium, strawberry geranium) [Note that "strawberry geranium" is an alternative name for a popular houseplant unrelated to the geraniums, *Saxifraga stolonifera* Meerb., better known as mother-of-thousands.]

P. tomentosum Jacq. (herb-scented geranium, mint geranium, peppermint geranium) [Mint geranium (mint-geranium) can refer to costmary, *Tanacetum balsamita*, discussed in this book.]

Pelargonium graveolens, the most important "species" for production of geranium oil, is illustrative of the confused state of understanding of some of the cultivated groups. The various cultivars that are presently included in *P. graveolens* probably trace to different parental species, wild or domesticated, and it is uncertain what the limits of the species, as encountered in cultivation, should be (Huxley et al. 1992).

Uses

For culinary purposes, fresh or dried leaves are used to flavor gelatins, puddings, and preserves and the like. The leaves can be infused in liquid, and the filtered liquid employed to flavor sauces, custards, jellies, buns, water ices, butters, jams, sugar, syrups, and vinegars (Bremness 1988). Sweet-scented geraniums can also be used to flavor liver pâaté, watercress soup, Welsh rarebit, and fish (Bremness 1988). Sweet cakes can be flavored by putting a leaf in the bottom of a cake pan. The flowers can be tossed in salads (Bremness 1988). Geranium ice cubes can be prepared by freezing sprigs (especially of lemon or mint-flavored forms) in the ice cube tray (Van Pelt Wilson 1947). Geranium oil is used in baked goods and fruit desserts. In the native African area of *Pelargonium*, the Hottentot allegedly used geranium leaves to make tea (Watt and Breyer-Brandwijk 1962). [Vorster (personal communication)

Fig. 300.
Pelargonium Chocolate Mint, prepared by S. Rigby.
(Based on greenhouse plant from Richters.)

"cannot imagine anyone drinking it for pleasure," and thinks that *Pelargonium* preparations are used exclusively medicinally in Africa.] The wide range of geranium tastes (e.g., lemon) and scents (e.g., apple, nutmeg) allows for an extensive range of culinary applications. As mentioned under Medicine, susceptible individuals can suffer dermatitis from contact with geranium or its oil. However, geranium is one of the few garden ornamentals that one can confidently use for culinary purposes, at least occasionally. "*Pelargonium* species are generally recognized as safe for human consumption as natural seasonings/flavorings and as plant extracts/essential oils" (Simon et al. 1984).

Geranium oil is extensively used in perfumery and cosmetics. Morton (1981) notes that oil from *P. capitatum* is commercially distilled from the leaves and stems, and used to scent perfume and soap; while oil from *P. graveolens* is used for food flavoring, as well as for scenting perfume, soap, and other toilet products. Dried, fragrant leaves are used in sachets and potpourris. The scented geraniums are widely grown in flower gardens and as potted plants. Because of its citronellol content, geranium has been reported to have some value in repelling insects (but see Curiosities).

Recipe Sources

Bryan and Castle (1974) have recipes for Rice pork balls and Cauliflower in geranium sauce. Garland (1979) gives recipes for Geranium jelly and Scented blackberry crêpes (with geranium leaves). Bonar (1985) presents recipes for Rose geranium punch and Rose geranium butter. Leggatt (1987) has recipes for Celeriac purée with pears or quinces and pelargonium and Scented-leaved geranium ice cream. Bremness (1988) presents recipes for Sweet rice with rose geranium, Scented geranium leaf sponge, and Spicy geranium tea. Holt (1991) has recipes for Rose-scented geranium tea and Fresh blackberry cake with rose geranium cream. Peddie et al. (1991) provide recipes for: Scented geranium jelly, Rose geranium syrup, Scented geranium sorbet, and Silver scented geranium cake. Barash (1993) has recipes for Rose geranium jelly, Rose angel cake, Rose geranium cake, and Scented garanium ice cream.

Other recipes are: Rose geranium jelly (Fox 1933); Geranium sugar (Muenscher 1978); Lemon salad dressing (Rose 1979); Geranium leaf sorbet (Boxer and Back 1980); Geranium tea (Marcin 1983); Lime geranium confectioners' sugar (Tolley and Mead 1985); Scented geranium jelly (Jeanneret 1987); Rose geranium vinegar (Hutson 1987); Sponge cake with rose-scented geranium leaf (Holt 1989); Rose [geranium] cake (Kublick 1990); Scented geranium cake (Belsinger 1991).

Importance

Geraniums are primarily popular garden plants, and a source of a fragrant oil. Except for some utilization of geranium oil in commercial food preparations, the culinary use of geranium is insignificant, and is essentially confined to occasional home use.

Rose geranium (*P. graveolens*) is grown commercially as a source of geranium oil in Egypt, France, China, India, Algeria, Morocco, Spain, and El Salvador (Morton 1981; Simon et al. 1984). It has also been alleged to be grown for oil in South Africa, but this is not the case, although it is the main industry on the island of Réunion (Vorster, personal communication). Verlet (1993) estimated the annual world value of geranium essential oil to be $10 million (U.S.).

Cultivation Notes

Soil

In nature, all species of *Pelargonium* grow on nutrient-poor sand (Vorster, personal communication). Geraniums thrive in well-rotted, well-drained compost and fertile soils. In their native habits they generally grown on dryish, well-drained loamy soils. "The key to successful cultivation is a very well-drained soil" (Vorster, personal communication). For pot culture, Van Pelt Wilson (1947) recommended three parts loam, one part coarse sand, and one part leafmold (or one-half part leafmold and one-half part peatmoss). For pot culture, a commercial grower's mix is preferable to garden soil (Peddie, personal communication).

Climate

Almost all *Pelargonium* species grow and flower best under cool conditions, in moist but well-drained soil (van der Walt et al. 1988). Curiously, they are not commercially viable either as an oil crop or as a horticultural subject in their native South Africa because the spring, although ideal, is only a few weeks long, and is followed by a summer which is far too hot (Vorster, personal communication). By contrast, the whole summer is ideal in Europe, where one sees splendid displays in flower beds. Areas of the tropics and subtropics where *Pelargonium* oil is produced are all at high altitudes with a temperate climate all year round (Vorster, personal communication). The peppermint geranium tolerates light shade, but all scented geraniums do best in full sun (Crockett and Tanner 1977). A high light level is very important, and in nature practically all species occur in direct sunlight [Vorster, personal communication; Peddie (personal communication), however, has found that many species do not grow well in the full sun of Texas or of other parts of the U.S. with intense insolation]. *Pelargonium* does not tolerate frost, and must be wintered indoors in Canada and the northern U.S. However, many of the species endure some drought, and indeed are damaged by heavy rains. Van Pelt Wilson (1947) recommended that pots of scented geraniums be allowed to dry out, but only a little, between thorough soakings, and that water should never be allowed to collect in pots or saucers under pots. Peddie (personal communication) advises against allowing the soil to dry significantly between waterings. Geraniums can be brought indoors during the winter as a potted house plants, preferably in a cool location, and lightly watered.

Propagation and Cultivation

Potted plants that have been sunken in the garden during the summer can simply be brought indoors before threat of frost. However, reproducing plants by cuttings tends to result in healthier stock. Most geraniums can be reproduced by root cuttings, but stem cuttings are universally employed.

Most species can be grown from seed, but many plants of geranium are of hybrid origin and need to be propagated vegetatively. Seeds are sown shallowly, and preferably kept at no lower than 13°C. Germination usually occurs in several weeks, or in some cases, in several months.

The best time to take stem cuttings is soon after the flowering season. Typically, cuttings are made in early fall before frost. Unlike some other house plants, cuttings of geraniums tend to rot if the attempt is made to root them in water. Brigham (1958) provided the following instructions for rooting scented geraniums. Cuttings (7-13 cm long) from young, short-jointed shoots can be placed in a sand and peat mixture to root. Using a sharp knife, cleanly cut a stem just below a node (where a leaf grows from the stem). Large varieties require cuttings 10-13 cm long, while cuttings of smaller varieties can be about 7 cm long. Remove all but three leaves. Cut ends may be dipped in root-stimulating hormone. The cuttings are inserted sufficiently deep in sand that they will stay erect. These are watered and kept shaded for a few days, then gradually exposed to sunlight. Subsequently the cuttings should be kept on the dry side, and not overwatered. Cuttings are potted when the roots are 1.5-2 cm long.

Keeping the root systems of potted plants slightly pot-bound usually prevents the plants from growing large and taking excessive room (Van Pelt Wilson 1947). Scented geraniums benefit from regular pruning, which encourages branching. They can be trained to standards to produce attractive pot plants. Peddie (personal communication) advises that many species do not respond well to pruning, and she recommends that "tip pruning" rather than regular pruning is preferable.

Indoor plants should be kept fairly cool if possible (12°C at night and 18°C during the day are desirable), best achieved in a house by placing the plants close to a sunny but cool window. Crockett and Tanner (1977) recommend that when wintered indoors, scented geraniums should be given at least 4 hours of direct sunlight daily, or 14 to 18 hours of artificial light. A half-strength house-plant fertilizer can be used every 2 weeks during the flowering season, and monthly during the remainder of the year. Plants should be watered sparingly, the soil allowed to become barely dry before watering. If the soil becomes too dry, the lower leaves tend to turn yellow and fall off. White flies may weaken indoor plants considerably, but once taken outside again in the spring they recover.

Harvest and Storage

For home culinary use, the leaves can be cut at any time from mature plants.

In commercial harvesting of geranium oil, the herb is cut in the morning, in sunny dry weather, with distillation beginning several hours after field drying. Crops are harvested two or three times annually.

Example Cultivars

There are numerous cultivars of scented geraniums. See Bailey and Bailey (1976) and Peddie et al. (1991) for examples of cultivars for the various species. Several recent arrivals of scented geraniums in North America are listed in Shimizu and Pailler (1993).

Additional Notes

Chemistry

Geranium oil is composed mainly of geraniol (often the main component), citronellol, linalool, citronellyl formate, and other compounds (Simon et al. 1984). All parts of the popular rose-scented geranium (*P. graveolens*), except the petals, contain citronellol and geraniol (Morton 1981). Peppermint-scented *P. tomentosum* was found to have essential oil composed mainly of isomenthone and menthone (Demarne and van der Walt 1990).

Medicine

In their native area of Africa, *Pelargonium* species were generally regarded as beneficial for treating diarrhea and dysentery, with the root of several species taken to treat syphilis (Watt and Breyer-Brandwijk 1962). Morton (1981) notes the following uses in Middle America: a bath in a decoction of *P. capitatum* is used in Central America to relieve skin problems; *P. graveolens* is also used in Venezuela as a healthful bathing agent; in New Mexico, a concoction of *P. graveolens* leaves mashed in vinegar and salt is applied to the forehead for headache; and warmed leaves of *P. graveolens* are stuffed into the ear for earache. In the West, geranium has been used as a folk remedy in the treatment of ulcers. In Chinese medicine today, the essential oil of geranium is applied locally to treat cervical cancer (Duke and Ayensu 1985). A terpine hydrate synthesized from geraniol has been found to be an effective agent promoting the discharge of mucus from the respiratory tract (Simon et al. 1984). Geraniums are not used today in modem western medicine.

Scented geranium and geranium oil have been reported to cause contact dermatitis in some individuals (Simon et al. 1984). Duke and Ayensu (1985), however, note that a test of 400 persons failed to elicit dermatitis.

Nutrition

Geranium is used for culinary purposes in such small amounts that it cannot be considered to be a source of nutrients.

Curiosities

• The name *Pelargonium* is derived from the Greek *pelargos*, a stork, because the fruit is long and slender like a stork's bill. Species of the genus *Pelargonium* are often called storkbill.

• In Victorian England, pots of scented geraniums were strategically positioned indoors so that the long skirts of ladies would brush against them and spread the scent throughout the room (Bremness 1988).

• In the Victorian language of flowers, unexpected meeting was signified by lemon geranium, while nutmeg geranium meant expected meeting (Barash 1993).

• Scented geraniums generally do not thrive in the low light levels in many interiors. With the invention of Edison's electric light, one of the first houseplants suggested as benefitting from the extra illumination was the scented geranium (Peddie 1990*a*).

• An apparent hoax involved the marketing of a scented geranium called Mosquito Fighter [see Tucker and Maciarello (1993) for detailed discussion.]. It was claimed to be the result of genetic engineering that transferred to it a gene (from *Cymbopogon nardus* discussed in this book) producing citronella oil, a common ingredient in insect repellents. Said to keep mosquitoes, black flies and other insects away (tests have shown that these claims are untrue), the plants sold for up to $25.00 each (Richters 1994). Some scented geraniums, however, are actually used as intercrops to repel insects (Duke and Ayensu 1985). Barash (1993) warns against using Mosquito Fighter as a culinary herb. The artist who drew Fig. 301 experienced nausea and burning eyes simply from working near the plant. I have personally suffered breathing problems and vertigo when very near this plant, and have learned of similar ordeals from others who have grown the herb. This is an ideal gift for one's enemies.

Problems and Potential

Geranium is a popular bedding plant widely sold in the nursery trade, and its culinary use is quite incidental, and of very minor significance. Geranium oil, which has some importance for commercial flavoring, and considerable importance as an industrial scent, is extracted from plants grown in warmer regions than found in most of North America, and there is little prospect of establishing a geranium oil crop in the U.S. or Canada.

Fig. 301.
Pelargonium Mosquito Fighter, prepared by S. Rigby.
(Based on greenhouse plant from Richters.)

Selected References

Simon et al. (1984); van der Walt (1985); Peddie (1990*a*) (from a symposium on scented geraniums; also see pages 90-102 for other articles from the symposium); Peddie et al. (1991).

Fig. 302.
Perilla *(Perilla frutescens)*, from Curtis (1787-present; #2395).

Perilla

Family: Labiatae (Lamiaceae) (mint family)

Genus Notes

Perilla has about six species of annual herbs native to southeast Asia, from India to Japan. Leaves and flower clusters of *P. arguta* Benth., an annual herb of China and Japan called shiso, are used in Japan as a condiment, and its seeds and sprouts are also eaten (Uphof 1968).

Perilla Frutescens (L.) Britton

Scientific (Latin) Synonyms

P. ocymoides L. ("*P. ocimoides*"); *Ocimum frutescens* L.

English Names

Perilla
Also: beef-steak plant (beefsteak plant), mint perilla, perilla mint, purple mint, purple perilla, shiso (also applied to *P. arguta*), summer coleus, suttso, wild coleus

French Names

Family: Labiées, famille de la menthe
Pérille (f)
Also: grande basilique, mé1isse (normally used for *Melissa officinalis*), shiso

Warning

Although widely consumed, this species has been shown to have poisonous constituents (see Problems and Potential). It should be avoided during pregnancy (Foster and Duke 1990). Prolonged skin contact may produce dermatitis (Kuebel and Tucker 1988).

Description, Taxonomy, and History

Perilla frutescens is an erect, white-, purple- or red-flowered, bushy annual herb growing 0.5-2.0 m in height. The foliage is strongly aromatic, with a cinnamon aroma. The leaves often become purplish at maturity. Leaves of some horticultural selections may be quite purplish, bronze-purple, or green mottled with purple, red, pink, or white, and are sometimes wrinkled. The fringed leaves are reminiscent of coleus, hence the name summer coleus. The leaves also have a superficial resemblance to basil. As noted below, perilla has been selected for divergent uses, and cultivars vary considerably in appearance and chemistry.

The species is indigenous from the Himalayas to eastern Asia, including India, Burma, and China. In Japan it probably is introduced (Mansfeld 1986). Perilla seems to have first been cultivated in China, and has long been grown in Japan, Korea, Vietnam, Burma, India, Iran, and southern Europe (Mansfeld 1986). It has been cultivated as an oil crop at least since the 13th century in Korea (Lee et al. 1989). Perilla has escaped from cultivation in many areas, and has become naturalized. It was introduced as an ornamental to the U.S., and escaped to become a troublesome weed in much of the southeastern U.S. It has been collected as far north as southern New England and as far west as eastern Texas, Oklahoma and Kansas. In the U.S. it occurs along streams and roadsides and in pastures and waste areas, preferring semi-shade such as moist, open, wooded locations.

Uses

Perilla is a multi-purpose plant. Brenner (1993) noted nine ways the species has been used: the seeds as food for birds and humans; the seed oil as a fuel, drying oil, and cooking oil; the leaves as a potherb, for medicine, and for food coloring, and to produce an essential oil for flavoring. To this may be added use as an aromatic ornamental, honey plant, and condiment.

Perilla is important in Japanese cooking, as one of the popular garnishes and as a food colorant, especially in *shisho*, the Japanese national dish. The aroma of the herb has been described as pleasant, and the flavor as somewhat cinnamon-like (Morton 1991*a*). Seeds and leaves am used as food, to give a reddish color to pickles, as a condiment in foods such as tofu, and as a garnish for tempura. Seeds can be preserved in salt. The seeds may be germinated and the sprouts consumed. Seedlings are used as a spice for sliced raw fish. Young leaves and tender shoots are deep fried in butter. The leaves am an ingredient in mume (pickled Japanese plum) tea. Flowers are used to make an unusual tempura: cut young flower spikes are dipped in tempura batter and deep fried. Flowers are also occasionally added to soups as a seasoning. The seeds and flowers can be used in herbal teas. Immature flower clusters are used as a garnish for soups and chilled tofu, while older ones are fried. The leaves are also used to flavor dishes in India, China, Korea, and Vietnam. In Hawaii the Japanese use the young leaves as serving beds for deep fat-fried shrimp (Standal et al. 1985). Hutson (1987)

recommends wrapping the leaves around shrimp, fish, chicken or beef and dipping in spicy sauces. Seeds of perilla are eaten as a subsistence food by various tribal groups in northeast India, and the oil is also used for cooking (Longvah and Deosthale 1991).

Perilla seeds are pressed to express an oil. This oil is commercially produced in Korea (Lee et al. 1989). The oil makes up about 40% of the seeds. After oil is extracted, the residue has been used as a high-protein calf feed (but see Medicine for potential toxicity of seeds). Perilla seed oil is a drying oil, resembling linseed oil and tung oil, and when dry provides a hard, tough, brilliant film, useful for water-proofing paper. The oil is used in cooking, and to manufacture cheaper lacquer varnishes, and in printing ink, dyes, paints, enamels, Japanese oil paper, artificial leather, linoleum and protective clothing (Uphof 1968; Mansfeld 1986). The oil has been used for fuel (Brenner 1993).

An aromatic oil is distilled from the leaves and inflorescences in Japan. The herb oil (in contrast to the seed oil) is largely used as a flavoring and sweetening agent in confectionary and in cosmetics. It is employed to sweeten tobacco, and flavor sauces, chewing gum, and candy. The oil is strongly antiseptic and is also used in toothpaste, mouthwash, and as an antimildew agent (Vadivel et al. 1981; Mansfeld 1986).

A nonnutritive sweetener, much sweeter than sucrose, is extracted from perilla in Japan (Duke 1992; see Curiosities). Perilla alcohol, prepared from perilla aldehyde, is employed in fragrances, and can be used in food (Brenner 1993).

Perilla is frequently planted as an ornamental, particularly in subtropical areas, but also in temperate regions.

Recipe Sources

Tsuji (1980) gives recipes using perilla leaves, including Tempura, Yellowtail lemon sashimi, Kisu sashimi, Beef sashimi, and Tangy white salad. Hawkes (1984) has a recipe for Perilla-cucumber relish.

Importance

The main economic use for perilla is as a source of oil (i.e. as an oilseed, not as an essential oil plant). Perilla is a minor source of essential oil, with about 1500 kg produced annually in the world (Lawrence 1992). The species is grown as an oilseed in Russia, Cyprus, South Africa, Austria, and the U.S. (Mansfeld 1986), and in Korea (Lee et al. 1989). Perilla has been grown experimentally in the U.S., but was not considered to have potential as an oilseed (Brenner 1993). In the U.S., the species has been grown for non-ornamental uses in Hawaii, California and Florida

Fig. 303.
Perilla *(Perilla frutescens)*,
from Lamarck and Poiret (1791-1823).

(Morton 1991*a*). Commercial plantings in the U.S., Cyprus, and South Africa have met with little success (Roecklein and Leung 1987).

Perilla is also a well known condiment and ornamental in southern Asia, particularly in India, Korea, and Japan, where it is predominantly grown. In the southeastern U.S. it is a troublesome weed that has the potential of poisoning livestock. Perilla products are generally available in Oriental food stores in North America. The plant is occasionally grown as an ornamental. Duke (1992) notes that in the Washington, De area, perilla is cultivated in window boxes and gardens near Oriental restaurants, presumably as edible landscaping. Seasoned leaves in oil, packaged in small flat fins, are commonly marketed in the U.S. (Morton 1991*a*).

Cultivation Notes

Soil

According to Crockett and Tanner (1977), perilla grows in any soil. It grows well in sandy loams and rich, well-drained, moisture-retentive soils. The pH range occupied is 5.0-7.5 (Duke 1979).

Climate

Perilla frutescens can be grown like other tender annuals. Although perilla tends to die with the first frost, Duke (1992) notes that it is not quite as sensitive to frost as basil. It grows well in both full sunlight and partial shade (Crockett and Tanner 1977; Duke 1992). Perilla is a short-day plant, and is very sensitive to shortening days (of late summer), which bring it into flower (Lee et al. 1989).

Propagation and Cultivation

Perilla is propagated by seeds. According to Anon. (1983), the seeds will not germinate without first being exposed to a low temperature. Light is required for the seeds to germinate, so they should not be covered, or should only be thinly covered with soil (Parke 1984). Germination takes 15-30 days (Parke 1984). The seeds seem to be short-lived, and can die in less than a year at room temperature; lowered temperature or humidity dramatically improves storage life (Brenner 1993). Seedlings should be kept at a temperature no lower than 13°C (Parke 1984). Crockett and Tanner (1977) recommend starting seeds indoors 8 to 10 weeks before outdoor night temperatures remain above 12°C, when the seedlings may be transplanted to the garden. When the plants are about 15 cm tall, the tips may be pinched off to stimulate branching, with repeated pinching at every 15 cm of growth to promote bushy plants (Crockett and Tanner 1977). Given its demonstrated weediness in the southeastern U.S., perilla does not seem to require a great deal of care. Deadheading (removal of seed pods) will prevent seed dispersal.

Harvest and Storage

Fresh, young leaves and flowers can be harvested as desired for immediate consumption. In Japan, entire plants with roots and stems are sold in stores, although usually only the leaves are used (Tsuji 1980).The plants wilt fairly quickly after harvest, and unlike many other edible plants, the leaves are not revived well by placing them in water (Tsuji 1980). Foliage that is dried for aromatic oil distillation is harvested at flowering and dried in sheds (Publications and Information Directorate 1966). Seed yields of up to 680 kg/ha have been realized in Japan (Publications and Information Directorate 1966).

Example Cultivars

Atropurpurea, Crispa (= Nankinensis), Curled, Green, Green Cumin, Laciniata, Lemon, Red. Facciola (1990) describes most of these. Anon. (1983) discussed the use of Crispa for food in Japan.

Additional Notes

Chemistry

The volatile oils of *Perilla frutescens* contain several compounds, such as *1*-perillaldehyde, perilla ketone, egomaketone, and isoegomaketone (Kerr et al. 1986). Oil from dried leaves and inflorescences contains about 50% perillaldehyde, which as observed earlier is used as a flavoring and antiseptic agent. Main constituents may be perillaldehyde and related compounds, furyl ketone derivatives, phenylypropanoids, citral, limonene, transcitral or other compounds (Aritomi 1982; Aritomi et al. 1985; Misra and Husain 1987; Fujita et al. 1994; Nguyen-Xuan-Dung et al. 1995; Yuba et al. 1995). Perilla ketone has been associated with poisoning in domestic animals, as noted below. There is considerable chemical diversity in perilla, and consumption of the distinct chemotypes may result in different biological effects (Brenner 1993). The chemical type which mainly contains the monoterpene perillaldehyde is preferred for human consumption because of its agreeable fragrance; the chemotypes with ergomaketone and perillaketone have disagreeable ketone odors and are toxic; and the phenylpropene chemotype is almost odorless (Franz 1993).

The seed oil of perilla is unusual for its high iodine number; that is, it has many unsaturated bonds (Brenner 1993). The seed oil consists mainly of the polyunsaturated fatty acid, linolenic acid (Lee et al. 1989), some samples containing up to 70% (Publications and Information Directorate 1966).

Colored leaves of some forms of perilla contain the anthocyanin perillanin chloride; such leaves are used in Japan for coloring plum preparations (Publications and Information Directorate 1966).

Medicine

In Asian herbal medicine perilla is used as a sedative, to treat spasms, uterine and head problems, and to increase perspiration (Pandey 1990). In Korea it is used for colds and coughs. In Vietnam perilla is used against fever and malaria (Nguyêñ-Xuân-Duñg and Dô-Tât-Loi 1991). In Chinese medicine it is employed alone or in combination with other herbs to treat cholera, colds, influenza, stomach problems, nausea, poisoning, asthma, bronchitis, chest pain, rheumatism, and other ailments (National Academy 1975; Duke and Ayensu 1985). In Chinese folk medicine the seeds are used to treat premature ejaculation (Duke 1992). Perry and Metzger (1980) and Duke (1985) review additional medicinal uses in other parts of Asia.

Perilla is well known as a cause of poisoning in domestic animals. Although cattle avoid it, perilla has been implicated in cattle poisoning (Brenner 1993). Kerr et al. (1986) studied the toxicity of the plant. Perilla ketone appears to be the primary toxin, the amount increasing notably during fruiting. Both seeds and leaves contain the ketone, which has been described as a potent lung toxin (Kuebel and Tucker 1988). Dermatitis has been reported on the hands of 20 to 50% of long-time workers who handle perilla plants (Duke 1985).

Nutrition

Duke (1977) characterized leaf content of calcium, fiber, iron, potassium, and riboflavin as high; the seed content of calcium, calories, iron, niacin, protein, and thiamin was characterized as high, and the content of fiber as very high. Lee et al. (1989) state that the leaves are rich in vitamins B and C. Nutritional analyses of seeds of perilla were conducted by Standal et al. (1985). They found that roasted seeds contained over 26% lipid and over 15% crude protein, and thus may be considered a good source of these nutrients. Moreover, examination of the essential amino acids showed that in some respects the seeds surpassed milk and cheese as sources of quality protein. Longvah and Deosthale (1991) conducted additional nutritional studies of the seeds. They noted that perilla seed protein was comparable in quality to several other oilseed proteins, and was a rich source of polyunsaturated fatty acids.

Curiosities

• Perilla was once used as a fish poison (Foster and Duke 1990).

• Duke (1992*a*) presents some interesting speculations on the use of perilla as food. He notes that the observation that Orientals have less breast cancer than Occidentals *until* they adopt a western diet, and wonders if this could be related to the alpha-linoleic acid content of perilla. And, he notes that perilla has a folk reputation as an antidote to fish poisoning, and wonders if that is why it is so widely used in sushi. (For a comparable hypothesis about sushi, see ginger Curiosities.)

• Perillaldehyde in perilla, used as a sweetening agent in Japan, is 2000 times as sweet as cane sugar and about six times sweeter than saccharin (Brenner 1993).

Problems and Potential

The presence of components in perilla that have proven to be toxic to domestic animals remains a concern, although it is interesting that the plant and its oil continue to be widely used in Asia as human food. The food use of perilla in North America has a potential market (albeit limited), at least for those of Asian origin who are aware of the traditional uses of the plant. The sweet components of perilla may have some promise for development as a nontoxic sweetener (Morton 1991*a*). Perilla's habit of ripening and dropping the seeds over a long period limits collection of the seeds for extraction of oil (Roecklein and Leung 1987). Early maturing oilseed cultivars were developed for the North Central U.S., but they have not been grown commercially (Brenner 1993). The plant is the subject of breeding in Korea to improve the production of leaves as a potherb, as well as for the harvest of seed oil (Lee et al. 1989).

Selected References

Publications and Information Directorate (1966); Kuebel and Tucker (1988); Lee et al. (1989); Morton (1991*a*); Brenner (1993).

Petroselinum

Family: Umbelliferae (Apiaceae) (carrot family)

Genus Notes

There are three species of *Petroselinum*, all herbs of the Old World. One of these, discussed below, is grown as a root vegetable, and for its leaves for use as a herb and garnish.

Petroselinum Crispum (Mill.) Nym. ex A.W. Hill

Scientific (Latin) Synonyms

P. hortense Hoffm., *P. sativum* Hoffm., *Carum petroselinum* (L.) Benth. & Hook.f.

This species is a biennial or short-lived perennial, that probably originated in southern Europe or western Asia. It is cultivated in parts of Europe, Asia, northern and eastern Africa, and warmer parts of the New World. *Petroselinum crispum* has been selected for edible leaf blades, edible leaf stalks, and edible roots. Plants grown for these three purposes are often separated taxonomically (e.g., Bailey and Bailey 1976). Mansfeld (1986) presents an elaborate system of groupings of cultivars. This book adopts a simplified treatment with just two varieties, one grown for the roots, the other for the leaves (whether for the leaf blades or leaf stalks).

Variety *tuberosum* (Bernh.) Crov., turnip-rooted parsley, is grown as a vegetable for its thickened, parsnip-like root, occasionally also for its leaves. This is discussed extensively as a vegetable in Munro and Small (1997). The subject of this chapter is variety *crispum*, parsley, grown for its edible leaves used as a herb, garnish, and occasionally in vegetable dishes.

Whether or not there are truly wild forms of *P. crispum* is unknown, although the species is ruderal (Simmonds 1976). Wild-growing forms in Europe or western Asia may represent a native distribution, while wild-growing plants in other areas, including North America, are commonly interpreted as escapes from cultivation. Plants are occasionally collected outside of cultivation in Canada and the U.S., but are scarcely established.

Petroselinum Crispum. var. Crispum

English Names

Parsley
Also: common parsley, Neapolitan parsley (as explained below, for certain cultivars)
Chinese or Japanese parsley is coriander (*Coriandrum sativum*), discussed elsewhere in this book. Beaked parsley, French parsley, and gourmet parsley refer to chervil, *Anthriscus cerefolium*, also discussed in this book.
[Vietnamese parsley is a name occasionally applied to two other culinary herbs discussed in this book: the herb rau ram (*Polygonum odoratum*, which see); and *Oenanthe javanica* (see *Apium* curiosities).]

French Names

Family: Ombellifères, famille de la carotte
Persil (m)
Also: persil commun, persil cultivé, persil des jardins, persil frisé, persil odorant, persil vulgaire, persin
[Also persil + variants; e.g., Neapolitan parsley = persil aux feuilles de cé1eri (Stobart 1977).]

Description, Taxonomy, and History

Parsley is a hardy biennial or short-lived perennial plant usually cultivated as an annual, unless grown for seed (Greenhalgh 1979).The roots are thin and fibrous, the main tap root capable of penetrating the soil to a depth of over a metre. Some cultivars with curled and crisped edible leaf blades are sometimes called "moss-leaved" or "common parsley" (as noted below, in some countries this is much less common than Italian parsley). These are widely cultivated in North America and parts of western Europe. So-called "fern-leaved" forms, with quite dissected leaf blades, are variants of the curly type. Many cooks contend that the flat-leaved forms are superior for culinary purposes to the curly-leaved forms (Crockett and Tanner 1977).

Some cultivars with flat, non-crisped leaf blades, are grown for their edible leaf stalks. These are referred to as Neapolitan parsley, Italian parsley, celery-leaved parsley, plain-leaved parsley, or flat-leaved parsley (var. *neapolitanum* Danert of some authors). Italian parsley is widely cultivated in the Mediterranean region (Prakash 1990), sometimes in countries where the curly-leaved form is almost unknown. Some authors (e.g., Bailey and Bailey 1976) separate parsley grown for leaf blades as var. *crispum*, contrasting this formally with Italian parsley as var. *neapolitanum*. Both groups are included here in var. *crispum*.

Parsley was used medicinally by the ancient Greeks and Romans (le Strange 1977). Both forms noted above were known by 322 B.C., as mentioned by the Father of Botany, the Greek Theophrastus (370-285 B.C.). Parsley was also used as a flavoring and in large quantities in

Fig. 304.
Parsley *(Petroselinum crispum)*, from Köhler (1883-1898).

broths. Some forms were selected for petiole (leaf stalk) characteristics, to be consumed much like celery. Domesticated parsley spread to western Europe during the 15th and 16th centuries. Parsley was introduced to England from Sardinia in 1548, and was often used in pies. Parsley is now found cultivated and naturalized in most temperate and many tropical areas worldwide (Grieve 1931).

Uses

Parsley leaves "have endless uses as seasoning in sauces, dressings, croquettes, egg, fish, shellfish, and meat dishes" (Morton 1976). The fresh leaves are employed for garnishing and seasoning, and can even be regarded as a vegetable in some dishes because of the amount used. The leaves are added to soups, salads, stews, and vegetable dishes, and are steeped as a tea. Dehydrated parsley leaves, known as parsley flakes, are employed to flavor soups, meat and fish dishes, vegetable dishes, and salads. Parsley is also an ingredient of many meat and poultry seasonings.

Three French terms in the culinary arts refer to parsley. *Persillade* is a finely chopped mixture of parsley and shallot, added toward the end of cooking a dish. An unusual but delicious application is in preparing biscuits. *Bouquetgarni* is a combination of parsley and other herbs. According to Farrell (1985), *aux fines herbs* refers to the use of parsley alone, although originally it was a mixture of parsley with tarragon, chives, or chervil.

The Neapolitan or celery-leaved forms, grown for the leafstalks, are very popular in European cooking. The leaf-stalks are blanched and eaten. They are said to have a stronger flavor than the more common curled-leaved forms.

Fig. 305.
Parsley *(Petroselinum crispum)*,
from Vilmorin-Andrieux et C^{ie} (1883).

An oil extracted from leaves and seeds is used for flavoring of food products such as cured and canned meats, condiments, sauces, pickles, bakery products, and soups. The oil is also employed in the formulation of compounded aromatics, and to a limited extent in perfumes, soaps and creams (Greenhalgh 1979; Simon and Quinn 1988; Prakash 1990).

The juice of fresh leaves has been used as an insecticide (Prakash 1990).

Recipe Sources

Day and Stuckey (1964) have recipes for Parsley-cheese biscuit ring, Parsley-cheese croustades, and Lemon-parsley butter. Rosengarten (1969) presents recipes for Turkey giblet stuffing with parsley, and Asparagus with parsley sauce. Sanecki (1974) has recipes for Parsley sauce and Parsley mayonnaise. Owen (1978) presents recipes for Tab(b)ouleh (Tabouleh is a Middle Eastern salad), and Parsley and potato soup. Rodway (1979) gives recipes for Bread with herbs (parsley) and Parsley tea. Shepard (1979) has recipes for Parsley chutney, Parsley sauce, and Parsley salad. Belsinger and Dille (1984) present 11 parsley recipes, notably: Cream of parsley soup, Sweet potato and parsley salad, Parsley cheese spread, Pecan parsley dip, Fillet of sole with parsley, and Braised artichokes with parsley. Hawkes (1984) has the following recipes: Parsley bread, Parsley jelly, and Parsley dumplings. Holt (1989) gives recipes for Hot parsley mousse with chive cream, Parsley potatoes, Rabbit pie with parsley cream, and Potato pie with garlic and parsley. Richardson (1991) has recipes for Parsley butter, Parsley-shallot stuffing for chicken or Cornish game hens, Tabouleh with Italian parsley, Parsley winter soup, Parsley green sauce, and Parsley potato pancakes.

Other recipes are: Parsley soup (Fox 1933); Crushed wheat, tomato, mint and parsley salad (Nickles 1971); Parsley sauce (Bryan and Castle 1974);Tabouleh (Lebanese salad with parsley) (Lappé 1975); Stuffed cucumbers in parsley sauce (Kuo 1977); Ham in a parsley jelly (Garland 1979); Ladies' thighs' croquettes (Mallos 1979); Fried parsley (Mességué and Peter 1982); Parsley tea (Marcin 1983); Chicken and parsley pie (Hemphill and Hemphill 1984); Parsley salad (Brennan et al. 1985); Sweet parsley wine (Jessen-Klixbull 1985); Sardines in wine with parsley (Bremness 1988); Ham in parsley aspic (Holt 1989).

Importance

Parsley is the most popular of all garnishing herbs in the West, and is a major herb in many parts of the world. It is grown in the Mediterranean region of southern Europe, Algeria, Belgium, Germany, France, Hungary,

Great Britain, the Netherlands, and several other European countries, as well as the U.S. (Farrell 1985) and Canada. "It is more common in home gardens the world over than any other herb" (Morton 1976). Parsley has been described as "the most widely cultivated and useful culinary herb in the United States," where it is "the volume leader of fresh market herbs in the produce trade" (Rabin 1987). The U.S. is the world's largest producer of parsley, with California as the major grower. Prakash (1990) estimated that in the U.S. about 1360 t of parsley leaves are dehydrated annually. Dehydrated parsley from the U.S. achieves a superior green color to that produced in Europe and is therefore in much demand. Fresh parsley in the U.S. is produced in California, New Jersey, Florida, and Texas, with smaller volumes from Ohio, Massachusetts and other states (Rabin 1987). In the early 1960's about 30 000 t/year of fresh parsley was produced in the U.S. The 23 major U.S. cities use about 18 000 t/year (Rabin 1987).

Canada is also a world producer of dehydrated parsley flakes and it has occasionally exported sizable but irregular quantifies to the U.S. For instance, in 1988, Canada exported to the U.S. 23 t of unprocessed parsley valued at about $19,000.00 (U.S.). Canada also exported processed parsley valued at 48 t (worth $38,000.00 [U.S.]) in 1986, but only 0.06 t (worth $2,440.00 [U.S.]) in 1988 (Anon. 1989*a*). Parsley is also an important fresh herb and is sold fresh in Canadian supermarkets. In Canada in 1991, 819 t of domestic and 2800 t of imported fresh parsley were unloaded at 10 major Canadian markets (Anon. 1992*c*). There is room for increased domestic production to offset the need for imported parsley in Canada.

Essential oil produced from parsley is of minor value. Verlet (1993) estimated the annual world value of parsley essential oil to be $600,000.00 (U.S.), while that of "parsley herb" essential oil amounted to an additional $360,000.00 annually.

Cultivation Notes

Soil

The best substrates for parsley are fertile, moisture-retentive clay and loam soils. Good drainage is required on heavy clay, and light sandy soils may become too hot, producing poorly developed plants (Prakash 1990). Crockett and Tanner (1977) recommend supplementing the soil with manure or compost. A pH tolerance range of 4.9-8.2 has been reported (De Baggio 1987) (4.9-8.3 according to Simon et al. 1984). A pH between 5.5 and 7.0 is best (Hackett and Carolane 1982).

Climate

Parsley is a cool-season plant that grows optimally at temperatures between 7 and 16°C, while growth slows considerably below 7°C. Germination is best at 12-15° C. Only a rosette of leaves is produced the fast year. Plants can be left in the ground until the second season, when this biennial will flower and set seed. Parsley will self-sow, and once established a patch can maintain itself as far north as the warmer parts of Canada (Halpin 1978; Lima 1986). Moisture is most important during germination and early growth. Irrigation is beneficial during dry periods (Halpin 1978; Yamaguchi 1983). Parsley thrives in full sun, but tolerates very light shade.

Propagation and Cultivation

For commercial production the plants are grown as annuals, with new plants started from seed each season. Germination is slow, erratic, variable, and low, even under optimum conditions (Rabin 1987). Soaking seeds overnight in lukewarm water and irrigating the soil before planting will increase germination efficiency. Alternatively, briefly freezing the seed helps to break dormancy. Major seed suppliers can usually provide seed that has been treated to enhance germination (Mansour, personal communication). Seeds should be planted at a depth of about 6 mm, with seedlings usually emerging in 15-21 days (Wang et al. 1993). Parsley seeds can be sown indoors 4-6 weeks before transplanting outside. The plants are unharmed by light frosts. Planting seeds outdoors too early in the spring may result in premature bolting. For outdoor plantings, mixing in a few radish seeds (which germinate quickly) will help mark the rows where parsley is planted. Seed production of parsley is discussed by Simpson et al. (1985).

Harvest and Storage

The outer two to four leaves of parsley that are completely developed should be picked regularly during the growing season. If not picked the leaves turn coarse and become inferior in quality. The fresh harvested leaves are cooled as quickly as possible using cold air. The leaves may be gathered early in the morning when the air temperature is low. Fresh parsley leaves can be stored successfully for 1-2 months at 0°C and a relative humidity of 90-95% (Wagner 1979).

Commercial production of dried leaves is important to the herb and spice industry. The fresh leaves are dehydrated rapidly to about 4% moisture under controlled conditions of heat and air, to avoid loss of the essential oil that gives

the leaves their characteristic flavor, and to ensure good green color. About 11 kg of fresh leaves yields 1 kg of the dehydrated product (Prakash 1990).

The home gardener can freeze or even dry parsley. The leaves may be dried by spreading them on a screen in a shady, well-ventilated place. The dried product should be stored in an airtight container.

Parsley can be grown indoors as a potted plant to provide fresh leaves all winter. It requires at least 5 hours of direct sunlight daily, or 12 hours of artificial light, and does best at day temperatures below 21°C (Crockett and Tanner 1977). Outdoor plants can simply be potted in late summer and maintained indoors on a cool, sunny window sill.

Example Cultivars

Curled-leaved form: Champion moss curled, Curlina, Dark Moss Curled, Decora, Exotica, Forest Green, Green Carpet, Sherwood, Unicurl.

Plain-leaved form: Plain Dark Green Italian.

Facciola (1990) provide an extensive description of parsley cultivars. Bettencourt and Konopka (1990) list institutions in various countries that conserve germplasm of *P. crispum*.

Additional Notes

Chemistry

Over 75 aromatic volatile components have been characterized in parsley oils (Shaath et al. 1988). The most prevalent constituents in parsley leaf oil are 1,3,8-*p*-menthatriene, myristicin, apiol, -phellandrene,

Fig. 306.
Parsley *(Petroselinum crispum)*,
cultivar Double-curled Dwarf,
from Vilmorin-Andrieux et C^{ie} (1883).

myrcene, and 4-isopropyl-1-methylbenzene (Simon and Quinn 1988).Apiol is often dominant in the oil. Just which of these components is responsible for the flavor and aroma of parsley has been debated (Simon and Quinn 1988).

The oil is obtained by steam distillation and is chiefly used as a flavoring for food products. Commercially, seed oil is extracted mainly from the seed, or the entire aerial parts of the plant at seed formation, prior to ripening. Parsley leaf oil, which is much more characteristic of parsley aroma, is usually not extracted because of the low yield (Simon and Quinn 1988; but as noted in Importance, about 38% of world production of parsley oil is reported to be herb oil). Yield from the herb varies from about 0.04-1.15% on a fresh weight basis (Simon and Quinn 1988). Yield from the mature fruits is about 7%. The herb oil may be adulterated with seed oil, which is of lower quality (Prakash 1990).

Medicine

In folk medicine, parsley was purported to have many medicinal properties (le Strange 1977). Leaves applied to the breasts several times daily were said to suppress secretion of milk. Braised leaves have been employed as a poultice for sore eyes, and applied to bites and stings of insects (Prakash 1990). As a cure for baldness, it was recommended that powdered parsley seed be placed on the skull several nights each year (le Strange 1977). The juice of parsley was used as a general tonic and is said to be a specific tonic for the kidneys. Parsley has been used for tumors, warts, and dysentery (Duke 1985), and for asthma, conjunctivitis, dropsy, fever, and jaundice (Simon et al. 1984). Morton (1981) notes additional folk uses in Central America including employment as an aphrodisiac, to stanch bleeding, and to treat hypertension, kidney infection, and various other problems.

Apiol has been used in medicine to treat kidney ailments and to promote menstrual discharge (Rosengarten 1969). Present-day pharmacological preparations from parsley include infusions and decoctions made with leaves or roots, although the uses of these are limited (Greenhalgh 1979). Apart from some possible minor value for treating digestive problems and stimulating urine flow, parsley has little contemporary value in medicine (Tyler 1993).

Occupational dermatitis occurs in some individuals who work with or harvest the fresh leaves and oils (Mitchell and Rook 1979). Parsley contains 5-methoxypsoralen, a furocoumarin, which can cause photodermatitis (producing a rash after exposure to sunlight) (Mitchell and Rook 1979). Apiol in parsley can be toxic, and the oleoresin of parsley (containing apiol, apiolin and myristicin) in large

doses can produce serious health problems (Duke 1985). "Apiol, in excess, has caused peripheral motor paralysis in humans" (Morton 1981; but see below). Apiol and myristicin are uterine stimulants, accounting for the use of parsley oil to stimulate menstrual flow, and the misuse of parsley oil as an abortifacient (Tyler 1993). Parsley volatile oil should never be consumed by pregnant women. Some years ago it was observed that nerve damage and extensive paralysis frequently followed the use of apiol to produce abortions. The paralysis usually disappeared in a year or two. It has been found that the nerve damage was not due to apiol, but to triorthocresyl phosphate that was also present (Weiss 1988).

According to Morton (1976) "fresh sprigs of parsley are unequalled as garnish but, fortunately, rarely eaten, for parsley is harmful in quantity." She also notes (Morton 1981) "the leaves, eaten in excess, can cause kidney, liver and stomach ailments."

Nutrition

Parsley leaves are a good source of vitamin C, ß-carotene (provitamin A), iron, and iodine (Rosengarten 1969; Hackett and Carolane 1982). Duke (1977) characterized content of calcium, fiber, iron, riboflavin, and vitamin A as high, and content of vitamin C as very high. Morton (1981) stated the leaves are high in calcium, iron, carotene, thiamine, niacin, and ascorbic acid, but noted that the fruits contain the toxic principles apiole and myristin. Of course, there is no nutritional benefit so long as parsley is used merely as a decorative garnish and not actually consumed.

Curiosities

• Ancient writers claimed that consumption of parsley would strengthen blood, soothe the stomach, and absorb the fumes of wine while reducing intoxication. For these reasons, Greek and Roman heroes wore it on their heads at ceremonial banquets (Farrell 1985). Romans were known to wear parsley leaves around their necks to ward off intoxication when drinking (le Strange 1977). Even in the Middle Ages parsley was considered to "helpeth men that have weyke braynes to beare drinks better" (le Strange 1977).

• Ancient Greeks and Egyptians placed parsley wreathes on the tombs of their dead. Parsley was reputed to have sprung from the blood of a Greek hero, Archemorus, the fore-runner of death (Grieve 1931).

• Because of the association with death and funeral rites, in ancient Greece there was fear of bringing parsley plants to the dinner table. In Pennsylvania it was believed that parsley should not be planted in a house for fear someone would die (Fox 1933).

• In ancient Greece, chariot horses were fed parsley leaves to accelerate their speed (Grieve 1931).

• The slowness of parsley to germinate gave rise to the legendary expression "the seed goes nine times to the Devil and back before it starts to grow" (Lust 1974).

• It was believed in the Middle Ages that parsley was one of the Devil's favorite plants, and therefore wicked. Its wickedness could be overcome only by sowing it on Good Friday under a rising moon (Lust 1974).

• In the Middle Ages it was believed that sick fish could be cured by throwing parsley into their pond (Grieve 1931).

• In Spain, parsley has been fed to sheep to bring them into heat (Morton 1981).

• A number of mimics of parsley are known which are rather poisonous. One of these is fool's parsley (*Aethusa cynapium* L.), an annual weed of waste places and gardens which has been accidentally introduced from Eurasia into the northeastern U.S. and southeastern Canada (Fernald 1970).

• Parsley has been used for centuries as a breath freshener, especially for garlic. There is no proof that it works (Rinzler 1990).

• As noted above, it is recommended that parsley seeds be soaked overnight before planting as wetting speeds up the rather slow germination. However, parsley seeds become adhesive when wet, sticking to the fingers like glue, which may make planting by hand difficult (Gilbertie 1988).

• Caterpillars of the eastern black swallowtail butterfly (*Papilio polyxenes*) are regularly found feeding on parsley, dill, and other members of the carrot family. These very rarely significantly damage the plants, and unless very numerous they should be allowed to complete their life cycle (Cheatham and Johnston 1995).

Problems and Potential

Parsley is an important fresh herb and dehydrated seasoning in North America. With increased interest in ethnic cooking, fresh parsley is being consumed in larger quantities for such dishes as Lebanese tabouleh. There is potential for increased domestic production to meet growing consumer demand (Anon. 1992*c*).

Selected References

Greenhalgh (1979); Hackett and Carolane (1982); Farrell (1985); Lima (1986); Rabin (1987); Prakash (1990).

Pimpinella

Family: Umbelliferae (Apiaceae) (carrot family)

Genus Notes

Pimpinella has about 150 species of herbaceous plants native to Eurasia and North Africa. Perhaps the most notable species after the one discussed below is *P. alpina* Koord, a perennial herb of Java, whose aromatic root is in demand there as an aphrodisiac (Uphof 1968). *Pimpinella major* (L.) Huds. (greater burnet saxifrage) and *P. saxifraga* L. (burnet saxifrage) of Eurasia are grown in North America as ornamentals; their roots produce an essential oil used to flavor candy and liqueurs, and in pharmaceutical products (Morton 1976). The latter's leaves and shoots are used to give a cucumber flavor to salads and cooling drinks,

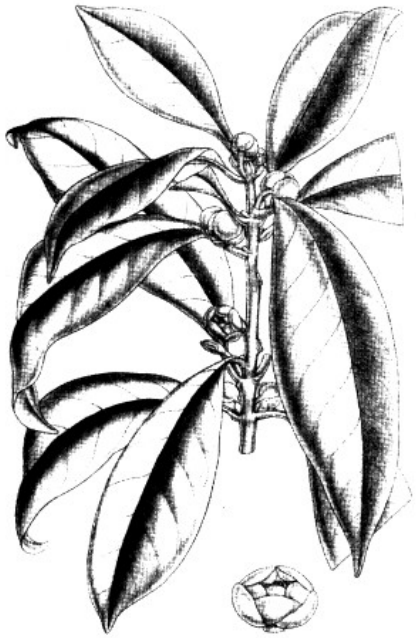


Fig. 307.
Edible Chinese star anise *(Illicium verum)*,
from Curtis (1787-present; #7005).

and to flavor beer, ale and wine; and the seeds are coated with sugar and eaten as a confection (Morton 1976; Facciola 1990).

Pimpinella anisum or anise, treated in detail in this chapter, should not be confused with anise tree, the genus *Illicium* (family: Illiciaceae), which contains species known as Chinese or Japanese anise, purple anise, and star anise. Chinese star anise, *I. verum* Hook. f., is like anise in being the source of a culinary spice and the same distilled oil (anethole) used in medicine and in industry for flavoring. Verlet (1993) estimated the annual world value of star anise essential oil to be $4,560,000.00 (U.S.). The fruits are used as a condiment to flavor foods and

Fig 308.
Poisonous Japanese star anise *(Illicium anisatum)*,
from Köhler (1883-1898).

beverages (Tanaka 1976). It is not discussed in detail in this text as it is a sub-tropical woody plant unsuitable for most of the North American climate. Star anise competes with anise for some of the same market. The poisonous Japanese star anise is noted below. Remarkably, the common names for the poisonous Japanese star anise and the edible Chinese star anise are confused in standard horticultural references works (e.g., Bailey and Bailey 1976; Huxley 1992), which could lead to accidental poisoning (Small 1996*b*).

Japanese anise or Chinese anise, *Illicium anisatum* L. (*I. religiosum* Siebold & Zucc.), a native of China, Japan and Korea, is sometimes cultivated in the warmer parts of North America. Branches are commonly used to decorate Buddhist graves in temple grounds in Japan (Bailey and Bailey 1976). Although the seeds are used in China to treat toothache and dermatitis, and the essential oil has been used to treat colic in children, the seeds are very toxic, and indeed have been used as fish poison (Uphof 1968). Using the seeds of Japanese anise for culinary purposes could be fatal.

As with other members of the carrot family, the fruit of *Pimpinella* is composed of two halves called mericarps (literally half-fruits), each containing a seed. These half-fruits are called "seeds" in non-technical literature and this practice is followed here.

Pimpinella Anisum L.

English Names

Anise
[The vegetable Florence fennel, (*Foeniculum vulgare* subsp. *azoricum*; see discussion of fennel in this book) is sometime known as "anise" or "sweet anise" (because of its anise taste), a practice which often leads to confusion.] Also: aniseed (applied both to the seeds and the whole plant), common anise, heal-bite, sweet Alice, sweet cumin

French Names

Family: Ombellifères, famille de la carotte
Anis vert (m)
Also: aneth, anis boucage, anis d'Europe, anis officinal, boucage, boucage à fruits suaves, herbe odorante, petit anis, pimpinelle, pimpinelle anis
[In France, anis is the name for caraway, *Carum carvi*, also discussed in this book. This is the result of a confusion of caraway and anise dating back to the ancient Greeks. Aneth is best reserved for dill, *Anethum graveolens*, also treated in this book.]

Description, Taxonomy, and History

Pimpinella anisum is an aromatic, white- or yellow-white- flowered annual, typically 50-90 cm in height when cultivated, sometimes as small as 10 cm in the wild. The feathery, fern-like foliage is lobed and finely cut, and the small flowers and slender seeds are subtended in fiat clusters. The indigenous wild range is unknown, since the plant is widely distributed as a result of escape from cultivation. The species may be native to the area of Egypt, Syria, or Cyprus to Greece (Mansfeld 1986). It is now widely established in other parts of Asia, and in Europe and North America. It has been claimed that anise seed was found in Egypt as early as 1500 B.C. (Farrell 1985). Anise has been valued as a drug plant and condiment since antiquity, when it was used by the classical Egyptians, Greeks, Romans, and Hebrews. In many countries it is valued as much medicinally as for culinary purposes.

Uses

The seeds, Which are the economically important part of the plant, have an agreeable odor and pleasant, spicy taste. The aroma and flavor of the seeds have been described as powerfully sweet, aromatic, licorice-like, warm, fruity, camphoraceous, and cooling with little perceptible after-taste (Farrell 1985). The taste is reminiscent of licorice, and indeed anise seed is often used to impart a licorice taste (true commercial licorice comes from the root of another Mediterranean herb, *Glycyrrhiza glabra*, also treated in this book). The flavor of the leaves resembles that of the seeds. Both seeds and leaves are used to brew a sweet licorice-tasting tea. The seeds are an ingredient of such baked goods as bread, rolls, cookies, and cake; and of soups, stews, curries, cheese, apple sauce and baked apples, and confections. Many meats are seasoned with anise seeds or extract, including bologna, frankfurters, knockwurst, dry sausage, mortadella, pepperoni, spiced luncheon loaf, and sausages. The seeds can be added to such cooked vegetables as beet, cabbage, and carrot. Like most herbs and spices, it should be remembered that a very little goes a long way. For example, 0.62 mL (1/8th teaspoon) of ground seed is sufficient to season 454 g (1 pound) of canned green beans (Farrell 1985).

Oil from the seeds provides the flavoring agent for many famous alcoholic beverages, such as anise liqueur or Anisette (French), Pernod (French), Ricard (French), Berger (French), Pastis (French), Ojen (Spanish), Raki (Turkish), Arrak (eastern Mediterranean), Ouzo (Greek), Aguardiente (South American), Allasch (Latvian), Tres Castillos (Puerto Rican), and muscatel wine. Anise milk is

Fig. 309.
Anise *(Pimpinella anisum)*, from Köhler (1883-1898).

another beverage that is popular. The oil is also used in cooking, in industry, and in medicine. It is employed to flavor a remarkable range of products, from toothpaste. to mouse bait. Licorice-flavored candy, cough syrups, cough drops, chewing gum, tooth powder, ice cream, and pickles often have been flavored with anise oil. Tobacco products are also flavored with anise oil. The oil is also employed externally, as in perfumes, soaps and skin creams, and has such additional uses as a sensitizer for bleaching colors in photography (Simon et at. 1984).

The leaves of anise are used as a seasoning, salad component, and garnish. Small amounts of chopped leaves can be added to cooked vegetables, soups, stews, sauces, meat dishes, salads, fruit salads, and pies. Leaves of anise are sometimes encountered in herbal tea blends, and are in fact recommended by many herbal practitioners as a digestive for various ailments. As noted frequently in this book, herbal teas should be taken cautiously, if at all.

Recipe Sources

Corey (1962) gives recipes for Arak (anise-flavored liqueur), Anise bread, and Anise tea. Day and Stuckey (1964) have recipes for Mexican sesame-anise cookies, Anise fruit compôte, Anise chicken, Anise French dressing, and Aniseed cookies. Rosengarten (1969) has recipes for Anise wafers, Anise fruit cup, Anise lemonade, Anise fish chowder with pineapple, and Italian anise cookies. Garland (1979) presents recipes for Rhubarb fool with aniseed, Aniseed brittle, Cream of fish soup with aniseed, and Boiled cod with aniseed and yogurt. Holt (1989) gives recipes for Carrots with fresh aniseed [leaves and seeds], and Butter fougasse [one of the most distinct breads of France] with green aniseed.

Other recipes are: Anise brandy (Leyel 1938); Anise biscuits (Loewenfeld and Back 1974); Anise coffeecake (Muenscher 1978); Aniseed cookies (McCormick 1979; Kublick 1990); Anisette (Sokolov 1979);Anise tea (Jaffrey 1981; Marcin 1983); Spiced Indian tea (Chantiles 1984); Anise sponge (Algar 1985); Sweet anise salad (Bremness 1988); Anise shortbread (Norman 1990).

Importance

Anise is widely cultivated commercially, notably in southern Europe (Cyprus, Bulgaria, Germany, Italy, France, Spain), North Africa, Turkey, Syria, Russia, India, Pakistan, China, Japan, Malagasy Republic, Chile, Argentina, and Mexico. There is limited cultivation in the U.S. In Canada, cultivation has been mostly on an experimental basis (e.g., Embong et at. 1977*d*). Annual world production of anise oil and coriander oil combined amounts to as much as 500 t

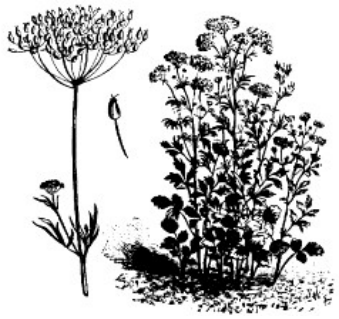


Fig. 310.
Anise *(Pimpinella anisum)*,
from Vilmorin-Andrieux et C^{ie} (1883).

(Ernst 1989). Verlet (1993) estimated the annual world value of anise seed essential oil to be $5,500,000 (U.S.). The U.S. imported 64 702 kg of anise oil worth $767,500 in 1991; 53 557 kg worth $532,500 in 1992; and 49 455 kg worth $400,800 in 1993 (Dull 1994*a*). Synthetic anethole provides competition for anise oil (Morton 1976).

Cultivation Notes

Soil

Soils recommended for anise are fairly dry, light, sandy, deep, well drained, and moderately rich. A fertile sandy loam is best (Lewis 1984).A great advantage of such soils is that they can be so pulverized that the small seeds can be planted at a uniform depth and the very young seedlings cultivated (Stephens 1978). Soil pH should be 6.3-7.3 according to Duke and Hurst (1975), 5.5-6.5 according to Crockett and Tanner (1977). The tolerance range is 6.3-8.2 (Duke 1978). Nitrogen fertilization increases fruit production significantly (Simon et at. 1984).

Climate

Anise does best in a warm location, in full sun. Growth occurs between 5 and 26°C, optimally about 20°C. The plants have relatively weak stems that often lean over, and this makes it advisable to grow them in sheltered locations where they will receive some protection from wind. Regular watering is recommended during hot, dry weather. A frost-free season of 4 months is needed, with uniform rainfall desirable as the plants respond poorly to changes from wet to dry periods. Fairly uniform

temperature throughout the growing season is also desirable. Alternate rainy and dry periods while the plants are maturing seeds causes the seeds to become brown, reducing quality and making harvesting of the seeds difficult (Stephens 1978).

Propagation and Cultivation

Anise is established by seeds, generally sown where the plants are desired, and not transplanted, as the plants recover slowly from the shock of breaking their delicate roots. Nevertheless, in northern areas it is necessary to start the seeds indoors 8-10 weeks in advance of being moved outdoors, since the required growing season is long. To minimize the shock of transplanting, seeds need to be established in fibre pots. Like many species in the carrot family, the seeds are short-lived, generally 1-3 years, and should be as fresh as possible. The seeds should be planted at a depth of 6-13 mm, with a soil temperature of at least 21°C (Wang et al. 1993). Seedlings emerge in 10-14 days. Anise is very slow-growing and so requires regular weeding to protect it from more competitive plants.

Harvest and Storage

Commercially, harvests of 450-675 kg/ha of seeds are typical according to Stephens (1978), 500-700 kg/ha according to Lewis (1984), and 600-800 kg/ha according to Ernst (1989). Commercial harvesting involves cutting the tops or pulling the plants out of the ground while the fruit clusters are still green (but substantially mature) and stacking the plants to allow them to fully mature their seeds. The seeds continue to ripen and when mature, do not discolor and shatter from the plant. Seeds are collected by flailing or are threshed away by machinery. Clean seed is bagged for the market, and the oil is extracted by steam distillation.

In the home garden, mature seeds can be collected directly from the plant. However, once full, brown seeds have developed, the fruit clusters can be cut off the plant, and dried in a warm place to remove as much moisture as possible. When the seeds are to be eaten, Crockett and Tanner (1977) recommend washing the seed heads in warm water, draining on a towel, and spreading them flat to dry. When dry, the seed heads can be rubbed between the palms to remove the seeds, and the seeds can be sieved away using a screen of suitable hole size. The seeds should be stored dry, in airtight containers, in darkness. Anise seeds lose their flavor fairly quickly, and amounts purchased in markets should be limited to what can be used quickly. Anise seeds can be ground before use. Fresh leaves can be harvested from young plants, before flowering, and can be dried for winter use.

Example Cultivars

Alberta

Additional Notes

Chemistry

Anise seed contained 8-15% fixed oil and 1.5-4% essential oil (Lewis 1984; Farrell 1985). The essential oil contains 80-90% anethole, and 10-15% chavicol, which are separated by distillation. Methyl chavicol and *p*-methoxyphenylacetone are also present (Simon et al. 1984). Detailed information on essential oil composition is provided in Lawrence (1983), Lewis (1984), Lawrence (1987*b*) and Ernst (1989).

Medicine

Anise has long been used in medicine. The Greek physician and Father of Medicine, Hippocrates (460?-377 B.C.), used it for the treatment of jaundice, and in the Middle Ages it was employed for cough, cancer, snake and scorpion bites, mental diseases, and epilepsy (Ernst 1989). In Asia, anise seeds continue to be used for a variety of medicinal purposes (Perry and Metzger 1980). In the West, herbalists continue to recommend it for personal health (e.g., Loewenfeld and Back 1974; Hemphill and Hemphill 1984). The oil has been used recently to promote lactation in nursing mothers (Simon et al. 1984). It should be remembered that herbs should not be self-administered for medical purposes except under the care of an authorized physician. Anise oil in sufficient dose may induce nausea, vomiting, seizures and pulmonary edema, and even contact of the concentrated oil with the skin can cause irritation (Simon et al. 1984). Anethole, the major component of the esssential oil, can cause dermatitis (Duke 1985). Anise seeds and toothpastes flavored with anethole have caused cheilitis (peeling and bleeding of the lips) (Rinzler 1990). However, anise and oil of anise are generally regarded as safe for human consumption as a spice, natural flavoring, and oil extract (Simon et al. 1984).

Oil of anise has medicinal properties, and is used in cough medicines and lozenges. It is listed as a pharmacological agent in a number of European pharmacopoeias (Ernst 1989). There are indications that the oil is useful as

a carminative (to expell gas and relieve colic), spasmolytic (agent controlling spasms or convulsions), and expectorant (promoting discharge of mucus from the respiratory tract) (Ernst 1989, which see for additional medical information).

Nutrition

Aniseed is used in such small quantities that it can not be considered a nutritional source, although about 17% of the seed is protein (Lewis 1984), and fresh leaves may contain 9 mg vitamin C per 100 g (Duke 1985).Anise is a good source of iron according to Rinzler (1990).

Curiosities

• Anise has been known to have estrogenic activity since antiquity, and has long been considered to be an aphrodisiac (Farrell 1985). The sex hormones known as estrogens are currently used to treat medical conditions related to deficiencies in the naturally produced sex hormones, for example, menstrual irregularities. Not just humans, but animals respond to estrogens. Cattle given estrogens mate more readily because of increased libido. Increased milk secretion is another result. Dianethole and photanethole in anise are similar to the female sex hormone estrogen (Castleman 1991). It is remarkable that the estrogenic effects of anise may have been appreciated thousands of years ago, possibly as a result of careful observations by herdsmen of the effects on their animals of eating anise (Albert-Puleo 1980).

• Anise was apparently used like money to pay taxes in the ancient Mediterranean (Castleman 1991). In the Bible, Matthew 23:23 reads: "Ye pay tithes of mint, anise and cumin." [According to Macleod (1968) "Although the word 'anise' is given in the Authorized Version of St. Matthew xxiii.23, this is now considered to be a mis-translation of the Greek word *anethon*, which has been rendered as 'Anise' from Wyclif onwards. *Anethon* was in fact dill."]

• After rich meals, the classical Romans traditionally ate a spiced cake containing anise seeds, possibly in the belief that it promoted digestion. This may have given rise to the modem tradition of a spicy cake at weddings (Grieve 1931).

• The Greek Theophrastus (370 B.C.-285 B.C.), the "Father of Botany," wrote that anise by one's bedside brought sweet dreams (Castleman 1991).

• To pay for the repair of London Bridge in 1305, King Edward I levied a tax on luxuries, including anise (Swahn 1991).

• In 1619 the Virginia Assembly decreed that each household should plant at least six anise seeds and continue to plant the crop in succeeding years from the seeds that were produced (Farrell 1985).

• Anise odor has been used in England and the U.S. as an artifical scent for "drug hunting" with fox hounds. A sack saturated with oil of anise is dragged to lure the hounds (Rosengarten 1969). According to Erichsen-Brown (1975), anise is also reputed to be good bait for fish.

• In the Middle East, a ceremonial rice pudding with aniseed called *Meghlie* is traditionally served to visitors and well-wishers on the birth of a son. According to a saying, a family will serve it also on the birth of a daughter, but only if they are truly pleased to have one after a succession of four sons (Roden 1958; see for recipe).

• Reminiscent of the above (but not chauvenistic), in the Netherlands a traditional confection made with sugar-coated anise seeds that are colored pink, blue and white is eaten to celebrate the birth of a child (Bouwmeester, personal communicaton).

• Components in the oil of anise (also of dill and parsley, dealt with in this book) can be chemically transformed (by amination) *in vivo* (in the living body, after ingestion), resulting in the production of dangerous, hallucinogenic amphetamines (Duke 1985). (Note dangers of consuming the oil in "Medicine.")

Problems and Potential

Anise is a well known spice crop in the world, and markets are fairly stable. There is presently extensive cultivation in Mexico, limited cultivation in the U.S., while in Canada cultivation remains basically experimental. The long growing season required to mature seeds is a chief difficulty in growing the crop in Canada and the northern U.S. It may be possible to expand production in the U.S. and Canada with the development of suitable cultivars, but established competition on other continents makes this difficult.

Selected References

Rosengarten (1969); Stephens (1978); Lewis (1984); Farrell (1985).

Plectranthus

Family: Labiatae (Lamiaceae) (mint family)

Genus Notes

Plectranthus is closely allied to *Coleus*, and depending on how the two genera are separated, *P. amboinicus*, examined in detail below, is put in one or the other genus. This discussion follows J.K. Morton (1962) and Codd (1971, 1975) in placing it in *Plectranthus* rather than in *Coleus*. This species is the *type species* of the latter, and is referred to as *Coleus amboinicus* in several standard garden references and by J.F. Morton (1992). Blake (1971) recognized about 100 species in *Plectranthus*. Codd (1975) delimited *Plectranthus* as a genus of about 300 species of herbs and shrubs ranging over much of Africa, southern Asia, Maleysia, Australia, and eastward to Hawaii. Some of the species are grown as ornamentals or used medicinally (Rivera Nuñez and Obón de Castro 1992). Tubers of *P. esculentus* N.E.Br. (including *P. floribundus* N.E.Br.) of southern Africa are eaten there like potatoes by indigenous peoples (Uphof 1968). It is sometimes cultivated (Gold 1975).

Plectranthus Amboinicus (Lour.) Spreng.

Scientific (Latin) Synonyms

Coleus amboinicus Lour., *C. aromaticus* Benth.,

C. crassifolius Benth.

English Names

Country borage
Also: allspice, broadleaf thyme, Cuban oregano, five seasons herb, fivespice, French thyme, Indian borage, Indian mint, Mexican mint, oregano, Puerto Rico oregano, soup mint, Spanish thyme, stinging thyme, sugánda, sweet-scented *Coleus*, thyme
[See *Origanum* for discussion of how "oregano" is used to designate many unrelated plant species. Country borage is called oregano in numerous warm-temperate and tropical countries (Morton 1992). Morton (1992) also lists numerous foreign language names; and a number of English names (all used in countries where English is not the first language), including: bread-and-butter plant, coleus, cowsleaf, cowslip, Cuban oregano, East Indian thyme, French thyme, Indian borage, Mexican thyme, sage, soup mint, Spanish thyme, stinging thyme, tropical oregano, and wild thyme. The use of most of these English names represents confusion with other herb species which have the same common names.]

Fig. 311.
Country borage *(Plectranthus amboinicus)*,
from Lindley (1829-1847; #1520).

French Names

Family: Labiées, famille de la menthe
Aromate des Javanais (m)
[This is the current French name used in New Caledonia (H.S. MacKee, personal communication).]
Also: oreille [in Haiti, as pointed out by Morton (1992)], plectranthre (name used for the genus *Plectranthus*)

Description, Taxonomy, and History

Plectranthus amboinicus is a many-stemmed, succulent, erect or trailing, perennial herb or tender semi-shrub, 0.3-2 m in height (usually 0.6-0.9 m). The leaves are crowded, somewhat brittle, and have both surfaces dotted with tiny, pale to brownish glands which resemble dew drops. The inflorescence consists of an elongated stalk bearing small, purple, lilac, mauve, or white flowers that are in small clusters encircling the stem, the clusters regularly spaced along the flower stalk. The stems become somewhat woody at the base. Roots arise from the lower nodes of the woody stem and serve as a mode of natural vegetative multiplication. The entire plant is very fragrant without being bruised, various authors comparing the aroma to oregano, mint, thyme, and turpentine (Morton 1992). According to Codd (1975), the indigenous area of *Plectranthus amboinicus* is in Africa, from Kenya southward to Angola and Natal (Codd 1975). In southern Africa the species occurs on rocky, wooded slopes, loamy flats, and on the margin of sand forest near the sea (Codd 1975). Morton (1992) stated that it is believed to be native to the Moluccas (Spice Islands) of Malesia. Country borage has been cultivated for some time from India to northern Malesia, and later in the West Indies and tropical America (Codd 1975). An ornamental variegated form is sometimes grown.

Country borage was introduced as a useful herb into many areas of the Old World tropics and some of the Pacific islands in the distant past, both for medicinal and culinary purposes (Morton 1992). It was common in gardens in India during the period of British colonization (Merrill 1937). Leaves of country borage were often steeped in wine and beer by Europeans in India (Morton 1976). The plant was introduced into greenhouse cultivation in England during the 18th century. It was also introduced into Mexico, and other warm countries. It was apparently transported to America from Spain, and is now common in the West Indies and tropical America (Morton 1981). In the Caribbean and adjacent areas of the Americas country borage has been adopted more as a folk medicinal plant than a culinary herb (Morton 1992).

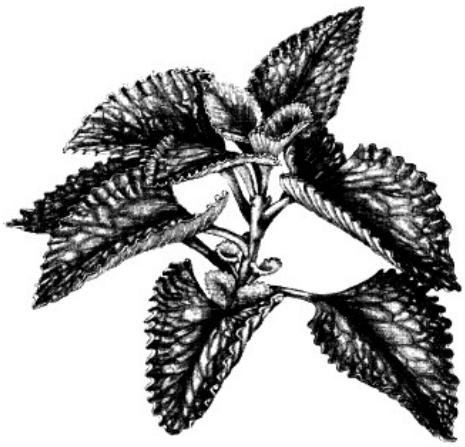


Fig. 312.
Country borage *(Plectranthus amboinicus)*,
prepared by M. Jomphe.

Uses

Plectranthus amboinicus is grown both as an ornamental and as a potherb and condiment. It has been described as "admirably adapted to cultivation as a house plant" (Merrill 1937).As a condiment, its leaves are used mainly in stuffings, to flavor meat (Brouk 1975), in stews, salads, fruit salads, soups, and as an addition to herb mixtures such as chile paste. The herb is used to season black beans (Morton 1976). Country borage is employed as a substitute for sage (*Salvia officinalis*), borage (*Borago officinalis*), and thyme (*Thymus vulgaris*) (all discussed in this book). The fresh leaves have an aroma like that of oregano (note the names Cuban oregano and Puerto Rico oregano), and have been employed to disguise the strong odors and flavors of fish, shellfish, goat and mutton (Morton 1981, 1992). A favorite Indian dish called *bajeb* is made of the chopped leaves (Thomas, personal communication). A tea is also sometimes made, and the crushed leaves have been added to wines and homemade beer (Morton 1992). The species has been cultivated in the Far East for its oil (Morton 1992). A decoction of the herb has been employed in Asia for washing clothes and haft (Uphof 1968).

Recipe Sources

No recipes have been located. Since country borage is substituted for borage, sage and thyme in tropical countries, it may replace these herbs in recipes.

Importance

Plectranthus amboinicus is widely cultivated throughout the tropics, from Africa, India, Malaysia and the Philippines to the Virgin Islands, Cuba and Mexico. It is frequently sold in native markets in Middle America (Morton 1981). A market for the ornamental form has developed in southern Florida (Morton 1992). However, Morton characterized the plant as largely unfamiliar and underutilized in the U.S.

Cultivation Notes

Soil

Country borage apparently prefers a dry, rocky environment (Morton 1992), and grows best in well-drained loam soils. Excess moisture in the rooting medium induces stem rotting (Thomas, personal communication). The pH range recommended is 5.8-6.8 (Duke and Hurst 1975), with a tolerance range of 5.0-8.7 (Duke 1979).

Climate

Plectranthus amboinicus tolerates temperatures between 10 and 32°C. It requires at least 4 months of warm temperatures, and is too tender to be cultivated exclusively outdoors in Canada and the northern U.S. It should be grown indoors, leaving the option of moving the plants outdoors for the summer. It is best located in full sun (Adams 1987), but "does well in partial shade" (Morton 1992). The crop is raised in the partial shade of coconut gardens in the state of Kerala, India (Thomas, personal communication). The plant prefers good drainage, and is apparently naturally adapted to dry environments. Plant damage from bacterial wilt often occurs when excess humidity and soil moisture prevail (Thomas, personal communication). Flowering in country borage depends on where it is grown. The plant blooms in spring (April and May) in the West Indies and Florida, but from May to October in Sri Lanka (Morton 1992). It rarely flowers in Java (Ochse and van den Brink 1980) or India (Morton 1992). However, in south India, flowering has been noticed from December to March (Thomas, personal communication).

Propagation and Cultivation

The plant is propagated by seeds or cuttings (Adams 1987). Germination may take 6 weeks (Adams 1987). According to Morton (1981) the species is grown mainly from cuttings, rarely seeds. The plant is easily propagated through tender stem cuttings, less so using woody cuttings (Thomas, personal communication).

Harvest and Storage

Dr. J. Thomas kindly provided the following information, based on his experience in India. The leaves can be picked before they become yellowish, directly from the plant, or the whole stem may be cut from the base and the leaves subsequently stripped. A harvest of 1.2-1.6 t/ha each 4 months is possible in the tropics. Leaves are used fresh, but may be stored for a few days under refrigeration without losing their aroma.

Example Cultivars

Variegated [discussed by Facciola 1990; Morton (1992) provides the longest available account of variegated plants in cultivation].

Additional Notes

Chemistry

Oil yield of the plant is about 0.055% according to Morton (1992); and 0.1 to 0.2% in leaves on a fresh weight basis, or 0.01-0.02% in the stems (Thomas, personal communication). The peculiar odor of the leaves is due to its essential oil which contains carvacrol (as much as 60%) and caryophyllene (ca. 3-20%) (Bos et al. 1983; Tucker and Maciarello 1987; Kuebel and Tucker 1988). The following studies by different researchers illustrate the somewhat different composition reported for country borage. Smith (1974) and Gurib-Fakim et al. (1995) found that the chief constituents are carvacrol and camphor, with trace amounts of limonene. Baslas and Kumar (1981) reported thymol (41%) and carvacrol (13%). Malik et al. (1985) found -selinene (17%), limonene (10%), thymol (8%), carvacrol (40%), and eugenol (7%). Nguyêñ-Xuân-Duñg and Dô-Tât-Loi (1991) reported: carvacrol ca. 40%, caryophyllene ca. 6%, and -terpinene ca. 17%. Flavonoids of *Plectranthus amboinicus* were studied by Brieskorn and Riedel (1977).

Medicine

Country borage has been used in Asia for various purposes, internally for coughs, stomach and heart pain, externally as a poultice or wash for headache, fever, and bites of centipedes and scorpions (Burkill 1935; Perry and Metzger 1980). Vapor from the leaves has been used to relieve chest colds (Smith 1974). Morton (1992) also notes the use internally in Asia after childbirth, and for urinary diseases and vaginal discharge; and external use to treat

conjunctivitis, burns, and irritated skin. Country borage is used in Vietnam to treat cough (Nguyêñ-Xuân-Duñg and Dôt-Tât-Loi 1991). Morton (1981) has outlined uses in Middle America: to relieve colds in Cuba and Jamaica, as a digestive and to treat kidney complaints in Venezuela, and to treat indigestion and congestive heart failure in Trinidad. In Sri Lanka, country borage was used as a medicine for cattle (Codd 1975). In India, the plant is a common home remedy for infant cough, cold and fever; and for urinary diseases, colic, and dyspepsia (Thomas, personal communication). In Ayurvedic medicine of India, the plant is used to treat epilepsy and other convulsive conditions, kidney and bladder stones, indigestion, diarrhea, dysentery, and cholera (Thomas, personal communication). Inhaled vapours from the leaves provide immediate relief from sinusitis (Thomas, personal communication).

Nutrition

Duke (1977) characterized content of calcium, iron, vitamin A and Vitamin C as high. Morton (1992) also provides an analysis of nutrient content of the leaves.

Curiosities

• The word *amboinicus* in the species name is based on the island of Amboina in the Moluccas (or Spice Islands) in the Malay archipelago (Morton 1992).

• The Malays of Perak mixed the leaf juice of country borage with rice flour for offerings to the spirits when a house was being built (Burkill 1935).

•In Malaysia the fleshy aromatic leaves were rubbed on hair and clothing, and used in bathing, to acquire the scent as a sort of perfume (Burkill 1935).

• A common practice in Ceylon, where country borage is employed as a medicine for cattle, is to cultivate a plant in a little box suspended on the side of native carts (Codd 1975).

• In south India, when a child is born, it is customary to plant a cutting of country borage in the backyard of the house (if the plant is not already growing there) for its probable use in treating numerous child ailments (Thomas, personal communication).

Problems and Potential

Plectranthus amboinicus is a generally obscure herb with limited market potential for essential oil, ornament, and condiment. It is too tender to be grown commercially in most of northern North America, at least outdoors. Although it has some popularity in tropical areas, its economic potential in the temperate world seems to be limited. Even if it could be economically grown on a commercial greenhouse basis in temperate regions, importation might be more competitive. The main interest in this species in temperate areas will likely remain as an exotic houseplant that can furnish a condiment. In southern areas of the U.S., it may have some potential; Morton (1992) commented that "commercial culture and distribution to specialty markets will quite likely result in much broader utilization of this exotic herb."

Selected References

Burkill (1935); Merrill (1937); Ochse and van den Brink (1980); Kuebel and Tucker (1988); Morton (1992).

Polygonum

Family: Polygonaceae (buckwheat family, smartweed family, knotweed family)

Genus Notes

Polygonum is a widely distributed genus of about 150 species. Most of these are annual or perennial herbs, a few more or less woody, some twining vines, and some aquatic. (Some taxonomists split the genus into several genera, in which case *Polygonum* has fewer species than indicated above. Note below that one taxonomist assigns the species discussed in detail to *Persicaria*.) Several species are grown as ornamentals. Many of the species are weeds. Several wild species are used medicinally or harvested for greens.

Polygonum cuspidatum Siebold & Zucc. is known as Japanese knotweed. [Other scientific names: *Reynoutria japonica* Houtt.; *Fallopia japonica* (Houtt.) Ronse Decraene; according to Beerling et al. (1994), "*Polygonum japonicum*

Fig. 313.
Japanese knotweed *(Polygonum cuspidatum)*,
from Curtis (1787-present; #6503).

Fig. 314.
Water-pepper *(Polygonum hydropiper)*,
from Bulliard (1784).

Meisn." is widely misapplied to this species.] It was introduced to North America from Japan as an ornamental. Japanese knotweed spreads so aggressively that it is now often considered a weed. Once established it is practically ineradicable, and it has become widely established in the U.S. and Canada. The Japanese once used it as a vegetable. The raw shoots are very reminiscent of rhubarb, and even the roots are edible. The stems can be boiled or roasted for use as a cooked green, or served fresh as a salad green. Japanese knotweed shoots can also be used to make jam, jelly, pie filling, and wine. Phillips (1986) gives a recipe entitled Japanese knotweed crumble. Szczawinski and Turner (1978) give several recipes, but note that some species of knotweed could cause photosensitization (hypersensitivity to light) with resulting dermatitis.

Polygonum odoratum, discussed in detail in the following, resembles *P. hydropiper* L., water-pepper, which is widely used in the cuisine of Far Eastern countries, including Japan, China, and Korea. Seedlings of water-pepper are employed to make *tade*, described as "unbelievably hot to the taste, still it is a big favorite" (Anon. 1983). The latter is difficult to obtain in North America as the seeds are short-lived and need to be kept moist to survive.

Polygonum multiflorum Thunb. is a climbing perennial from China, widely used as a folk remedy in Chinese medicine. According to legend, a 50-year-old root keeps hair

from turning gray; 100-year-old roots promote a cheerful appearance; 150-year-old roots can produce new teeth; 200-year-old roots preserve youth and energy; and 300-year old-roots result in immortality (Tyler 1993). A certain Professor Chung Yun Li is reputed to have lived to the ripe old age of 256 and outlived 23 wives by taking this "elixir of life" (Richters 1994). The only use that has been authenticated is to relieve constipation (Tyler 1993).

Polygonum seeds were a prehistoric food source. They are often found in archaeological remains, for example at a Kansas City Indian village occupied from 635 to 870 A.D. (Kuhn 1987). *Polygonum erectum* L. may have been a prehistoric cultivated crop (Kuhn 1987). The Sioux reportedly ate the young shoots of swamp smartweed (*P. amphibium* L.) as a relish (Kuhn 1987).

Fig. 315.
Fo-ti *(Polygonum multiflorum)*, prepared by S. Rigby.
(Based on greenhouse plant from Richters.)

Polygonum Odoratum Lour.

Scientific (Latin) Synonyms

Persicaria odorata (Lour.) Soják
[This species should not be confused with *Polygonatum odoratum* (Mill.) Druce, angular Solomon's seal, a Eurasian herb of the lily family, that is sometimes cultivated as an ornamental.]

Potter et al. (1993) state that the identity of the plant known as rau ram in North America is somewhat uncertain, and they imply that it may be the same species that has been identified as *Polygonum minus* Hud.

English Names

Rau ram
[The name has been transferred to English from the original Vietnamese, rau ram. The word is often pronounced "zow-zam" or "zow-ram" by the Vietnamese (Barclay 1993). Arora (1985) calls it rauram. In Laos, it is called phak pheo.]
Also: Vietnamese cilantro, Vietnamese coriander, Vietnamese mint, Vietnamese parsley [a name also occasionally applied to *Oenanthe javanica* (Blume) DC., an Asian aquatic leafy vegetable of the carrot family (also considered a herb) recently introduced to the U.S. by Vietnamese immigrants; see *Apium* Curiosities for information on *O.* javanica.]

French Names

Family: Polygonacées, famille de la renouée
Rau ram
[A French name does not seem to exist, and as in English the Vietnamese is used. The name poivre d'eau may sometimes be applied to the species, although it is more appropriate to the true water-pepper, *P.* hydropiper, mentioned above. F. Jacquemoud (personal communication) suggests the attractive name renoué odorante.]

Description, Taxonomy, and History

Polygonum odoratum is a fragrant, tender, Indochinese herb with red stems and green leaves marked with red. It spreads rapidly on moist ground by its creeping rootstocks. The lower stems become woody. The species was introduced into the United States by Southeast Asian immigrants, especially the Vietnamese. It is a tender perennial, but can be grown as an annual. The flowers are small, red, or sometimes pink depending on growing conditions.

The odor has been described as like fresh coriander foliage (hence the name Vietnamese coriander) with a hint of lemon, or like cilantro (cilantro is coriander foliage;

see discussion of *Coriandrum*). The penetrating odor permeates an area when used in cooking, and because it is not universally admired, is not often used in Vietnamese or other Southeastern Asian restaurants catering to western tastes (Bond 1989). The flavor is milder than that of cilantro, hot and peppery but refreshing. Barclay (1993) characterized the taste as "extremely soapy flavored, with fruity overtones." Although it often seems that a taste for rau ram needs to be acquired, many who dislike cilantro can tolerate rau ram (Hutson 1987).

Uses

Rau ram can be eaten fresh as a component of salads, or used as a garnish. Small amounts go well with chicken salad, potato salad, and devilled eggs (Kuebel, personal communication). Only the young, green leaves are used, as the older, redder leaves are too hot in flavor. Rau ram is employed as a condiment to add taste to cooked dishes, especially fish, fowl and meat dishes. It is also eaten with duck eggs, and with rice or vegetable dishes. Vietnamese traditionally eat rau ram with embryonic duck eggs (Hutson 1987). One of the dishes well known for using rau ram is Du'a 'Cân, a pickled preparation resembling sauerkraut. Barclay (1993) offers the following advice: "A little goes a long way! Like other corianders, the flavor is easily destroyed with cooking and overchopping. Those in the know just use the tender stems and all, tom into soups, salads and noodle dishes, or rolled with the other herbs into lettuce and rice paper with meats, seafood and vegetables."

Recipe Sources

None found. Rauthier (1989) recommends rau ram in the vegetable platter that accompanies many Vietnamese dishes. Because there is some similarity with cilantro, recipes for this herb might be suitable (see *Coriandrum*).

Importance

Rau ram is an important condiment crop in Southeast Asia. It is a very important herb in Vietman, although primarily used as a garnish there (Kuebel, personal communication). In North America, however, it is essentially unknown except by immigrants.

Cultivation Notes

Soil

A rich, moist soil is required.

Climate

Unlike common coriander (see *Coriandrum*), "Vietnamese coriander" or rau ram tolerates heat and thrives with plenty of water in partial shade. In North America, rau ram has been grown in the southern U.S., including California and Texas. In northern areas, the plants can be cultivated under glass; or, by starting them early, they can be transplanted outdoors after danger of cold weather, and grown as annuals. Semi-shade is preferred, although full sunlight is tolerated if abundant moisture is provided. If not adequately supplied with water, the lower stems tend to become quite woody, and the leaves yellowish (Hutson 1987). The plants have been found to flower occasionally

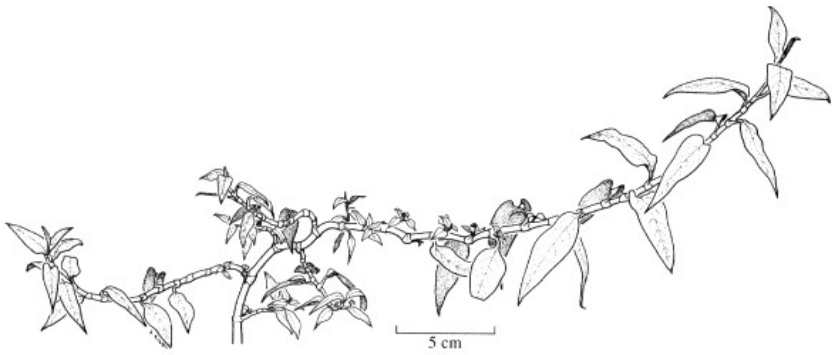


Fig. 316.
Rau ram *(Polygonum odoratum)*, prepared by S. Rigby. (Based on greenhouse plant from Richters.)

after being subjected to a late fall chill and then moved into a greenhouse. Where it can be grown, it has been said that an advantage is that it produces edible foliage all year (Tucker and Maciarello 1989).

Propagation and Cultivation

Propagation is usually by cuttings. Roots are produced easily from the nodes of the stem cuttings, placed in water or moist sand. Rau ram rarely flowers in the U.S. or Canada, so seeds may be difficult to obtain. Keeping the plants cut back encourages new growth. Growth in the shade promotes softer plants with more trailing growth habit. The species can be troubled by fungus and slugs, which is sometimes alleviated by moving the plants to a sunnier location (Barclay 1993). Very few North American garden sources offer rau ram, but it can often be obtained fresh in Vietnamese grocery stores, with roots attached, making it easy to get started.

Harvest and Storage

No information found. Given the unfamiliar and often unappreciated taste of rau ram, it is probably advisable for most people unfamiliar with it to consume it when it is fresh.

Example Cultivars

No information found. There may not be any recognized cultivars.

Additional Notes

Chemistry

Potter et al. (1993) found 0.06% of the fresh weight of the leaves was essential oil. They reported that saturated aliphatic aldehydes are the principal constituents of the essential oil, accounting for 78% by weight; additionally in the oil are sesquiterpenes (15%), alkanols (3%) and alkanes (2.3%). Principal constituents of the sequiterpene fraction are ß-caryophyllene and -humulene.

Medicine

Polygonum odoratum is used medicinally in southeastern Asia against nausea, fever, and to promote urination (Perry and Metzger 1980). It is sometimes employed as an anaphrodisiac (Kuebel and Tucker 1988; see Curiosities). In Cambodia the twigs and leaves are used to stimulate urination, and to combat fever and nausea (Uphof 1968). In Vietnam the plant is used to treat wound and snake bites (Nguyêñ-Xuân-Duñg and Dô-Tât-Loi 1991).

Nutrition

No information found.

Curiosities

• Because of its alleged anti-aphrodisiac properties, rau ram is widely used by Buddhist priests to help retain their celibacy (Bond 1989).

Problems and Potential

Rau ram is a distinctive ethnic dish, known basically to people of Southeast Asian origin. Limited culture has been initiated in the southern U.S. in response to demand for it by immigrants. There is a possibility of a growing market, should it become more widely known, but raising rau ram economically as a crop would seem to be confined to the warmest areas of the U.S. K.R. Kuebel, a leading expert on the use of Vietnamese herbs in the U.S. (see Kuebel and Tucker 1988), has indicated that of all the Vietnamese herbs he has sampled, rau ram has the greatest potential for use in a variety of American dishes (Kuebel, personal communication).

In subtropical areas such as found in its native Vietman, rau ram can spread rapidly and become a pest. Its cultural requirements in North America need to be explored.

Selected References

Kuebel and Tucker (1988); Bond (1989).

Pycnanthemum

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

Although *Pycnanthemum* requires additional study (Carr and Hunter 1973; Chambers and Hamer 1992), it is generally thought to have 19 species (Grant and Epling 1943; Chambers 1993). These are perennial, aromatic herbs, distributed in eastern North America and California. The center of distribution is in the southeastern U.S., from Virginia south to Florida and west to the Mississippi River, where 16 species occur (Chambers 1993). Usually known as mountain mints, these produce a pungent, often mint-like odor when crushed. Several of the species have been used by North American Indians as medicinals and condiments (Uphof 1968). *Pycnanthemum incanum* (L.) Michx., hoary mountain mint, was used extensively by North American Indians for medicinal purposes (Moerman 1986). It is sometimes used as a tea by wild food enthusiasts, like the species described in detail below. It has a relatively high natural rubber content - about 1% on a dry weight basis (Buchanan et al. 1978). *Pycnanthemum virginianum* (L.) Pers., Virginia mountain mint or wild basil, grows from Quebec to North Dakota, and south to Georgia and Oklahoma. Indians used the buds and fragrant flowers to season soup and meat (Morton 1976). The species is sometimes cultivated in gardens, but rarely used as a culinary herb (Morton 1976). A lemon-scented form of it was described by Sørensen and Matekaitis (1981). Brief notes on the ornamental and culinary potential of several other species of *Pycnanthemum* are provided by Peterson (1978) and Foster (1987).

Pycnanthemum Pilosum Nutt.

English Names

Mountain mint
["Mountain mint" is sometimes also applied to lesser calamint, *Calamintha nepeta*, also treated in this book. *Monardella odoratissima* Benth. is also called mountain mint. It is native from Washington to New Mexico, and is to be expected (not yet collected according to Scoggan 1978-79) in southern British Columbia and southern Alberta. It is often grown as a fragrant ornamental.]
Also: American mountain mint, hairy mountain mint, pilose mountain mint [mountain-mint is a variation of mountain mint]

Fig. 317.
Mountain mint *(Pycnanthemum pilosum)*,
prepared by S. Rigby.
(Based on greenhouse plant from Richters.)

Fig. 318.
Mountain mint *(Pycnanthemum pilosum)*, prepared by S. Rigby.
(Based on greenhouse plant from Richters.)

French Names

Family: Labiées, famille de la menthe
Pycnanthème montaigneux (m)
[Pycnanthème could be used for any species in the genus. A French name for *P. pilosum* was not found and the name given above was coined for this book; menthe de montagne is also possible, but this is currently used for *Calamintha officinalis* Moench.]

Description, Taxonomy, and History

Pycnanthemum pilosum is found in dry to moist woods, thickets, and clearings from Iowa to Michigan and southern Ontario, south to Oklahoma, Arkansas and Mississippi. It has been introduced in neighboring regions such as Massachusetts, Connecticut, Pennsylvania, and eastern Quebec. The species is often found in the partial shade of wooded roadsides and in forest openings. *Pycnanthemum pilosum* is a member of section *Virginianum* of the genus, in which six species are placed. The plants of *P. pilosum* are commonly 90-100 cm tall, up to 150 cm, with branching stems, some with clusters of small pink flowers, and leaves that are very aromatic when bruised.

Uses

Fresh and dried leaves are used for tea, the flavor described as mint-like and delicious (Facciola 1990). The species is also grown as an ornamental in North America, and is a fine nectar plant for honeybees (Widrlechner 1992) and butterflies.

Recipe Sources

None found. Mountain mint may be used in recipes calling for mint species (*Mentha*).

Importance

Mountain mint is basically a wild plant, of no commercial importance. It does not seem to be cultivated commercially as a crop, although a commercial demonstration of its potential as an oil plant was carried out in 1949, and it has potential as bee forage (Pellett 1950). Because it is grown as an ornamental and is an indigenous North American plant, it is available for use as a culinary herb in much of North America.

Cultivation Notes

Soil

In the wild state, the species is often found on soils of low fertility on exposed hillsides (Pellett 1950). In cultivation, a rich, well-drained loamy compost is recommended. The soil should be kept moist.

Climate

The plant grows naturally in the eastern U.S. and southern Ontario, so that it can be cultivated as far north as the warmest regions of Canada. Its natural habitat is one of partial shade, but it will grow in full sun.

Propagation and Cultivation

Mountain mint is reproduced by seeds or divisions. The seedlings should be kept moist and shaded (Pellett 1950). Seed germination is enhanced by a short period of moist pre-chilling (Widrlechner, personal communication). The plant does seem well adapted to machine culture (Pellett 1950), although not presently cultivated commercially.

Harvest and Storage

Information regarding harvest of the plant as a culinary herb was not located. The home gardener who grows mountain mint probably can treat its harvest and storage for home use the same as for the mints (see *Mentha*).

If mountain mint is used as a source of oil, it probably needs to be harvested at the height of bloom; consequently its potential subsidiary use as bee pasturage for the remainder of the season would cease (Pellett 1947). Pellett (1947) estimated that about 224 kg/ha of essential oil could be produced. Pellett (1950) estimated that 112 kg/ha of menthol could be produced.

Example Cultivars

No information located. Given the infrequency of cultivation of mountain mint it may be that cultivars have not yet been selected.

Additional Notes

A collection of *Pycnanthemum* germplasm is maintained in Corvallis, Oregon, consisting of about 50 accessions, conserved as living plants or as seed (Chambers 1992; Chambers, personal communication).

Chemistry

The chemical composition of the essential oil of *P. pilosum* is somewhat variable. An analysis in Pellett (1950) showed: 80% pulegone, 10% menthone, 3 to 5% limonene, 2% menthol. Lawrence (1982) reported 44% menthone and 27% pulegone. Carr and Hunter (1973) studied the fiavonoids of the species.

Medicine

The Mesquaki Indians used both the roots and leaves for medicine (Pellett 1947). A tea made with the leaves and an infusion of the tops were used to cure such conditions as chills and fever. [Also see last entry in Curiosities.]

The high content of pulegone in some analyses (see Chemistry) is of concern, since this chemical is toxic (see information for *Mentha pulegium*).

Nutrition

No information located. Comparatively little material of mint-like flavoring plants is consumed, so that little nutrients are added to the human diet.

Curiosities

• The generic name *Pycnanthemum* comes from the Greek *pycnos*, dense, and *anthemon*, blossom, referring to the compact flower-heads (Bailey and Bailey 1976).

• The Mesquaki Indians employed the pungently-smelling mountain mint to scent traps used to catch mink (Pellett 1947).

• According to Kindscher (1987) "mountain mint is not an appropriate name for these plants that grow in prairies and woodlands of the eastern portion of the Prairie Bioregion."

• There are about 100 000 florets in one well grown plant of mountain mint (Pellett 1947).

• Mountain mints were once prized by American Indian tribes because the flower buds were considered effective tenderizers for buffalo meat (Shimizu 1991).

• American Indians used a tea made with local mountain mints (*P. pilosum, P. virginianum*) to wash inflamed penises (Foster and Duke 1990).

Problems and Potential

Cart and Hunter (1973) stated that *P. pilosum* may be a valuable crop to bee keepers, and could give returns comparable to agricultural crops if harvested for its essential oils.

Selected References

Pellett (1947); Pellett (1950); Chamber (1993).

Rheum

Family: Polygonaceae (buckwheat family, smartweed family, knotweed family)

Genus Notes

Rheum has about 25 species [more according to some authorities; 49 according to Lozina-Lozinskaja (1936)]. The species are stout herbaceous perennials, native to the northern and central districts of Asia, especially Siberia, Mongolia, Chinese Tatary, Tibet and northern India. Some occur in Iran and Asia Minor, but none (with the debatable exception of *R. rhaponticum* L.) is indigenous to Europe. Several species are eaten (Facciola 1990), although none rivals garden rhubarb in culinary value. In addition to the common garden rhubarb discussed in detail below, several species are grown as ornamentals. By contrast with garden rhubarb's unlobed smoothly-margined leaves, many ornamental species of *Rheum* have more or less lobed leaves with toothed margins.

Fig. 319.
Medicinal rhubarb *(Rheum officinale)*,
from Köhler (1883-1898).

The history of medicinal and culinary rhubarbs has been treated in detail by Foust (1992). The use of *Rheum* for medicinal purposes dates back into early history. The earliest record of use (as a laxative) has been said to be the Chinese herbal, the Pen-ts'ao-ching, supposedly produced about 2700 B.C. by the legendary emperor Shen-nung (Turner 1938). Early Egyptian, Greek, and Roman civilizations were all familiar with medicinal rhubarb. Several species of *Rheum* are used for drugs, mostly in Asia, although the drags are readily available in herbal shops in Europe and North America. *Rheum officinale* Baill., native to western China and Tibet, is apparently the chief source of medicinal rhubarb drags, obtained from the roots. It is rarely cultivated for this purpose in North America, but fairly commonly grown for medicinal rhubarb in Asia, especially in China. *Rheum palmatum* L. of Mongolia is cultivated occasionally in the Old World as a source of purgative drugs, but finds more use as an ornamental. It is available through North American garden catalogs. The roots of *R. ribes* L. of Iran, Afghanistan and Turkestan are occasionally used in these countries as a vermifuge for horses. The roots of *R. australe* D. Don (*R. emodi* Wallich.) of the Himalayas finds some use there as a drug. The use of any of these rhubarb species as a laxative usually causes intestinal griping or colic, and there are better laxatives available (Tyler 1994).

Of all the species examined in detail in this book, perhaps rhubarb is the most distant from most people's idea of a "culinary herb." Rhubarb is often said to be grown like a vegetable and consumed like a fruit, but it is not quite either, despite a court ruling that it is a fruit (see Curiosities). It has been said to be "the only vegetable that replaces fruit in our diet" (Hardy 1957). It is left to the reader whether or not it meets the definition used here of a culinary herb: a food plant consumed in small amounts to obtain a large amount of flavor. Admittedly, it is often consumed in bulk quantities, but its intense flavor also makes it useful in small quantities as a flavorant.

A few other plant species unrelated to *Rheum*, mostly in *Rumex* (which is also in the buckwheat family), sometimes have "rhubarb" in at least one of their names (Bailey and Bailey 1976; Facciola 1990). For the most part, these are not cultivated, but are simply harvested as foods from the wild. Young leaves of the Eurasian *Rumex alpinus* L. (monk's rhubarb, mountain rhubarb) are eaten as greens or in salads. *Rumex patientia* L. (another European species known as monk's rhubarb) is

naturalized in North America. Leaf blades of *Rumex hymenosepalus* Torr. (wild rhubarb) of western North America are also eaten as greens, and the leaf stalks are sometimes made into pies like rhubarb. This species is sometimes cultivated (Uphof 1968). Leaves of the European *R. hydrolapathum* Huds. (great water dock, also called "wild rhubarb") are sometimes also eaten. *Rumex occidentalis* Wats., western dock, is sometimes known as Indian rhubarb, and has long been commonly consumed like rhubarb by many Northwest Coast indigenous peoples (Kuhnlein and Turner 1991). Another "Indian rhubarb" is *Heracleum sphondylium* L. subsp. *montanum* (Schleich. ex Gaudin) Briq. (*H. lanatum* Michx., *H. maximum* Bartr.), better known as cow-parsnip and master-wort, widely used as a wild food plant by indigenous peoples of North America, although containing skin-irritating chemicals (Kuhnlein and Turner 1991). In Alaska, "wild rhubarb" is generally applied to *Polygonum alpinum* All. [*P. alaskanum* (Small) Wight; treated as *P. phytolaccaefolium* Meisn. by Scoggan 1978-79]. "The succulent young stems and leaves are edible and provide an acceptable substitute for fresh rhubarb" (Porsild and Cody 1980). Its leaves are rich in oxalic acid, and are sometimes used for tanning hides and cleaning aluminum (Rowland 1969). The tart taste of species of *Rumex* and *Polygonum* is due to the presence of oxalate salts and oxalic acid, and as described below for rhubarb, eating large quantities could be inadvisable because the oxalates may interfere with calcium metabolism in the body, especially in a calcium-poor diet (Kuhnlein and Turner 1991).

Marshall (1988) provides an exceptionally extensive bibliography of articles on all aspects of rhubarb species. A supplement to this is in preparation.

Rheum × Cultorum Thorsrud & Reis.

Scientific (Latin) Synonyms

R. hybridum hort., *R. undulatum* hort.
[In much of the literature garden rhubarb is identified as *R. rhabarbarum* L., which as noted below is probably the main ancestor. The names *R. rhaponticum* L. and *R. undulatum* L. have also been misapplied to *Rheum cultorum* (Akeroyd 1989).]

English Names

Rhubarb
Also: garden rhubarb, pie plant (pieplant, pie-plant),

wine plant

French Names

Family: Polygonacées, famille de la renouée
Rhubarbe (f)

Fig. 320.
Rhubarb *(Rheum ×cultorum)*, from Vilmorin-Andrieux et C^{ie} (1883).

Also: rhapontic
[Rhubarbe, rhubarbe du diable, and rhubarbe sauvage are sometimes applied to the common burdock, *Arctium minus* (Hill) Bernh., sometimes known in English as horse rhubarb because of its large rhubarb-like leaves.]

Warnings

(1) Oxalate levels are extremely high in rhubarb, which should not be consumed by those susceptible to medical problems from oxalate consumption; (2) The leaf blades are commonly thought to be highly poisonous, and should not be consumed (see Medicine); (3) Because of the high acidity and the danger of leaching ions into food, rhubarb should not be cooked in aluminum, copper, or iron containers (stainless steel is recommended).

Description, Taxonomy, and History

Rheum cultorum is a perennial, producing many deciduous leaves from a very short, semi-woody stem or crown. It appears to be a cultigen, maintained in cultivation, mostly vegetatively. The main wild ancestor, *R. rhaponticum* L., is apparently native to the southeastern part of the former USSR (C.I.S.); an isolated population is also found in Bulgaria and another isolated population (now extinct) apparently also occurred in Sweden (Libert and Englund 1989).

The *crown* is usually interpreted as the area where stem and root meet, but the term is often, somewhat inappropriately, applied to the rootstock of rhubarb. The excavated roots of rhubarb are frequently (and incorrectly) called rhizomes (Loughton, personal communication). The leaf blades are very large, sometimes more than I m long and 1 m wide. The foliage forms a dense canopy, which tends to prevent growth of weeds. The economic portion of the plant is the elongated, fleshy leaf stalk or petiole, which is sometimes as long as 75 cm and as thick as 8 cm. The petioles are somewhat hemispherical in cross section, with the plane side uppermost. They vary from green to red in color, red preferred in North America. Green types are grown more frequently in northern Europe and Russia than in North America. The cultivars Victoria (named for Queen Victoria) and Linnaeus (for the Father of biological nomenclature) are well known old cultivars with green petioles.

Large, thick, fleshy (but somewhat woody) storage roots develop below the crown, protruding downwards and sideways. Extensive fibrous "feeder" roots grow from the base of the rootstock and from the storage roots. The main fleshy roots may extend downward for more than 2 m, while the thick laterals may spread horizontally for a metre. The root system is profusely branched, thoroughly occupying the surface soil. If plants are left undisturbed for years, the crown grows outward while the central tissues die and rot, and the petioles become smaller in diameter. Eventually the crown may be more than a metre across, with a large, rotten, unproductive center. Buds develop on the crown during the summer, overwinter, and rejuvenate the above-ground portion of the plant in the spring. Each bud may possess up to 30 tiny well developed leaves when the plant becomes dormant in the fall.

Cultivars differ greatly with respect to tendency to bolt (to develop flowering stems) at the beginning of the season. The flowering stems are 1-2 m tall, erect, slightly branched, generally hollow, and bear small leaves, The flowers produced are small, greenish white, whitish, or cream, sometimes almost red, and lack petals. Pollen is distributed both by wind and insects. The fruit is technically an achene (a seed covered by a thin fruit wall). It is 5-10 mm long, with three broad, thin wings.

The history of rhubarb has been outlined by Turner (1938) and Foust and Marshall (1991). It is commonly believed that Marco Polo first brought some rhubarb back to Europe. By the end of the Middle Ages there was a steady importation of medicinal rhubarb roots from central Asia into Mediterranean ports. Garden rhubarb may have first been cultivated in Europe in the late 16th or very early 17th century. It has little pharmacological value, and it, rather than the medicinal species, was probably imported for cultivation by error (Simmonds 1976). Garden

Fig. 321.
Rhubarb *(Rheum ×cultorum)*,
from Nicholson (1885-1889).

rhubarb was gown in herbal gardens to supply druggists, and by the 18th century the petioles began to be used as food. Prior to that time, in England and the Middle East, it appears that rhubarb leaves were eaten as a table green, the present concern that the leaf blades can be toxic not having arisen. Quite probably the culinary use of rhubarb petioles is very old in parts of Asia (Libert, personal communication), although tracing only to the 18th century in Europe. By the early 19th century much improved selections became available, and the technique of forcing rhubarb was developed. These innovations resulted in the extensive adoption of rhubarb as an attractive food. The widespread expansion of use of cane sugar in the first half of the 19th century also contributed greatly to popularizing rhubarb, as most people prefer it with sugar.

Benjamin Franklin (1706-90) is generally credited with the introduction of rhubarb to America in 1770 (Hedrick 1950, p. 83), although it is likely that there was some seed imported before then (Foust 1992). However, it has also been claimed that an amateur gardener in Maine acquired rhubarb from Europe about 1800 and, following this in the early part of the 18th century, rhubarb became a popular item in New England (Camp et al. 1957). Cultivation spread over North America from the Atlantic coast, and by the 19th century rhubarb was a common crop in North America. Rhubarb consumption peaked in North America and probably in most of the world in the 1920's and 1930's, and since then production has fluctuated, but on the whole has declined.

Garden rhubarb appears to be an ancient, complex hybrid originating substantially from *R. rhaponticum*, but also apparently from *R. palmatum* L. (Simmonds 1976). The cultivated *Rheum cultorum* has 44 chromosomes, double the number of the wild *R. rhaponticum* (Libert and Englund 1989).

Uses

Rhubarb is canned and frozen commercially, and is used in a variety of ways in home cooking. This versatile food may be baked, stewed, and eaten with any meal as a side dish or dessert. It is most famous baked in pies, but is also made into wine, punches, sauces, puddings, jam, jelly, relish, cakes, tarts, ice cream, and other sweet dishes. As a jam or sauce it is often blended with other fruits or vegetables. Most commercially grown rhubarb is frozen by processing companies for later use in pies (Marshall 1988).

The young inflorescences, which look like cauliflower, may be deep fried, or boiled and served with cream sauce (Facciola 1990). Bryan and Castle (1974) state that the flowers are edible, and give instructions on how to prepare them for culinary purposes. However, Grieve (1931)

Fig. 322.
Rhubarb *(Rheum ×cultorum)*, apparently forced (note relatively small, unexpanded leaf blades), from Nicholson (1885-1889).

notes that when the young inflorescences were eaten as a vegetable in the early 18th century, no ill effects resulted for some, but others became severely ill. Grieve notes the same mixed record of tolerance exists for eating leaf blades. Although some people seem not to be affected by eating the leaves, inflorescences, and flowers, the only reasonable recommendation is that they not be eaten by anyone. "Oxalic acid poisoning gives you the most gut-wrenching discomfort from which you wish you could die, if you don't!" (Marshall, personal communication). For more information on the question of how poisonous the leaf blades are, see Medicine.

Because of their high oxalic acid content, the leaves have occasionally been used to tan hides and clean aluminum and other metal containers (Greene 1992).

Recipe Sources

Recipe books dedicated to rhubarb include: Saling (1978), with 195 rhubarb recipes; Kidston (1987), with 69 recipes; Smart (1991), with 115 recipes; and Greene (1992) with 37 recipes. Day and Stuckey (1964) have recipes for: Rhubarb punch, Rhubarb and pineapple compote, Rhubarb ginger pudding, Rhubarb and lemon conserve, Rhubarb and orange jam, Cinnamon-rhubarb jelly, and Two-crust rhubarb pie. Wiebe and Zubeckis (1967) give recipes for pies, sauce, jam, juice, jelly, and jelly candy.

Bryan and Castle (1974) recipes include Rhubarb bread/muffins, Rhubarb popovers, and Rhubarb salad mold. Héiteau (1983) gives recipes for: Barbro's cold rhubarb soup, Rhubarb mother's way, Hasty-tasty rhubarb mousse, Gay's rhubarb jam, and Mrs. Wetmore's rhubarb marmalade. Batmanglij (1986) has the following recipes: Stewed rhubarb and Rhubarb syrup. Creasy (1988) rhubarb recipes include Stewed rhubarb and Strawberry-rhubarb cobbler. Hacker (1993) has recipes for Rhubarb fool and Rhubarb and yogurt ice cream. Harrap (1993) presents recipes for Rhubarb chutney, Rhubarb and fig jam, and Rhubarb crumble.

Other recipes are: Rhubarb rosemary parfait (Rosengarten 1969); Rhubarb sherbet drink (Nickles 1971); Rhubarb and orange cheese (Garland 1979); Rhubarb custard pie (McCormick 1979).

Importance

Principal countries where rhubarb is cultivated include England, the Netherlands, Germany, the Nordic countries, the U.S. and Canada (Libert, personal communication). In the U.S., rhubarb is produced commercially particularly in Washington, Michigan, Oregon, and California. Commercial production has essentially ceased in New York and Ohio, and has been severely reduced in California (Marshall, personal communication). In Canada, production is mainly in British Columbia, Ontario, and Nova Scotia. Field-grown and hot-house (i.e., forced) production statistics for the period 1959-89 for these regions are given in Foust and Marshall (1991). Hothouse rhubarb represents about 10% of total production. Reported value of production for 1989 [the highest figure reported by Foust and Marshall (1991) for the period 1959-89] was $4,599,000.00 (U.S.) for the U.S. and $423,000.00 (CAN) for Canada.

Because rhubarb appears at times of the year when most fresh fruits are out of season, it occupies an important economic and culinary niche.

Cultivation Notes

Soil

Excellent growth is achieved on muck, and on heavy and organic soils, but very good growth is also possible on light soils, provided that adequate moisture is available. Lighter soils produce an earlier crop but require more irrigation and fertilization. Good drainage is necessary. Deep cultivation is recommended. Although rhubarb is tolerant of acidic conditions, growth is optimal with a pH between 6.5 and 7.0 (Huxley et al. 1992). Rhubarb has been described as "the strongest feeder of all vegetables" (Shoemaker 1939). In areas where it is grown on a large scale, nitrogen and potassium additions have increased yield considerably, although phosphorus fertilizers have not resulted in increased growth. Rhubarb is quite exhausting of soil, and since it is grown for long periods without replacement (up to 7 years commercially; often over 20 years in the home garden) heavy fertilization with well-rotted manure is strongly recommended in initial land preparation. Actual contact of the manure with newly planted cuttings is inadvisable, and it is preferable to apply manure 1 to 2 months before planting new cuttings. Annual fertilization is appropriate. Contact between chemical fertilizer and cuttings may kill the latter.

Climate

Rhubarb is a cool-weather species, normally achieving suitable growth where the mean summer temperature is below 24°C and the mean winter temperature is below 5°C. Exposure to temperatures below approximately 10°C is required to break dormancy, insufficient exposure resulting in reduced yield. The exact accumulated low temperature requirement is different depending on cultivar. Temperatures below freezing are not advantageous in shortening the dormancy period, and in fact when the dormancy-breaking requirement is met by temperatures above freezing, increased yield results. However, colder temperatures fulfil the dormancy period more quickly than warmer temperatures (below 10°C). In commercially important rhubarb areas, soil temperatures in fall and winter often tend to be in the range of 0-11°C, considered ideal for the rest period. Two months of such exposure is generally completely satisfactory. In regions with mild winters, rhubarb may grow during the winter and become dormant during the summer (Halpin 1978); this generally does not produce a good commercial yield. The cultivar grown in southern California (see below) may have become adapted to warmer environments than other kinds of rhubarb (Marshall, personal communication).

Because of the dormancy-breaking requirement of rhubarb, it is grown mostly in cooler regions of the world. Not surprisingly then, this hardy crop is cultivated extensively in northern North America, and is a significant minor commercial crop that can be raised in much of Canada and the northern U.S. Rhubarb is poorly adapted to the southern half of the U.S. (but see Cultivars for information about Cherry Giant).

Rhubarb has a high requirement for water.

Propagation and Cultivation

Rhubarb may be propagated from seed, but the resulting plants are not identical to the parents and are rarely as satisfactory as vegetatively reproduced material.

Crown cuttings or divisions are used to replace older plants. Divisions, cuttings (or "sets" as they are commonly known in the U.K.) are made by slicing down through the crown between the buds so as to leave as large a piece of storage root as possible attached to each large bud. Each division should be at least the size of a clenched fist (Loughton, personal communication). Rhubarb rootstocks may persist for 20 or more years, but become progressively unproductive after about 7 years. Lifting and division of the crown about every 5 years is recommended (Huxley et al. 1992). Once established, rhubarb requires relatively little attention. It tends to shade out weeds (although cultivation between rows is necessary to control perennial weeds), and is bothered by very few insects. Flowering stalks should be cut off while they are still small, to prevent the plant from diverting its energy into seed production.

As a commercial crop rhubarb is grown for the early summer market and is forced for winter and early spring use. "Forcing" of rhubarb amounts to accelerating resumption of growth. Commercially, this is usually carded out in heated, darkened buildings. It is also possible to force plants in the field by providing heat, although this is usually not done. Plants are grown for 2 or more years in the field and (by recommendation) not cropped during at least the year preceding harvest. The plants are lifted from the field in late fall or early winter before freeze-up, and taken inside for forcing in the dark in heated forcing houses. Before the plants are lifted, many modem commercial growers will have ascertained by reference to a formula based on soil temperatures whether the low-temperature dormancy requirement has been satisfied. Gibberellic acid sprayed on lifted plants acts as a substitute for the dormancy-breaking low-temperature period, and achieves speedier growth (Loughton 1972). Ideal air temperatures for forcing are 11-12°C. At these temperatures the crop is ready for first harvest in 28-30 days, and harvesting continues for 6-8 weeks. Forced rhubarb is considered superior to naturally grown material. The stalks are more crisp and tender, and the slightly acid flavor is milder than the more acidic field-grown product. When grown in darkness, the leaf blades do not enlarge greatly, seldom developing to hand-size, and remain yellow to pale green. They may be left on the petioles to provide an attractive marketable product. The stalks vary in color from delicate pink to deep red, becoming darker red the longer the rhubarb takes to force. The plants are sometimes salvaged after forcing, but this is not recommended as they are highly depleted and usually take two seasons to recover. Commonly used cultivars for forcing are Victoria and Sutton (or Sutton's Seedless); also suitable are German Wine, Crimson Wine, Strawberry, and Timperley Early. Large green-stalked kinds such as Victoria and Sutton's Seedless are often considered more productive than red-stalked cultivars for purposes of forcing, and when forced these normally all-green kinds produce pinkish stalks. Forcing rhubarb is a labor-intensive industry and, because of labor difficulties, tends to be attractive only to a small number of growers who supply a high-quality product for winter consumption.

Rhubarb is a notoriously space-hungry plant because of its spreading crown. The home gardener is advised to plant it at one side or end of the garden. This will minimize the amount of cultivated space required.

Harvest and Storage

Garden rhubarb is at its best in the spring, when it should be harvested from well established plants. Greene (1992) suggests watering the plants the night before picking. It is preferable not to cut rhubarb petioles, as this allows decay organisms a path of entrance into the plant. Pulling the petioles may be done as follows. Young petioles should be allowed to grow at least 25 cm before they are removed. The leaf stalks separate easily from the crowns, and are harvested by grasping them near the base and pulling and twisting to one side. This may be accomplished by grasping the leaf stalks with the thumb and last three fingers while thrusting the fore-finger down along the inside of the stalk, as far as possible down the sheath or basal "stipule," to below the surface of the soil, to lend support to the petiole and ensure that is drawn cleanly away from the plant without breaking. This method does not leave stubs to decay. Nevertheless, commercially in Michigan, rhubarb is cut at its base with a knife (Marshall, personal communication). After pulling, the leaf blades should be severed from the petioles and discarded. The petioles should be kept out of the sun and wind to reduce wilting. Rhubarb stalks deteriorate rapidly at room temperatures, but may be kept in cool storage for several weeks (e.g., at 0°C, 95% relative humidity, and with ample air circulation). Splitting of the cut ends of packaged rhubarb can be reduced by dipping the cut pieces into a sugar solution before packaging (Rowland 1969). Rhubarb freezes at below -2°C. Rhubarb stalks can be preserved by freezing.

It has been estimated that 6-15 pickings may appropriately be made from plants at least 2 years old. At least three or four leaves should be retained per plant to sustain it. Yields from established plantings may be quite impressive: 45 t/ha petioles considered a good yield, and 90 t/ha possible. Yields of 40-70 t/ha are typical (Libert 1987*a*).

Example Cultivars

Turner (1938) and Anon. (1949) provide information on many old English cultivars. Facciola (1990) describes 21 of the most important currently used cultivars. There has been a tendency in North America for the older variants with green leaf stalks to be replaced with red-stalked cultivars, many of which are Canadian in derivation. Canadian-produced cultivars include Macdonald (originated at Macdonald College, Quebec), Early Sunrise (originated at Dominion Experiment Station, Kentville, Nova Scotia), Ruby (from the Central Experimental Farm, Ottawa), Coulter (from John Coulter of Winnipeg, Manitoba), Canada Red (from Kentville, as above), Shortcake (a seedling of Ruby), and Valentine (from the Horticultural Experiment Station, Vineland, Ontario).

Notable U.S. cultivars are Martha Washington and Oregon Red Giant (Huxley et al. 1992). The cultivar Cherry Giant is very unusual in being able to grow in the climate of southern California. Virtually all other cultivars require dor-mancy in the autumn and winter, which is not possible in most of southern California. Cherry Giant becomes dormant June-August in southern California, not because of a need for a cold period, but because of restricted irrigation; it resumes development with irrigation in late September or early October (Foust and Marshall 1991). As a result, this unusual cultivar is the basis of a modest commercial rhubarb industry in southern California.

Additional Notes

Chemistry

The chemical composition of rhubarb petioles has been summarized by Wiebe and Zubeckis (1967). Up to 96% of the fresh petiole is water. Of the remainder, the main constituents are sugars (0.3-2.3%), malic acids (0.7-2.2%), and oxalic acid (0.1-1.4%). The pH of the petioles is between 3.0 and 3.6.

The reddish coloration of the petioles is due primarily to two anthocyanin pigments, cyanidin 3-glucoside and cyanidin 3-rutinoside (Gallop 1965).

Rheum roots are sources of medicinal anthraquinones (Gallop 1965). The fleshy storage root contains a purgative, chrysarobin (Roecklein and Leung 1987).

Medicine

Rhubarb roots (and sometimes the seeds) were once used in the same manner as the medicinal rhubarbs, as a laxative. Especially in the 18th centry, rhubarb was suggested for a wide variety of afflictions by one or another physician. It has been used for stomach and bowel problems in infants, and to treat sores (Grieve 1931). Early North American settlers sometimes gave their children rhubarb as a blood purifier (McNaughton 1991).

During the First World War in Europe food was in scarce supply and every effort was made to use all possible sources. Rhubarb leaves (i.e., leaf blades) were recommended for greens, despite the fact that as early as the 18th century there was widespread advice against ingesting the leaf blades. Poisoning and some deaths were reported from eating stewed rhubarb leaves, leading to the renewed recommendation that rhubarb leaves not be consumed (Brouk 1975). As noted in Uses, earlier cases of death had been widely reported. The alleged poisonous properties of the leaf lamina of rhubarb are puzzling. Most publications discussing the topic simply ascribe the toxicity to high levels of soluble oxalic acid, but numerous analyses have shown that there is not much difference between the petioles and blades in this respect. In fact, the blades may contain less oxalate than the petioles (Libert and Franceschi 1987). The presumed lethal dose of 5-15 g of oxalic acid is normally not approached in consuming rhubarb. Oxalic acid poisoning is closely associated with calcium metabolism, oxalic acid preventing utilization of an equivalent amount of calcium. Thus liberal consumption of such high calcium foods as milk, eggs and beans is recommended where there is high intake of oxalic acid. In an experiment in 1920 several researchers deliberately consumed rhubarb leaf blades "à la spinach" without the slightest ill effects. It may be that reported poisonings are the result of individual susceptibility, or overconsumption combined with poor calcium intake (Wiebe and Zubeckis 1967). It has also been suggested that there are poisonous anthraquinone glucosides or anthrone glycosides in the leaves (Brouk 1975; Foust and Marshall 1991). Medicinal anthraquinones are commonly obtained from the roots of *Rheum*.

Oxalic acid may present a hazard to growing children, nursing mothers, and others whose calcium balance may be precarious (Allison 1966). The very high level of oxalic acid in rhubarb is dangerous to individuals susceptible to some kidney disorders. Most urinary stones formed in people are calcium oxalate stones (Libert and Franceschi 1987). It has also been suggested that dietary oxalate may contribute to symptoms of arthritis (Libert and Franceschi 1987).

Rhubarb has been found to cause leaching of aluminium when cooked in aluminum cooking vessels (Liukkonen-Lilja and Piepponen 1992).As with other very acidic foods, because of the danger of metal ions being taken up in food, rhubarb is best cooked in stainless steel, and not in aluminum, copper, or iron containers.

As if enough medical dangers have not already been raised for what would seem to be a relatively harmless herb, Lewis and Elvin-Lewis (1977) note that this plant can cause hay fever.

Nutrition

Rhubarb stalks are rather low in vitamins and minerals, but contain significant calcium, potassium, and vitamins A (provitamin A) and C (see references in Marshall 1988). Rowland (1969) stated that rhubarb supplies only a fair amount of vitamins A and C. Cooking reduces vitamin C content. On the whole, rhubarb is of limited nutritional significance except as an item adding variety and attractiveness to meals. The sugar that is normally added to make rhubarb palatable is generally considered nutritionally undesirable.

Curiosities

• The genus name *Rheum* is derived from the ancient Greek *rheon* or *rhia*, a name apparently used for a plant of the genus, and based ultimately on the river Rha in Pontus, the modern Volga, whose banks were probably a source of medicinal rhubarb in ancient commerce (Turner 1938).

• The name rhubarb probably is derived from the river *rha,* as discussed above, and *barbarum*, meaning from the barbarian district beyond the immediate confines of the Roman Empire (Turner 1938).

• The *soma* plant was described in one of the oldest Sanskrit manuscripts, the Rigveda, a collection of poems of peoples who migrated in very early times to India. *Soma*, a preparation which allegedly gave strength, courage, long life, and wisdom, is reminiscent of the nectar and ambrosia of the ancient Greeks. Soma could only be taken by priests during religious rites. It has been suggested that the soma plant was a species of rhubarb (Weiss 1988).

• A 1657 English price list showed that the cost of medicinal rhubarb was about three times that of opium (Snow 1924).

• Seventeenth century women took advantage of the acidic nature of rhubarb to bleach their hair (Marshall 1988).

• In early rural America a common ice-breaker was "Think the rain will hurt the rhubarb?" In fact, rain can damage rhubarb by spreading the fungus disease anthracnose from one plant to another (Rowland 1969).

• In 1947 a U.S. customs court ruled that rhubarb is to be considered a fruit and not a vegetable because its principal use in the home is that of a fruit. This court ruling exempted rhubarb from the 50% import duty charged against vegetables at the time, and made it eligible for a lower 35% duty charged against fruits (Rowland 1969).

• Among the many curious Hoosier (Indiana) folk remedies recorded by Tyler (1985) is the following: to clean stains from under the fingernails, rub them into a big rhubarb stalk. [Oxalic acid was once known as "salts of sorrel" and was used as a stain remover (Loewenfeld and Back 1974). Accordingly, the high oxalic acid content in rhubarb could well act as a stain remover.]

• A "rhubarb" is a heated dispute or controversy. The term arose from its use specifically to mean a difference of opinion on the baseball diamond (Rowland 1969). It seems to have first been used during a game in 1943, by the Brooklyn dodgers announcer "Red" Barber (Smart 1991). The word was also used during World War 2, by the U.S. airforce, to mean a low-level strafing flight (Smart 1991).

• The giant leaves of rhubarb were once worn inside the bonnets of midwestern U.S. farm women as extra protection against sunstroke (Saling 1978).

• Rhubarb may color urine bright yellow or red (Castleman 1991).

• A variety of experimental rhubarb products have been created, including: rhubarb jerky, rhubarb catsup, rhubarb butter, rhubarb hamburger, and rhubarb leather (McNaughton 1991).

Problems and Potential

Foust and Marshall (1991) present an analysis of past and present market trends, and associated problems and potential of rhubarb production in North America. The popularity and marketability of rhubarb has waxed and waned for many years, and at difficult times many growers have been forced out of the industry. Rhubarb must compete with new fruits, often of exotic tropical origin. Growing techniques, especially for forcing rhubarb, require considerable expertise, and a relatively few specialized operations have tended to dominate the market, making it difficult for newcomers. Research to create new cultivars and products is presently improving the industry and offers considerable promise for the future.

The high oxalate content of rhubarb, which contributes to pathological conditions, is a drawback of the plant. Libert (1987*b*) examined the possibility of breeding a low-oxalate rhubarb, noting that it was a difficult but possible undertaking. There is considerable variation in oxalate content, and low-oxalate cultivars that are now available can be grown for those concerned with this problem.

Selected References

Anon. (1949); Lyall (1968); Rowland (1969); Marshall (1988); Foust and Marshall (1991).

Rosa

Family: Rosaceae (rose family)

Genus Notes

Rosa has over 100 species of prickly shrubs (a few are viny), mostly in the temperate northern hemisphere. A few roses yield important essential oils used in perfumery. Verlet (1993) lists rose as the world's third most valuable essential oil, with an annual value of $40 million (U.S.). The flavoring agent rose water is the result of distilling rose flowers with a little water, while the perfumery agent attar of roses is an oil which rises to the surface of rose water left to stand and kept cool. *Rosa damascena* Mill. is the main source of both. It is grown commercially mainly in Bulgaria and Turkey. This species is also used to produce rose petal jam. No flower is more popular and better known than the rose, and many species and their hybrids are grown as ornamentals. However, the fruits of some species remain on the plants overwinter, and are also quite decorative. The genus is included in this book because rose hips and rose petals are used for various culinary purposes. In relation to its small amount of edible matter, the rose fruit is the richest source of vitamin C of any temperate fruit (Nobbs 1980).

The use of the rose plant for food is very minor, but nevertheless has a long history. A neolithic archaeological site dated at 5000 B.P. shows evidence of humans intentionally collecting rose fruits for food (Widrlechner 1981). Kuhn (1987) provides considerable information on the use of rose hips as food by the Indians of the North American prairies, as do Kuhnlein and Turner (1991) for Indians of Noah America, but especially of Canada. Young leaves or branches of several species are presently eaten by indigenous peoples in Asia, and the fruits of various species other than those discussed here are also eaten (Ochse and van den Brink 1980; Morton 1976; Facciola 1990).

Rose flowers have limited, but interesting culinary uses. Drinks have been perfumed with roses, and rose petal wines have been made since classical times. During the Elizabethan era, rose petals were extensively used to scent food and even washing water (Loewenfeld and Back 1974). Rose water for flavoring sweet dishes, rose petal jam, rose petal-flavored honey, rose-flavored candy and rose-flavored vinegar are still marketed, albeit on a very limited scale (Stobart 1977). The food industry uses rose extracts to flavor beverages, candy, ice cream, bakery goods, gelatin desserts, and jelly (Morton 1976). Facciola (1990) lists 11 species of roses whose flowers have been

Fig. 323.
Scotch rose *(Rosa spinosissima)*,
from Syme et al. (1863-1886).

consumed as food. The French rose, *R. gallica* L., provides flower petals that are crystallized, preserved in syrup, or dried and used to flavor teas, beverages, cakes, honey and liqueurs (Facciola 1990, which lists several other species used as sources of edible flowers). Belsinger (1991) suggested that "strongly scented varieties usually taste like their fragrance, and in general, the more fragrant a rose is, the more flavor it has." She recommended *R. rugosa, R. damascena, R. alba* L., and *R. eglanteria* L. for their edible flowers.

Rose "hips" are the part of the rose of most culinary significance. Rose hips, commonly referred to as "fruits," are actually "false fruits," each containing a number of true fruits. Inside the hip are "achenes," which botanically are a type of fruit with a dry wall and a single seed. The fleshy part of the hip is derived from stem tissue at the base of the flower (hence technically the rose hip is an "accessory fruit"); by contrast, in true fleshy fruits the fleshy portion is usually derived from ovarian tissue. The usual practice of referring to the hips as fruits will be followed. The hips are covered with hooked, hairy outgrowths which should be removed before being cooked. In most species, the hairs on the outside are less troublesome than the fuzz on the inside. De-seeding the hips and removing the fuzz and hairs are tedious tasks.

There are at least 13 000 identifiable cultivars of roses, of which at least 5000 are commercially available (Crockett 1978). While any of the species and the thousands of cultivars could be considered for culinary purposes, only a few have been. Most roses are grown for their attractive flowers, notably the class of roses referred to as hybrid tea. In most cases, specimen roses are just too expensive to consider as food. Many rose hybrids are infertile and do not have hips, or only an occasional seed pod. The species described below have attracted the most attention as sources of rose hips. There are possibilities, however, of using other species. Hips of the Scotch or burnet rose, *R. spinosissima* L., are especially sweet (Morton 1976).

Fig. 324.
Dog rose *(Rosa canina)* from Lamarck and Poiret (1791-1823).

Rosa canina, described below, has of the order of 500 mg/ 100g of fruit wall of vitamin C. By contrast, *Rosa acicularis* Lindl. of northern Canada and Alaska has about ten times as much (Brouk 1975).

As will be noted, the period when rose hips were most important was in Europe during the 1939-45 World War when citrus fruits were unavailable. Vitamin C is now widely available as a supplement in foods or in tablet or powder form, but the attractive taste and novelty of rose hips have retained interest.

"Rose-apple" is *Syzgium jambos* (L.) Alston of the Myrtaceae family. This tree is widely cultivated in tropical regions for its dry, crisp fruit that is insipid raw, but prized for confections and jellies. The "Christmas rose" is *Helleborus niger* L., a perennial herb of the Ranunculaceae family. Several ornamental cultivars of this are available, and the plant has also been used medicinally. However, all parts of the plant are extremely poisonous, and it should not be consumed (Bunney 1992).

Fig. 325.
Dog rose *(Rosa canina)* from Hallier (1880-1888).

Warnings

(1) Cautions are given for several herbs in this book about not preparing them in non-stainless steel metal containers because the high content of acid may leach metal ions into the food. Similarly, because of the high ascorbic acid (vitamin C) content of rose hips, copper, aluminum, and iron containers should not be used. Stainless steel is best, glass containers and wooden spoons are also acceptable; earthenware, china bowls, and enamel are likely safe, but keep in mind that imported containers may not have been manufactured to domestic safety requirements, and toxic constituents could be set free by acid foods; (2) Do not pick rose hips from bushes unless certain that they have not been sprayed with pesticides.

Rosa Canina L.

English Names

Dog rose
Also: briar rose, brier rose, common brier, dog brier, doghip, hip rose, wild dog rose

French Names

Family: Rosacées, famille de la rose (famille du rosier)
Rosier de chien (m)
Also: églantier (commun), églantier vrai, rose canine, rose de(s) chien(s), rosier canin, rosier des bois, rosier des chiens, rosier églantier, rosier sauvage

Description, Taxonomy, and History

Rosa canina is native to Europe (it is the most common wild rose of northern Europe), western Asia and North Africa, and has become naturalized in North America as far as southern Canada, from coast to coast. It is an upright shrub to 3 m in height, with fragrant pink or white flowers. Its fruits are oval, orange-red or scarlet, and about 1 cm long.

Uses

This species is primarily grown as an ornamental, frequently as a hedge, and often as a stock for grafting. Its fresh fruit was used extensively medicinally, as noted later, and remains a desirable culinary treat. Roses are attractive for culinary purposes because of their high vitamin C content, and because of their characteristic sweet, tangy flavor that makes for excellent jam, jelly, syrup, wine and liqueurs. Short cooking does not significantly reduce the vitamin C content, so purées and syrups remain highly nutritious. Rose hip syrup can be poured over sweet dishes, and the purée used like jam. Rose hip wine can be made from the syrup. A tea can be made from the hips which is

Fig. 326.
Dog rose *(Rosa canina)* from Oeder et al. (1761-1883).

mildly diuretic (promoting urination). Dried rose hips are as hard as coffee beans; they may be pulverized in a blender, grinder or mill before use in tea. Soaking in boiling water will also soften them.

Morton (1976) provides the following culinary advice regarding rose petals. They can be used fresh as garnishes on salads and fruit cups, and can be placed under the crust of pies before baking. The buds can be pickled in white vinegar and sugar, or ground with sugar into a conserve. A jam can be made by soaking, draining, and boiling rose petals with sugar and lemon juice. The petals can be steeped in vinegar. Rose petals are often crystallized, made into syrup, and used in teas. A popular Near Eastern confection is made of honey and rose petals.

In addition to the hips, the leaves of the dog rose are sometimes used to make tea (Grieve 1931).

Recipe Sources

Gibbons (1966) gives recipes for: Rose hip syrup, Rose petal jam, Rose hip jam, Rose omelet, Candied rose petals, Rose water, Rose wafers, and Rose hip soup. Gordon (1968) presents about 150 recipes. Crowhurt (1973) has nine rose recipes. Smith (1973) gives 34 rose recipes. Bryan and Castle (1974) present recipes for Rose petal crêpes, Rose hip sauce, Rose hip soup, and Siamese rose petal salad. Scobey and Myers (1975) give recipes for Rose petal preserve, Rose hip jelly, and Rose petal sauce. Reppert (1976) has 13 rose recipes, including a confection made with brown sugar called Rose Tobacco. Turner and Szczawinski (1978) have recipes for Rose hip tea, Rose petal jam, and Rose petal tea. Garland (1979) has recipes for Rose petal jam, Rose petal butter, and Rose hip jelly. Rose (1979) gives recipes for Rose petal scrambled eggs and Rosehip honey. Michael (1980) presents 21 rose recipes. Nobbs (1980) has recipes for Rose hip jam, and Rose hip marmalade. Algar (1985) gives recipes for Pudding with rose water and Rose syrup drink. Batmanglij (1986) has recipes for Rosewater syrup and Rose petal jelly. Leggatt (1987) give recipes for: Rose petal jam; Moroccan chicken with pistachios, apricots, roses and marigolds; Rose and poppy seed pasta; White and yellow rose petal ice cream with crystallized rose petals; Rose petal sorbet with crystallized rose petals; Fresh June strawberry sorbet with tiny white rose petals; Strawberry sponge with rose petals; Chilled rosé punch with rose petals; Rose syrup for fruit and flower salads; and Fragrant casserole of rose duck.

Other recipes are: Caraway and rose cookies (Fox 1933); Rose wine (Grieve 1933); Rose hip sauce (Loewenfeld and Back 1974); Steamed cake with fragrant roses (Chang et al. 1979); Rose hip soup (Stuart 1979); Rose hip jelly (Creasy 1982); Rose petal tea (Marcin 1983); Rose hip tea (Lima 1986); Rose petal salad (Jeanneret 1987); Rose layered dessert (Bremness 1988); Snow eggs with rose petals (Holt 1989); Rose milk (Sahni 1990); Rose petal sorbet with rose-petal meringues (Holt 1991).

Fig. 327.
Dog rose *(Rosa canina)* from Johns (1853).

Importance

Rosa canina is widely grown and marketed in the horticultural trade, either as the pure species or in hybrid form. There is a very limited commercial market for the production of rose hips for jelly and dried petal for tea mixtures, and those interested in using the plant for tea or jelly mostly harvest materials from their own or someone else's garden. Nevertheless, a diverse range of rose hip products are marketed in North America, including soups, jam, wines, rose honey, rose vinegar, rose sugar, dried rose hips, canned rose hips, and beauty lotions (Nobbs 1980).

Cultivation Notes

In addition to the following, see remarks for the next species treated, *R. rugosa*.

Climate

In North American *Rosa canina* is hardy as far north as southern Canada.

Example Cultivars

Inermis

Additional Notes

Chemistry

Rose hips contain appreciable amounts (about 3% collectively) of malic and citric acids, and about 11% pectin (Grieve 1931; Tyler 1993).

Medicine

Rosa canina was one of the most important roses used in medicine during the Middle Ages. Roses were used to reduce fever, inflammation, pain, and to stop any kind of excessive flow, be it tears, diarrhea, or hemorrhage (Touw 1982). The popularity of the rose eventually resulted in its elevation to the status of a wonder drug, used even for epilepsy, tuberculosis, goiter, and gout; during plagues, rose fragrance was used to purify the air in public places (Touw 1982). Apothecaries even used rose galls, employing them to induce urination (Stuart 1979).

The pactin and acids found in rose hips are probably responsible for mild laxative and urination-stimulant effects (Tyler 1993). Rose pollen can be an allergen for sensitive people, and the geraniol in oil of roses may cause contact dermatitis in people handling rose bushes (Rinzler 1990).

Nutrition

Like all roses, the hips of this species are exceptionally high in vitamin C. On a weight basis, rose hips contain ten times as much vitamin C as oranges and lemons (Loewenfeld and Back 1974). Three rose hips can contain

Fig. 328.
Dog rose *(Rosa canina)*
from Fitch (1924).

as much vitamin C as one whole orange (Turner and Szczawinski 1978). Large amounts of provitamin A (carotene) are present; also present are some B vitamins (ribo-flavin and folic acid), and vitamins P, K and E (Nobbs 1980). Vitamin P or hesperidin is a yellow flavonoid pigment. It seems to be used in laboratory animals like vitamin C and to strengthen blood capillaries, although effects in humans have not been demonstrated (Rinzler 1990).

Curiosities

• The ancient Zoroastrian text *Bundehesh* recorded a "dog rose," mentioning that the rose acquired thorns only when evil appeared in the world (Touw 1982). Similarly, Christian legend holds that the rose grew in the Garden of Eden without thorns until the fall, after which thorns appeared to remind man of his sinful nature (Lust 1974).

• Since the time of the ancient Egyptians, roses have been associated with secrecy. Quelch (1946) relates the Greek myth that Cupid, shocked by the conduct of his mother Venus, took her flower, the rose, to Harpocrates, god of silence, to keep some blazing scandal confidential.

• Rose water was used to purify mosques profaned by infidels (Bryan and Castle 1974).

• Roses were customarily suspended over the dinner-table as a sign that confidences revealed under the influence of wine were to be kept sacred. Thus the plaster ornament in the centre of a ceiling is known as "the rose," and the expression "sub rosa" refers to activities conducted confidentially (Grieve 1931).

• Grieve (1931) advanced two theories how the dog rose got its name. First, there is an ancient tradition that the root would cure a bite from a mad dog. Second, and more probable, is that an early name was dagger rose (because of the formidable thorns), and the dag in

Fig. 329.
"Dog rose," prepared by B. Brookes.

dagger became corrupted to dog. Bunney (1992) suggested that the term dog rose traces to the Greek word for the plant, *cynorrhodon* ("dog rose"), the ancient Greeks merely using this name in a derogatory sense to imply that the species was of little worth in the garden.

• The Roman natural historian Pliny (62-113) recorded the use of roses as a cure for the bite of mad dogs. He wrote about a woman who dreamed that her soldier son should drink rose water. Considering this as an omen, she got word to him. He had in fact been bitten by a mad dog, and took the rose cure just in time (Moerman 1982).

• The first "rosaries" were made out of pounded rose petals, moulded into beads and threaded (Macleod 1968).

• Roses have been a heraldic emblem on the shields of soldiers since the time of the Romans. The War of the Roses was a series of battles (1455-87) between two branches of the Royal Family Plantagenet in England. The House of Lancaster, represented by the red rose, defeated the House of York, represented by the white rose. The white rose is reputed to have been a form of *Rosa canina* (Nobbs 1980). The two houses combined with the marriage of Henry VII of Lancaster to Elizabeth of York, Henry becoming the first Tudor king. He adopted a red and white Tudor rose as his symbol, and this is now the national flower of England (Lust 1974). A rose cultivar called York and Lancaster which develops both red and white flowers is currently marketed (Richters 1994). This is identified by Buckley (1980) as a cultivar (named in 1551) of the briar rose, *R. eglanteria*.

• The Latin that is used by botanists to describe and name species of plants has sometimes been referred to by the uncomplementary phrase "dogrose Latin" (Macleod 1968).

• The symbolism of the rose surpasses all other flowers (Lust 1974). The perfect blossom represents love, beauty, youth, perfection, and immortality; withering of the flower reflects the ephemeral nature of beauty and youth; the thorns epitomize the pain of love and guilt; the white rose portrays purity and innocence, and is often associated with the Virgin Mary; the red rose is the embodiment on the one hand of sensual desire, passion, and shame, and blood and sacrifice on the other hand; the yellow rose reflects perfect achievement or sometimes jealousy.

• *Rosa*, section *Caninae* includes the dog rose and its close relatives. These have an unusual system of sexual reproduction (they also often produce seeds by complicated pseudo-sexual methods such as apomixis). Unlike most species in which males and females provide equal numbers of chromosomes to their progeny, the females of these species are genetically predominant, contributing 3 to 5 sets of chromosomes (seven chromosomes in each set), whereas the males pass on only one set (Nybom and Carlson 1992).

• Bears are said to relish rose hips as a pre-hibernation food (Kuhnlein and Turner 1991).

• Mischievous Engish schoolboys have been known to make an itching powder from the short brittle hairs of the hips of the dog rose (Launert 1981).

• The "Rosehattan" is a "liberated" feminine Manhattan cocktail, without the "man," made with whisky, vermouth, rose water, and a candied rose petal (Smith 1973).

• Continuing the culinary attack on males, Leggatt (1987) offers a recipe entitled *Ladies Beneath The Sheets*, decorated with rose petals, and to be served with "a smile on your face!" She also offered the following comments: "I invented this amusing dessert for a male chauvinist who liked to entertain young ladies in his apartment. I am ashamed to admit that I invented quite a number of 'seduction' recipes for this man!"

Problems and Potential

The commercial market for this species as an ornamental is large and stable. The potential for expanding the harvest of rose hips and petals for culinary purposes, and establishing an industry in North America, is limited, although some attempts are underway.

Selected References

Loewenfeld and Back (1974) (Loewenfeld conducted considerable dietary research on rose hips).

Rosa Rugosa Thunb.

English Names

Turkestan rose
Also: Japanese rose, large-hip rose, ramanas rose, rugosa

rose, wrinkled rose

French Names

Rosier rugueux (m)
[Rosier du Japon, rose du Japon = *Camellia japonica* L.]

Description, Taxonomy, and History

Rosa rugosa is a native of eastern Russia, Korea, northern China and Japan, that has been widely cultivated in different countries. In North America it has escaped from cultivation and become established in the northern U.S. and southeastern Canada. It is generally considered to be one the most ornamental of the roses, especially useful as a specimen shrub. It is upright, about 2 m tall, covered with prickles and bristles, flowering throughout the summer, generally with rose-purple or white flowers up to 8 cm across that are single or few in a cluster. Many color selections of flowers have been made, as well as double-flowered forms. Fruits are present on the plant from midsummer to late fall. The hips are glistening brick-red, sometimes orange, conspicuous, and about 2.5 cm in diameter. The species is taxonomically complex, and has been divided into many varieties. Moreover, it has been extensively hybridized with other species. The Ainu of Japan used rose hips of this species as food (Uphof 1968).

Uses

For culinary purposes, see remarks for the previous species, *R. canina*. As well as being an important ornamental shrub in its own right, *Rosa rugosa* has been used to breed hardier, better-flowered and more disease-resistant cultivars of other rose species.

Recipe Sources

See information provided for the previous species, *R. canina*.

Importance

See remarks for *R. canina*.

Cultivation Notes

Soil

The ideal rose soil is a rich, deep loam. Although the soil must retain moisture, it must also be well drained. Roses generally prefer a slightly acid soil (pH 6-6.5). *Rosa rugosa* is rather adaptable, doing well in both pure sand

Fig. 330.
Turkestan rose *(Rosa rugosa)*, from Curtis (1787-present; #3149).

and clay. Its adaptation to pure sand makes it useful for dune stabilization (Widrlechner, personal communication). This rose is notably salt-tolerant, surviving well in somewhat saline environments.

Climate

Rosa rugosa is hardy as far north as southern Canada. Like most roses, it prefers full sunlight, although it will tolerate slight shade.

Propagation and Cultivation

Roses are propagated by seeds, cuttings, grafting or budding, by layering, and by division. Except for the use of seeds, the other methods usually require skill, and are usually best left to professional horticulturists. *Rosa rugosa* suckers readily and can be divided quite easily. It can also be grown from seed, or more simply purchased from a reliable dealer as a potted plant intended for replanting. Growing roses from seeds can be frustrating. Seeds need to be stratified (cold-hardened, by exposure to temperatures around freezing; 3-4 months are recommended for

Fig. 331.
Turkestan rose *(Rosa rugosa)*, from Lindley (1829-1847; #1389).

Rosa rugosa), and germination may be irregular. Seeds obtained from dealers will usually have had this requirement met. Much has been written about the care and feeding of roses, and this information is too extensive to summarize here.

Harvest and Storage

Rose hips should be picked when they are plump and red, but not softly over-ripe. They can be left on the bush until the first light frost, and picked when slightly soft to the touch. They should be processed quickly after harvest to prevent loss of vitamin C. The stem and blossom ends should be trimmed, the hips cut in half lengthwise, the seeds and fibres scooped out with a small spoon, and the halves dried on a screen in an airy, shaded room indoors (Lima 1986). Alternatively, they can be dried by hot air from an electric heater, care being taken to prevent overheating and loss of natural color (Loewenfeld and Back 1974). The hips can be screened in a rough wire container to remove their hair (unless the hairs are strained away, they can be irritating in foods prepared with the hips). Storage should be in a cool place, and as vitamin C decreases gradually, the hips and their products should not be kept longer than a year.

Bryan and Castle (1974) give instructions for harvesting petals. They state that the darkest petals have the most flavor. Flowers should be harvested before it becomes sunny. Petals are pulled off, discarding the green or white heel attached to the flower base. The petals are washed, dried between paper towelling, and used immediately.

Example Cultivars (for Culinary Purposes)

Lima (1986) recommends Jens Munk and Scabrosa, which produced abundant hips in her garden, whereas Martin Frobisher, Agnes, and Hansa did not. Creasy (1982) recommends Belle Poitevine, Blanc Double de Coubert, Delicata, Frau Dagmar Hastrup, Hansa, Rubra, and Will Alderman; and Creasy (1990) recommends Belinda, Belle of Portugal, and Cecile Brunet. Barash (1993) recommends Tiffany, Mirandy, Double Delight, Fragrant Cloud, Perfume Delight, and White Lightnin.

Additional Notes

Also see information provided for the previous species, *Rosa canina*.

Chemistry

The essential oil contains numerous components (listed in Duke and Ayensu 1985). Fresh fruit contains quercetin, isoquercitrin, and tiliroside (Duke and Ayensu 1985). Organic acids, tannins, and pectin are also present (Stuart 1979).

Medicine

Roots of *Rosa rugosa* have been used as a folk remedy for treating diabetes in Korea (Lee et al. 1991). In Chinese medicine the leaves are used for fever, and the flowers to treat spleen, liver, and blood diseases, abscesses, hepatitis, stomach ache and other problems (Duke and Ayensu 1985). According to Perry and Metzger (1980) the drug made from the dried petals of *R. rugosa* is more commonly used to flavor tea than as a medicament.

Nutrition

Turkestan rose has up to 0.1% ascorbic acid (Vitamin C) (Duke and Ayensu 1985). Other vitamins recorded are B, E, K, and nicotinamide (Stuart 1979).

Curiosities

• The Persian philosopher Zarathustra (Zoroaster, the founder of Zoroastrianism; about 6th century B.C.) claimed the rose hip was the mother of all nutritious fruits (Marcin 1983).

• Various legends have evolved in different cultures to explain how the red rose acquired its color by the stain of blood (Lust 1974).According to ancient Greek myth, the goddess of love, Aphrodite, pricked her foot on a thorn and her blood colored the flower. In Turkish tradition the white rose was stained red by Mohammed's blood. A Christian interpretation holds that the color resulted from the blood of martyrs.

• A Turkish fable tells of the debate between a rose and a butterfly concerning who was better (Mercatante 1988). The rose pointed out to the butterfly that it was merely alive for the day and would be dead tomorrow. The

Fig. 332.
Turkestan rose *(Rosa rugosa)*,
from Bailey (1900).

butterfly replied that the rose was a prisoner in its garden. The rose then said that at least she was beautiful, while the butterfly was simply a worm with wings! As they argued, a woman plucked the rose and a bird carried off the butterfly.

• A Jewish fable in the Talmud tells of the debate between a rosebush and an apple tree (Mercatante 1988). The rose said that she was beautiful and fragrant. The apple replied that while the rose bush would not give up its flowers to man without wounding him with her thorns, the apple tree gives its fruit freely to all. [See *Myrtus* Curiosities for a chauvenistic view of the superiority of the myrtle over the rose.]

• The Roman Emperor Nero (37-68) reputedly used up the equivalent in modern currency of $100,000.00 in cut roses to decorate a night's feast (Crockett 1978; see saffron Curiosities for more of Nero's floral extravagances).

• Cleopatra (69-30 B.C.) reportedly welcomed Mark Antony (83?-30 B.C.) in a room filled with rose petals up to their knees (Crocket 1978).

• Isabel de Flores y de Oliva (1568-1617) was born to a poor family in Lima, Peru, and came to be known as St. Rose of Lima. Her story is told by Mercatante (1988). Noted for her beauty, she disfigured her face with a combination of pepper and quicklime to dissuade men from asking for her hand in marriage. A wreath of roses put on her head at her mother's request was transformed into a crown of thorns. Pope Clement X refused to canonize her in 1671, saying that her deserving sainthood was as likely as roses raining from heaven; instantly a shower of roses fell on the Vatican until the pope made her St. Rose.

• Western North American Indians thought wild roses repelled ghosts and evil spirits (Turner and Szczawinski 1978). Rose branches were scattered around the house and yard of recently died persons to prevent the return of the ghost, and relatives and friends drank a tea made from rose branches to protect them from it. Arose branch was used to sweep out the grave before burial to prevent the living from being drawn down (Turner and Szczawinski 1978).

• In England, it was found that the vitamin C content of rose hips increases towards the north, with four times as much in plants grown in Scotland compared to those in southern England (Loewenfeld and Back 1974).

• During World War II, rose hips were eaten for their content of vitamin C while supplies of foreign fruit were limited. The British Ministry of Health distributed "National Hip Syrup" (Loewenfeld and Back 1974). Similarly, German submarines and ships were supplied with rosehip syrup (Brouk 1975).

• Amygdalin is present in the seeds of many plants of the rose family, including rose, almond, apple, apricot, peach, and wild cherry. Amygdalin largely from apricot pits came to be called Laetrile or "Vitamin B17" (although not a vitamin), and elicited great interest as a cancer tumor destroyer during the 1970's. However, laetrile was banned from interstate commerce in the U.S. in 1971, and research has indicated that it is "ineffective as a treatment for cancer" (Duke 1985). Tyler (1993) discusses laetrile as an example of a fraudulent, sordid, and ineffective cancer cure. Laetrile continues to be used sometimes in cancer chemotherapy, mostly illegally in the U.S. (Blackwell 1990). (Toxic cyanide may also be released from amygdalin, and from the seeds of some plants of the rose family, such as apples. Indeed, cases of fatal poisoning after eating apple seeds have been reported (Duke 1985). For additional information on cyanide-producing plants, see discussion of hydrocyanic plants in lemon grass Curiosities.)

Problems and Potential

See comments for *R. canina*.

Selected References

Loewefeld and Back (1974); Turner and Szczawinski (1978); Nobbs (1980); Dirr (1986).

Rosmarinus

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

Rosmarinus has two species of evergreen shrubs native to southern Europe and northern Europe. [Some authorities recognize more species, others just one (Browse 1986).] *Rosmarinus eriocalyx* Jordan & Fourr. is confined to southern Spain and North Africa, although occasionally cultivated as an ornamental elsewhere. *Rosmarinus officinalis*, discussed below, is common in the Mediterranean region.

Rosmarinus Officinalis L.

English Names

Rosemary
Also: compass plant, compass weed, incensier, polar plant
[Several species are called compass plant, for their habit of orienting their leaves or flowers with respect to the sun. Australian rosemary is *Westringia rosmariniformis* Sm., a tender Australian perennial of the mint family, occasionally cultivated outdoors in warm climates (as in California) or in containers as an ornamental for its grey, hairy foliage and delicate white flowers.]

French Names

Family: Labiées, famille de la menthe
Romarin (m)
Also: encensier (see Curiosities), herbe aux couronnes, herbe des troubadours, romarin officinal, rose marine, rosmarin, rosmarin officinal, roumaniéou

Description, Taxonomy, and History

Rosemary is a native of southern Europe, Morocco and Tunisia. It is found among rocks and on dry, chalky, calcareous hills, often in bushy places. In the Mediterranean region it often occurs in the dry heathlands known as the maquis. This shrubby, sweet-scented, evergreen perennial grows as tall as 2 m, but usually no more than half this height. The narrow leaves are turned under at the edges, and matted on the underside with thick hair. In its native climate rosemary produces pale blue or bluish-lilac flowers 1-1.5 cm long, but may fail to flower when grown in northern North America. In the natural range plants normally flower during late winter-spring, but can flower intermittently throughout the year. Domesticated and wild kinds are usually indistinguishable. Rosemary has both erect and prostrate forms. The taxonomic status of these requires study (Yang 1985; Browse 1986).

Rosemary has been used in the Mediterranean region since ancient Greek and Roman times. It was cultivated by the classical Greeks (le Strange 1977). The Romans probably introduced the plant to Britain and other parts of their empire (le Strange 1977). Rosemary was much esteemed in the Middle Ages and cultivated on royal farms in central Europe by order of Charlemagne in the ninth century (Rosengarten 1969). It was the customary condiment for salted meat during the Middle Ages in Europe (Rosengarten 1969).

Uses

Rosemary is one of the most fragrant and pleasing of herbs, enhancing almost any food with which it is used. Rosemary herb (leaves and young shoots) is employed almost entirely for culinary purposes. The herb is marketed fresh, dried, and powdered. Rosemary herb is available in ground form, but is mostly sold whole, since crushing the leaves causes rapid flavor loss. It is used as a seasoning for pickles, jam, stuffings, soups, stews, sausages, sauces, chicken, duck, fish, shellfish, lamb, pork, rabbit, veal, egg dishes, and beverages such as vermouth. It can be added to salads and many vegetable dishes including asparagus, broccoli, cauliflower, eggplant, green beans, peas, potatoes, and zucchini (Duke 1985; Farrell 1985). The herb is also used as a garnish for salad dressings and in herb breads and herb biscuits. Rosemary is used discreetly in French, Greek, and Spanish cooking, but extensively in Italian cuisine (Greenhalgh 1979). Italian cooks even add it to a bread called *foccaccia* (Richardson 1991). The fragrance of the leaves has been described as like tea or like a combination of pine and nutmeg, while the flavor is somewhat peppery, warm, spicy and resinous with a hint of bitterness (Morton 1976; Prakash 1990). The flavor has also been described as "a cross between sage and lavender with a touch of ginger and camphor" (Bryan and Castle 1974). The flowers, with a milder flavor, are also added to food dishes. The flowers can be candied, preserved, or added to jellies, honey, vinegar, and wine. The fresh or dried leaves and flowers can be steeped for tea (Leggatt 1987; Facciola 1990). Because of its strong flavor, rosemary should always be employed sparingly, especially if dried, in which case it should first be soaked in hot water before being added to uncooked foods (Bryan and Castle 1974). As little as 1/8 to 1/4 teaspoon of fresh or dried rosemary leaves can season a dish for four people (Rinzler 1990).

Fig. 333.
Rosemary *(Rosmarinus officinalis)*, from Köhler (1883-1898).

Oil of rosemary, extracted from the leaves and flowering shoots, is used for culinary purposes, for example in wine and liqueurs. However, it is mainly employed in perfumery for scenting soaps, hair shampoos, bath essences, lotions, deodorants, cosmetics, and perfumes (especially eau de cologne). It is also added to insect repellents and odor-killing sprays, and is employed for denaturing alcohol. Still other uses for the essential oil include medicinal preparations such as inhalants, liniments, and tonics (Prakash 1990).

Fig. 334.
Rosemary *(Rosmarinus officinalis)*,
from Hallier (1880-1888).

Rosemary is often grown in warm regions as an ornamental, groundcover, and slope stabilizer (Simon et al. 1984). In warm climates it is an attractive low hedge. Rosemary flowers are very alluring to bees, and are good nectar sources in regions where the plants grow well.

Recipe Sources

Day and Stuckey (1964) have recipes for: Rosemary lemonade, Rosemary gin pineappleade, Rosemary fruit punch, Rosemary shish kebabs, Lamb loaf with rosemary sauce, Rosemary lamb casserole, Rosemary veal and ham casserole, Rosemary Turkey soufflé, and Fried rosemary parsnips. Rosengarten (1969) gives recipes for Rosemary fried chicken casserole, and Rosemary bridal punch. Crowhurt (1973) presents recipes for Rosemary butter, Rosemary conserve, Rosemary dip, Rosemary rounds, and Rosemary sauce. Smith (1973) has recipes for Rosemary vinegar, and Rosemary tea. Owen (1978) gives recipes for: Rosemary pickled beets; Rosemary venison steaks, Swiss style; and Rosemary pickled shallots à la rosemary. Michael (1980) has seven rosemary recipes. Belsinger and Dille (1984) present 13 rosemary recipes, notably: Mulled rosemary wine and black tea, Rosemary apple jelly, Rosemary scones, Trout baked in parchment with [Florence] fennel and rosemary, Rosemary ragout, and Oven-fried rosemary potatoes. Hutson (1987) has the following recipes: Garlicky rosemary shrimp New Orleans style, Baby Routh's rosemary muffins with goat cheese, and Regal rosemary butter. Leggatt (1987) presents recipes for: Italian tomato salad with spring onions (scallions), basil, and rosemary flowers; Lemon-grilled barbecued herring with lemon thyme and rosemary; and Barbecued lamb kebabs with honey and rosemary. Holt (1989) gives recipes for Rainbow trout marinated in marc with rosemary, Kid or lamb with rosemary, and Rosemary shortbread cookies. Holt (1991) has recipes for Pumpkin and rosemary soup with sun-dried tomato croutes, and Rosemary kebabs of char-grilled summer vegetables. Richardson (1991) has eight recipes, including Rosemary scallops and Rosemary meat loaf. Barash (1993) has six recipes with rosemary flowers, including Rosemary chicken, Rosemary veal chops, and Rosemary ice.

Other recipes are: Rosemary soup (Fox 1933); Rosemary wine (Grieve 1933); Lamb casserole with rosemary (Sanecki 1974); Fresh fruit purée with rosemary conserve (Garland 1979); Fried fish with rosemary and vinegar (Mallos 1979); Ragout of lamb rosemary (McCormick 1979) Rosemary wine or lemonade (Rose 1979); Chicken with rosemary (Stuart 1979); Rosemary tea (Marcin 1983;

recipes are provided both for flowers and leaves); Rosemary zucchini (Hemphill and Hemphill 1984); Rosemary sotbet (Tolley and Mead 1985); Rosemary potatoes (Thompson 1986); Rosemary chips (Adams 1987); Rosemary cheese fingers (Bremness 1988).

Importance

Most rosemary is collected from wild plants, but it is also cultivated, mainly around the Mediterranean, Rosemary is grown in Algeria, France, Germany, Italy, Morocco, Portugal, Romania, Russia, Spain, Tunisia, Turkey, the former Yugoslavia, and the U.S. (Farrell 1985). It is available on the international market mainly from Spain and France. The former Yugoslavia was also a major supplier. Small amounts are grown commercially in Mexico and in the southern U.S., particularly California. In 1988, the U.S. imported 802 t of unprocessed rosemary herb (leaves and tender stems) valued at $636,090.00 and an additional 7 t of processed rosemary products valued at $46,650.00 (Anon. 1989*a*).

Browse (1986) stated that about 100 t of rosemary oil is produced annually, chiefly in Spain, but also in Italy, France, the former Yugoslavia, the former U.S.S.R. and, in the Middle East, principally Tunisia and Morocco. A higher annual world production figure (295 t) is given in Lawrence (1992), who indicated that Spain produces about 150 t, Morocco 75 t, and Tunisia 65 t annually. Verlet (1993) estimated the annual world value of rosemary essential oil to be $5 million (U.S.). Most rosemary oil imported to the U.S. is from Spain, France, and Tunisia (Anon. 1989*b*; Dull 1994*a*). The U.S. imported 54 882 kg of rosemary oil worth $781,900.00 in 1991; 57 740 kg worth $713,100.00 in 1992; and 63 894 kg worth $717,500.00 in 1993 (Dull 1994a).

A new development in the U.S. is the cultivation of rosemary for its extractable antioxidants, approved for use as a food additive in the early 1990's (Motes, personal communication; cf. similar information for garden sage.). Thirty-two ha of the cultivar Arp were grown in 1995 in Oklahoma for yield of antioxidants (Motes, personal communication).

Cultivation Notes

Soil

Rosemary prefers light, well-drained, rather dry soils, with lime (Rosengarten 1969; Greenhalgh 1979). Wet soils inhibit growth. The soil pH should be between 6.0 and 7.5 (Yang 1985), with a tolerance range of 4.5-8.7 (De Baggio 1987). Fertilization schedules for container-grown rosemary were studied by Boyle et al. (1991).

Climate

Rosemary prefers full sunlight but will tolerate semi-shade (Greenhalgh 1979), In Mediterranean countries where rosemary is cultivated, it is usually grown without irrigation; after it is established, the roots grow very deep and the plant is drought-resistant (Hackett and Carolane 1982). In the Middle Eastern countries with high temperatures and minimal rainfall, along the Mediterranean Sea, rosemary stops growing during the summer months. Growth normally occurs between 2 and 35°C, optimally about 18°C. In its native range this tender perennial is able to tolerate temperatures in winter as low as -15°C, but it grows better in protected areas (Hackett and Carolane 1982). Flinn (1988) mentions that sometimes rosemary has successfully overwintered outdoors in upstate New York, with mulch for protection. According to Sherk and Buckley (1968), rosemary should be considered hardy in Canada only in the mildest areas of British Columbia. The hardiest cultivar, Arp, apparently tolerates -23°C so that it is winter hardy as far north as parts of southern Canada. Rosemary has survived winters in Ottawa, Canada. However, it is generally grown as an annual in cooler climates such as those found in most of Canada and the northern tier states of the U.S. It can survive dry periods outdoors, For the home gardener in all but the warmest parts of Canada and the northern U.S., rosemary is best grown in pots (at least 25 cm in diameter), kept indoors overwinter in a sunny, cool location. A bi-weekly misting is beneficial, and the plants should not be allowed to dry out. In its native area, rosemary thrives in areas of high humidity. The pots can be placed outside after frost danger (Lima 1986).

Propagation and Cultivation

Particular cultivars are maintained vegetatively, by semi-hardwood cuttings or division. Development is slow (Wang et al. 1993). Vegetative micropropagation is also possible (Misra and Chaturvedi 1984; Jain et al. 1991). Seeds can be used but reduced plant quality should be expected. Seeds should be planted at a depth of 13 mm or less, with seedlings usually emerging in 16-26 days (Wang et al. 1993). When grown commercially, rosemary is usually hand-transplanted to the field, although planting machinery used for other purposes can be modified for rosemary (Hackett and Carolane 1982). Direct commercial seeding in the soil is uncommon.

Rosemary is initially slow-growing. Mature plants can live for over 30 years (Greenhalgh 1979). If left outside, winter protection is important. Potted plants should be trimmed in the spring, before being placed outdoors for

the summer, and may require replacement every 3-4 years as they become straggly, with few lower leaves. Repotting can be easily accomplished by rooting 8 cm pieces from the top of new shoots with softwood hormone powder, in a small pot covered with plastic (punctured with a few ventilation holes). If kept in a sunny warm location, roots should form within 3 weeks (Lima 1986).

The home gardener can start new plants from stem cuttings. A sprig of robust new growth, 15-18 cm long, should be clipped from the top of the plant, and leaves stripped from the bottom 3 cm. The bottom of the twig should be stuck in wet sand until it has rooted, usually in 6 weeks or less. An alternative method of propagation (layering) is to pin down the lower rambling branches against the soil until they root, forming new plants (Crockett and Tanner 1977).

Potted plants should be grown in pots that are just large enough for the roots, as rosemary does best when the roots are somewhat crowded (Crockett and Tanner 1977). According to Elbert and Elbert (1974) "of the culinary herbs, rosemary is the easiest to grow in the house, and it is a nearly perfect foliage shrub." Indoor plants need at least 4 hours of direct sunlight or 12 hours of strong artificial light (Crockett and Tanner 1977). The soil should be left to become moderately dry between deep waterings. [Elbert and Elbert (1974) dispute this common recommendation for rosemary grown as a houseplant, instead advocating that the soil be maintained moist.]

Harvest and Storage

In commercial production the leaves can be harvested throughout the year. In Mediterranean countries, cultivated rosemary can be harvested 1-3 times a year for the culinary herb. Late fall harvest should be avoided in cold climates, or winter kill can occur (Motes, personal communication). Shoots are trimmed back several centimetres before they become woody (Rosengarten 1969).

The leaves are promptly dried after harvest to keep the loss of the essential oil to a minimum. When dried carefully, either in trays in well-ventilated, dark locations, or by artificial heat not exceeding 40°C, the leaves retain their green color and fresh, bittersweet flavor. The dried herb is packaged commercially either whole or ground (Prakash 1990). There is some loss of color when the herb is frozen (Simon et al. 1984).

The home gardener can harvest leaves for fresh use at any time. The flavor is best just before the plants bloom, and this is the optimal time to harvest for dried leaves (Crockett and Tanner 1977). Harvested stems and leaves may simply be placed on a screen to dry in a dark, well-ventilated area, then stored in an airtight container.

Fig. 335.
Rosemary *(Rosmarinus officinalis)*,
from Thomé (1903-1905).

Example Cultivars

Arp, Benenden Blue, Blue Boy, Golden Rain, Lockwood, Majoraca, Pink, Severn Sea. Motes (personal communication) reports that much of the cultivar Arp failed to survive in northern Oklahoma (U.S.D.A. climatic zone 7a), but is expected to survive in southern Oklahoma (zone

6b). Motes also found that Hill Hardy, reputed to be more cold tolerant than Arp, appeared to be about as resistant to cold as the latter.

Cultivars are usually offered as living plants in Canadian garden catalogs. Browse (1985) and Facciola (1990) describe culinary and ornamental cultivars available in the U.S. Additional cultivars are noted in Huxley et al. 1992.

Additional Notes

Chemistry

A pale yellow essential oil is obtained by steam distillation of fresh leaves, yielding approximately 0.1%. The major oil constituents of the leaves are cineole (typically 27-30%), borneol (16-20%), camphor (10%), and bornyl acetate (2-7%), with small percentages of -pinene, camphene, terpineol and verbenone (Farrell 1985; see Lawrence (1992) for a wider range of percentages). Borneol is responsible for the pungent odor and burning taste, cineole contributes a fresh, cooling aroma, -pinene produces a pine-like odor, and camphor contributes a cool, minty sensation (Farrell 1985). The oleoresin is a greenish-brown semisolid. About one part of the oleoresin is equivalent to 40 parts of crushed, dried rosemary leaves in flavor and aroma (Prakash 1990).

Oil of rosemary is produced by distillation of flowering tops or leafy twigs and is made up of nearly 60% monoterpenes such as -pinene. The major components of the essential oils vary widely in percentage composition depending on the cultivar (Tucker and Maciarello 1986; Prakash 1990). Inferior quality rosemary oil (indicated by larger amounts of -pinene and camphor and smaller amounts of 1,8 cineole and borneol) has sometimes appeared on the market, due in part to harvest of wild material (Lawrence 1992). In container-grown rosemary, essential oil content is higher in plants receiving low rates of fertilization (Boyle et al. 1991).

Medicine

In traditional folk medicine, the oil has been used internally as a cardiac and circulatory stimulant. Conditions treated in folk medicine with rosemary include asthma, baldness, bronchitis, bruises, cancer, chills, colds, cough, dandruff, fever, headache, hoarseness, hysteria, insomnia, nervous tension, neuralgia, rheumatism, and sprains (Duke 1985). Morton (1981), noting that rosemary has had many medicinal uses in Europe, lists a very wide variety of folk uses in Middle America (central America, northern South America and environs). In Chinese medicine the leaf is used to treat headache, colds, nervous tension, stomach ache, and other ailments (Duke and Ayensu 1985).

A decoction of the leaves was once employed to induce abortion and to treat rheumatism and paralysis (Prakash 1990). Rosemary can be abortive and poisonous if used in excess (Duke and Ayensu 1985). Toiletries with rosemary oil can cause dermatitis in hypersensitive individuals (Duke 1985).

Rosemary is not thought to have much medicinal value today, although the oil does have antibacterial properties, and there is some modern medicinal use for treating indigestion, rheumatic disorders, and circulatory disturbances (Tyler 1993). However, therapeutic doses of the oil are so large that they may cause irritation of the stomach, intestines, and kidneys (Tyler 1993).

Nutrition

Rosemary is not considered to be nutritionally significant (Hackett and Carolane 1982), although the dried herb contains about 5% protein, as well as vitamin A, thiamine, niacine, and ascorbic acid (Duke 1985).

Curiosities

• The scientific name *Rosmarinus* comes from the Latin *ros*, dew, and *marinus*, belonging to the sea, an allusion to growing wild by the sea in the Mediterranean region, where the plant is adapted to conditions of fog and salt spray (Grieve 1931).

• Ancient Greek students would braid rosemary wreaths in their hair when taking examinations because the plant was thought to fortify the brain and refresh the memory (Rosengarten 1969).

Fig. 336.
Rosemary *(Rosmarinus officinalis)*,
from Vilmorin-Andrieux et C^{ie} (1883).

• Rosemary flowers vary in color from pale bluish-white to a deep blue. Legend has it that the Virgin Mary, fleeing from Herod's soldiers with the Christ child to Egypt, hung her blue cloak one night on a rosemary bush with a white flower. The next morning the flower had turned blue like Mary's garment, and the herb thereafter was known as "rose of Mary" (Rosengarten 1969). The Spanish name for rosemary, *Romero*, means Pilgrim's flower, and is said to be related to the Holy Family's flight (Macleod 1968). Another legend held that during the flight of the Holy Family the bushes through which they passed crackled, increasing the danger of detection, while only the rosemary stretched out its branches in silence, letting the Family pass safely through (Jones 1961). Still another legend held that when Mary hung the Christ-child's clothing on a rosemary bush, she found that she had hung them on a sunbeam, and thereafter rosemary was endowed with magical powers (Jones 1961). It was also believed that rosemary grew for 33 years to the height of Christ, but grew no higher (Lust 1974; as noted earlier, rosemary will grow as tall as 2 m, about 6 feet). [See Curiosities for juniper, which is also reputed to have assisted the Holy Family in its flight.]

• During Medieval times, rosemary was believed to grow only in the gardens of the righteous and it was used as a magic charm for protection from witchcraft, particularly the "evil eye" (Rosengarten 1969).

• Rosemary was a symbol of happiness, fidelity and love, and a wedding flower in Europe for the last thousand years (Lust 1974). In 17th century England, branches of rosemary were gilded, fled with flowering silken ribbons, and carried before the wedding procession (Williams 1994). Rosemary is still worn by some brides. Someone could be made to fall in love merely by being tapped on the finger with a sprig of rosemary. A man indifferent to rosemary's perfume was said to be incapable of giving true love to a woman.

• Curiously rosemary also became a funeral flower, because it symbolized the memories of loved ones (Lust 1974). Rosemary was used to embalm the dead. In the 19th century, it was reported that when coffins were opened after several years, rosemary branches that had been placed in the hands of the dead were found to have grown so that they covered the corpse (Jones 1961; a believe-it-or-not report!)

• The dual symbolism of rosemary of both love and death was recorded in an old poem (Jones 1961):

Grown for two ends;

It matters not at all

Be it for my bridal or my burial.

It was said in 1603 of a bride who died of the plague on her wedding day "Here is a strange altercation, for the rosemary that was washed with sweet water to set out the bridal is now washed with tears to furnish the burial" (Jones 1961).

• In Medieval England, rosemary was widely planted around houses, to conceal the smells from primitive sewers (Browse 1986).

• Apothecaries provided oil of rosemary as a deterrent of baldness (Farrell 1985).

• In the Middle Ages rosemary was placed under pillows to repel evil spirits and bad dreams (Lust 1974).

• The tale is told of the aging, wrinkled queen in the Middle Ages who bathed three times daily in about 3 kg of rosemary leaves. She became so youthful that she was left with the problem of finding a suitable young and virile man (Yang 1985). The Spanish explorer Ponce de León (1460?-1521), credited with discovering Florida in an attempt to find the secret of youth, could perhaps have saved himself the trip had he appreciated the presumed rejuvenating powers of rosemary.

• Shakespeare mentions rosemary in five of his plays (Flinn 1988). For example, in Hamlet, Act. IV, Ophelia says: "There Rosemary, that's for remembrance. Pray you, love, remember." As noted above, since the time of the classical Greeks rosemary has had a reputation for stimulating the brain and increasing memory.

• Curiously, it has been speculated that rosemary, the "herb of remembrance," may have value for treating the most insidious of memory diseases, Alzheimer's. It has been suggested that Alzheimer's disease may result from acetylcholinesterase breakdown of acetylcholine, an essential neurotransmitter. Rosemary contains at least five acetylcholinesterase inhibitors (carvacrol, 1,8-cineole, fenchone, limonene and thymol), and so, it has been suggested, may have therapeutic value for Alzheimer's. It has even been suggested that rosemary shampoo might be a beneficial measure, since the chemicals mentioned can cross the blood/brain barrier and might be dermally absorbed. (For more information, see Beckstrom-Sternberg and Duke 1994.)

• It was customary in French hospitals to burn rosemary and juniper to sanitize the air and prevent infections (Farrell 1985). The French also hung rosemary in sick-rooms and in hospitals as a sort of healing incense, hence it was called encensier (Castleman 1991). Rosemary branches were once strewn in law courts to protect against typhus, and during the Plague of 1665 rosemary was carried in the handles of walking sticks to be sniffed for protection (Bremness 1988).

• Rosemary was an ingredient of "Hungary water," invented for Queen Elizabeth of Hungary who became paralysed in 1235 (Flinn 1988). Legend holds that a hermit rubbed an infusion of rosemary in wine on her limbs, curing her (Castleman 1991). Hungary water, a precursor of Eau de Cologne, was commonly used as a tonic to relieve muscle problems and spasms (Hackett and Carolane 1982), as well as to prevent baldness and treat gout, dandruff, and skin problems (Castleman 1991). Jones (1961) gives the following recipe for the original Hungary Water:

1 gallon brandy or clean spirits

1 handful of rosemary

1 handful lavender

1 handful myrtle

To those who would try this intoxicating remedy, keep in mind that it was used externally!

• In England a rosemary plant outside a house showed that the wife was the boss of the home (Lust 1974; this belief also prevailed for sage). The saying was: "If rosemary prosper, the mistress is master" (Flinn 1988).

• In Belgium, children were told that babies come from rosemary plants (Lust 1974). In Cicely, children are told that young fairies in the form of snakes lie in the branches of rosemary bushes (Hemphill and Hemphill 1984).

• In the Mediterranean, where rosemary grows wild on rocky hillsides, its fragrance becomes so intense that when the wind is right it can be smelled 37 km (20 miles) at sea (Crockett and Tanner 1977).

Problems and Potential

The relatively low price of rosemary, combined with its widespread occurrence in the Mediterranean countries and adaptation to warm climates, makes it a poor prospect for crop diversification in the northern areas of North America.

Selected References

Rosengarten (1969); Greenhalgh (1979); Hackett and Carolane (1982); Lima (1986); Prakash (1990).

Rumex

Polgyonaceae (buckwheat family, smartweed family, knotweed family)

Genus Notes

Rumex consists of 150-200 species of mostly perennial herbs, rarely shrubs, widely distributed in temperate regions. Many of the species are weeds, mostly from Eurasia. Several weedy species of Eurasia, North America, and South America are collected, dried, and used in flower arrangements. *Rumex hymenosepalus* Tort. is grown for its thick roots, to obtain tannin and a yellow dye. A few of the species are cultivated as ornamentals. Several species are grown as salad plants, or simply collected from the wild for the purpose (see *Rheum* genus notes for several with "rhubarb" in their names). Several of the wild species have been used medicinally. Generally the wild species are much more acidic and less tasty than the cultivated species. The two principal species that are grown for culinary purposes are discussed below. Sorrels have a very long culinary history, having been consumed by the ancient Egyptians, Greeks, and Romans.

The acidity of sorrels is due to vitamin C, oxalic acid, and oxalate salts (mostly potassium hydrogen oxalate). The latter are responsible for occasional poisoning in man and other animals.

Warning

Individuals susceptible to developing medical conditions from consumption of oxalic acid should avoid ingesting large quantities of *Rumex* species (see Medicine).

Sorrels (like spinach and rhubarb) contain considerable oxalic acid, which can react with metals. It is recommended that sorrels be prepared using stainless steel utensils and cookware. When sorrel is cooked in aluminum, the acid could free aluminum ions, suspected of being toxic. Sorrels should never be cooked in a cast iron pan, since iron with sorrel turns black and a nasty metallic taste is produced (Stobart 1977).

Rumex Acetosa L.

English Names

Garden sorrel
Also: broad-leaved sorrel, cuckoo sorrow, English sorrel, green sauce, green sorrel, kitchen sorrel, meadow sorrel, sour dabs, sour dock (sourdock), sour suds, wild sorrel [Hyphens are frequently encountered in all of the binomials; additional old-fashioned English names are in Wijk (1911).]

Fig. 337.
Garden sorrel *(Rumex acetosa)*,
from Hatter (1988).

French Names

Family: Polygonacées, famille de la rhubarbe
Grande oseille (f)
Also: aigrette, oseille, oseille commune, oseille cultivée, oseille de Belleville, oseille de Hollande, oseille des jardins, oseille des prés, oseille d'Italie, oseille domestique, oseille grande, oseille longue, oseille ordinaire, oseille sauvage, oseille vierge, oseille vulgaire, patience acide, patience des prés, patience grande oseille, rumex oseille, surelle, surette, vinette
[Additional old-fashioned French names are in Wijk (1911).]

Description, Taxonomy, and History

Rumex acetosa is a native of Europe and Asia that has become naturalized in North America as far north as Alaska. It is a perennial herb, growing 30-150 cm in height, the larger sizes usually attained in cultivation. Its leaves are narrow and arrow-shaped, distinct from the shield-shaped leaves of French sorrel (discussed next), which are wider at the base. *Rumex acetosa* is polymorphic, and is sometimes split into other species, such as *R. vinealis* Timb.-Lagr. & Jeanb. and *R. hibernicus* Rech. fil. (Turin et al. 1964). Cultivated selections are sometimes placed in *R. acetosa* var. *hortensis* Dierb. Page and Steam (1993) split *R. acetosa* as understood here into "common sorrel," *R. acetosa* L., and "garden sorrel," *R. rugosus* Campdera. "Garden sorrel" is taller, with a much branched inflorescence, and may be called *R. acetosa* subsp. *ambiguus* (Grenier) A. Löve, or simply separated as the species *R. rugosus* (Steam, personal communication).

Fig. 338.
Garden sorrel *(Rumex acetosa)*,
from Syme et al. (1863-1886).

The young leaves of garden sorrel were very popular with early Egyptians and Romans (Morton 1976). In the West, garden sorrel has been used as a salad and vegetable plant at least since the 14th century (Stuart 1979). It was widely cultivated in England until the late 19th century, at which time French sorrel surpassed it in popularity. With the development of new cultivars it is regaining popularity.

Uses

Like the other sorrels used as pot herbs, the pleasantly acidic leaves of garden sorrel are edible and are used to add piquancy to various dishes. The leaves can be eaten raw as a salad green, or used as a potherb, puréed, or added to soups, omelettes, sauces and various dishes. Sorrel sauces complement lamb, veal, pork, duck, and geese. Sorrels taste bitter and somewhat sour, but are nevertheless considered good condiments. Morton (1976) recommends boiling the leaves in two or three changes of water. The seeds are used in Sweden to make bread (Morton 1976), and indeed native Americans living along the Colorado River used the seeds as a source of flour (Phillips 1986). The juice of the leaves curdles milk, and is used by Laplanders as a substitute for rennet for the purpose (Phillips 1986).

Recipe Sources

Bryan and Castle (1974) give recipes for Sorrel-celeriac salad, Chiffonade of sorrel, Frog legs with sorrel, Scallops and ham in sorrel sauce, and Turkey and hearts of palm with sorrel. Launert (1981) has recipes for Eggs stuffed with sorrel, Purée of sorrel, Sorrel sauce for a fish dish, Sorrel soup, Caucasian sorrel soup, and Polish sorrel soup. Belsinger and Dille (1984) present 13 sorrel recipes, notably: Shrimp paste with sorrel, Sorrel cheese spread, Sorrel sushi-style, Celery sorrel soup, Sorrel spinach soufflé, Creamed eggs sorrel in croustades, Salmon with sorrel butter, Chicken and cantaloupe salad with sorrel mayonnaise, Lentil salad with sorrel, Warm potato and turnip salad with sorrel, and Sorrel grape tart. Phillips (1986) gives recipes for Sorrel soup, Sorrel salad, Sorrel sauce, and Buttered sorrel. Hutson (1987) has recipes for Spicy shrimp and sorrel salad and Green sorrel butter. Bremness (1988) gives recipes for Pork and sorrel terrine, and Sorrel and parsnips mousses. Jeanneret (1987) presents recipes for Mushrooms stuffed with peas and sorrel, and Veal chops in sorrel sauce. Holt (1989) gives recipes for Iced sorrel soup and Courgette and sorrel soup with almond and chive sables. The recipes given later for French sorrel are also all suitable for garden sorrel.

Other sorrel recipes are: Cooked sour dock (Muenscher and Rice 1955); Suprême de saumon à l'oseille (Kenyon 1979); Chicken stuffed with sorrel (Brennan et al. 1985); Shchav [Russian recipe for a chilled summer soup] (Bacon 1988).

Importance

Garden sorrel is an old-fashioned herb, of limited commercial value at present, grown mostly as a garden curiosity. It is generally considered inferior to French sorrel, although some attractive cultivars are now available.

Cultivation Notes

In addition to the following comments, also see the information for French sorrel, discussed next.

Propagation and Cultivation

Garden sorrel is reproduced by seeds and by root division. Once established, it tends to self-sow.

Harvest and Storage

The green parts of the plant are edible while tender and juicy. Unlike *R. scutatus*, the flavor of *R. acetosa* is not fully developed until the plant is in full season (Loewenfeld and Back 1974). Nevertheless, *R. acetosa* is often harvested while young as the flavor becomes more acidic later in the season. If the leaves are large, the veins can be cut away. The leaves can be washed, dried, wrapped in paper towelling, and refrigerated in a plastic bag until ready for use (Bryan and Castle 1974).

Fig. 339.
Garden sorrel *(Rumex acetosa)*, from Sturm (1900-1907).

Example Cultivars

Belleville, Blonde de Lyon, Gourmet Brand Verte, Larghe Fooglie Bionde, Low Oxalic Acid, Nobel, Pallagi Nagylevelü (all discussed in Facciola 1990).

Additional Notes

Also see information for French sorrel, below.

Chemistry

Garden sorrel has a leaf content of about 1000 mg/100 g of potassium binoxolate, with some tartaric acid (Watt and Breyer-Brandwijk 1962). By comparison, the reported oxalic acid content of the two most-well known high-oxalate acid plants are 1336 mg/100 g for rhubarb (leaf stalks), and 658 mg/100 g for spinach (Watt and Breyer-Brandwijk 1962). Tartaric acid is also present (Stuart 1979), as well as malic acid and tannic acid (Rinzler 1990).

Medicine

In Europe garden sorrel has been used as an antiseptic, and as an antiscorbutic (to fight scurvy or vitamin C deficiency), while the roots and seeds have been employed as a tonic and to treat diarrhea (Watt and Breyer-Brandwijk 1962). In Africa it has been used to treat abscesses and skin irritations (Watt and Breyer-Brandwijk 1962). A decoction of leaves and stems of garden sorrel was taken as a cure for diarrhea by the western Eskimo (Moerman 1986).

Fatal cases of oxalic acid poisoning in man and livestock have been recorded from consumption of *Rumex acetosa* (Watt and Breyer-Brandwijk 1962). Oxalic acid is mildly laxative (Rinzler 1990). Foods such as sorrel and spinach that are high in calcium and oxalates are inadvisable for people susceptible to calcium-oxalate kidney stones, and may also be imprudent for those with arthritis or gout (Rinzler 1990). Large amounts of sorrel tea may be poisonous (Rinzler 1990).

Nutrition

Garden sorrel is a rich source of vitamin C, with 63 mg/100 g fresh weight in the leaves (Watt and Breyer-Brandwijk 1962). It is also high in iron (Duke 1977) and very high in vitamin A (Oakley 1980).

Curiosities

• In discussing *Rumex*, the monumental (1457 page) reference book *Medicinal and Poisonous Plants of Southern and Eastern Africa* (Watt and Breyer-Brandwijk 1962) notes on page 864 that "on account of its high intestinal content of calcium, the chicken is practically immune to oxalic acid poisoning." However,

in direct contradiction on page 865 it is stated that "hens have developed symptoms of oxalic acid and oxalate poisoning from eating [*Rumex*]." (Possibly it should be pointed out that authors who live in glass houses shouldn't throw stones!)

• In humans, an XY chromosome system determines sex, with females having two X chromosomes, and males one X and one Y. In *Rumex acetosa* females also have two X chromosomes, and males one X, but the males have two (different) Y chromosomes (Rejón et al. 1994).

Problems and Potential

Garden sorrel competes with French sorrel, which at least in Europe is generally considered superior for culinary purposes. However, garden sorrel is much milder, and will probably be preferred by those who haven't developed a palate for the very acidic French sorrel. The cultivar Low Oxalic Acid was bred for low content of oxalic acid, and the flavor is only slightly sour (Facciola 1990). Garden sorrel has at least enough appeal to be considered by commercial culinary herb specialists as one of their offerings.

Selected References

Articles providing comprehensive information on garden sorrel were not located.

Rumex Scutatus L.

English Names

French sorrel
Also: buckler-leaved sorrel, buckler-shaped sorrel, garden sorrel (better reserved for *R. acetosa*), round-leaved sorrel, sour grass

Fig. 340.
French sorrel *(Rumex scutatus)*,
from Vilmorin-Andrieux et C^{ie} (1883).

French Names

Petite oseille (f)
Also: oseille à feuilles rondes, oseille en bouclier, oseille franche, oseille petite, oseille ronde (des jardins), patience à écusson(s), rumex à écusson(s)
[Petite oseille is also a name for *R. acetosella* L., a common weed in North America, naturalized from Europe.]

Description, Taxonomy, and History

Rumex scutatus originates from the mountains of southern and central Europe and southwest Asia (including the Near East and the Caucasus). It is a low-growing perennial herb with small, reddish unisexual flowers. The stems are either prostrate or ascending, 20-100 cm long, and form thick clumps. The rootstock is tough and branched. Domesticated forms are sometimes separated as *R. scutatus* var. *hortensis* Lam. &DC. French sorrel is thought to have been introduced to Britain in 1596 (Loewenfeld and Back 1974). It used to be cultivated in the large market gardens near London, England, but gradually lost popularity to herbs that require less care in gathering and packing (Organ 1960). French sorrel continues to be cultivated on a limited commercial scale in other parts of Europe and in Eurasia.

Uses

French sorrel is valued for its sharply acidic leaves, more lemony than garden sorrel. French sorrel can be used as a condiment, a few leaves added to the cooking pot lending a deliciously tart flavor to such vegetables as chard or spinach. Indeed, the young leaves cart be cooked and served like spinach. Chopped French sorrel adds piquancy to mixed green salads. Sorrel sauce can be used with vegetable, meat, fish, poultry, and omelette dishes. However, French sorrel is best known for making soup, and has been used for this purpose in France since the beginning of the country's recorded history. Sorrel is the chief constituent of soupe aux herbes. Other French specialties with sorrel include ragouts and fricasées.

Sorrel flowers can be eaten as a vegetable or used as a garnish. The seeds can be ground and used to make bread. Juice from the leaves has been used to curdle milk.

French sorrel is sometimes grown as an ornamental.

Recipe Sources

Owen (1978) has recipes for Sorrel soup and Shad stuffed with roe in sorrel sauce. Garland (1979) gives recipes for Sorrel omelette and Hard-cooked eggs and sorrel. Schneider (1986) has recipes for: Sorrel cream sauce for vegetables; Puréed potatoes, parsnips, and sorrel; Salad of sorrel, endive, and mushrooms with walnut dressing;

Fig. 341.
French sorrel *(Rumex scutatus)*, from Hallier (1880-1888).

Chilled sorrel-and-pea soup, and Cold poached salmon in sorrel cream sauce. Hutson (1987) presents recipes entitled Sorrel-wrapped salmon with lemony beurre blanc, and French sorrel soup. Leggatt (1987) has recipes for: Sorrel soup with sorrel flowers and soured cream; and Cowslips, primroses and heartsease with young sorrel and endive. Holt (1989) gives recipes for Roast goose with sorrel and apple sauce Oie, Salmon trout with fresh fennel and sorrel cream, and Cocotte eggs with sorrel.

Other recipes are: Sorrel soup (Organ 1960; McDaniel 1976); French sorrel soup (Loewenfeld and Back 1974); Sorrel sauce (Halpin 1978); Terrine of smoked trout with sorrel (Tolley and Mead 1985); Sorrel salad (Richardson 1990); Salmon and dill fishcakes with sorrel sauce (Holt 1991); Sorrel-spinach purée (Richardson 1991).

Importance

French sorrel is grown on a limited scale in farmers' gardens in central and southern Europe, sometimes farther east (Mansfeld 1986). Formerly, it was also grown in western Europe. It is considered the best of the sorrels by many, and is often found in private herb and vegetable gardens. It is grown in greenhouses in the U.S. for winter supply on a limited scale (Schneider 1986).

Cultivation Notes

Soil

French sorrel tolerates almost any substrate, but prefers a rather deep, rich, moist but well-drained soil.

Climate

The plants grow well in full sunlight, but are somewhat more tender in partial shade, which they tolerate. French sorrel (*R. scutatus*) is more drought-tolerant than garden sorrel (*R. acetosa*) (Huxley et al. 1992). According to Grieve (1931), garden sorrel likes a damp situation, while French sorrel prefers a dry soil. Crockett and Tanner (1977) stated that in hot weather sorrel leaves may turn bitter, but the mild flavor of the leaves returns when the weather becomes cooler.

Propagation and Cultivation

French sorrel can be easily established from seeds planted in fall or early spring, or well grown clumps can be divided every third or fourth year. Seeds can be started in pots indoors and transplanted out in early spring. Acidity of leaves increases during the summer, and French sorrel is sometimes grown as an annual, with staggered plantings to supply young plants on a regular basis. Plants can be lifted and forced under glass to obtain greens during the winter. Flower stalks should be cut off to prevent the plant from going to seed and to encourage leaf growth. The roots penetrate deeply into the soil and are difficult to eradicate after they are established (Crockett and Tanner 1977).

French sorrel grows well as a houseplant, provided that it has at least 5 hours of strong direct sunlight daily, and is watered frequently enought to keep the soil from becoming completely dry. It should be given a deep container of commercial potting soil to accommodate its long roots, and fed with half-strength liquid fertilizer every 2 weeks (Crockett and Tanner 1977).

Harvest and Storage

Leaves can be gathered from newly sown plants 2 months after planting. Indeed, with such young plants, the shoots may be gathered whole. To maintain the plants, single mature leaves should be collected. This is the method favored by market gardeners on the outskirts of Paris, resulting in leaves of about the same size, allowing the plant to live 3-4 years, and producing a larger yield than harvesting whole plants (Brennan et al. 1985). Sorrel wilts

rapidly after cutting, and crisp leaves can be difficult to find in markets. However, even wilted sorrel retains much of its distinctive taste.

Leaves can also be dried by laying them out flat in a cool dry place, in darkness, with good air circulation; dried leaves can be stored in airtight containers (Hemphill and Hemphill 1984). Washed young leaves can be sealed in foil and frozen.

Example Cultivars

Huxley et el. (1992) list the ornamental cultivars Silver and Silver Shield.

Additional Notes

Chemistry

Oxalates are present (Stuart 1979).

Medicine

In classical herbal medicine French sorrel was used internally to cure scurvy, to cleanse blood, promote urine flow, and eliminate kidney stones (hardly warranted, given the information presented for the previous species, that the sorrels can produce kidney stones!). Externally, sorrels were used to cure skin disorders and promote a good complexion. French sorrel used to be officinal, i.e. listed in pharmacopoeias as a medicinal agent, but it is not used in modern medicine. According to Crockett and Tanner (1977), excessive sorrel acts as a diuretic.

Nutrition

The use of this herb as an antiscorbutic reflects high content of vitamin C. Sorrel is also considered an excellent source of fiber and vitamin A, as well as a good source of iron (Schneider 1986). Larkcom (1984) also lists vitamin B_1. Also see information for the preceding species.

Curiosities

• The name sorrel derives from the Old French *surele*, through the Germanic *sur*, meaning sour (Schneider 1986).

• Because of its acidic taste, sorrel was sometimes called "sourgrass" in England (Lima 1986).

• In France, shad is stuffed with purée of sorrel, with the result that the oxalic acid softens, and somewhat dissolves the numerous bones (Facciola 1990).

Problems and Potential

French sorrel wilts quickly after picking, and is therefore difficult to market. It continues to be grown on a limited commercial scale in Eurasia, but does not seem to have potential for North America. While it will likely remain simply a garden curiosity in North America, it is at least deserving of attention of specialty herb growers on a very limited scale.

Selected References

Hemphill and Hemphill (1984); Schneider (1986).

Ruta

Family: Rutaceae (rue family)

Genus Notes

Ruta has about 50 species (much fewer according to some) of perennial herbs, subshrubs, and shrubs native from the Mediterranean region to western Asia. A few species are grown as ornamentals, and some are used as a source of rue oil, or employed as a medicament or flavoring as is *R. graveolens* described below (Uphof 1968). *Ruta chalepensis* L. (*R. angustifolia* Pers., *R. graveolens* var. *angustifolia* Hook. f.), known as fringed rue, is commonly used in folk medicine in both the Old and New Worlds (Uphof 1968; Morton 1981). In Mexico, it is steeped in sugarcane alcohol for 2 weeks to a month, and drank early in the morning by women performing hard labor (Morton 1981). It shares many of the same alkaloids possessed by

Fig. 342.
Fringed rue *(Ruta chalepensis)*,
from Curtis (1787-present; #2311).

Fig. 343.
Rue *(Ruta graveolens)*, from Hallier (1880-1888).

R. graveolens, and is dangerous. Used internally, the leaves and oil can cause hemorrhages, miscarriage, and abortion in pregnant women; and vomiting, gastroenteritis, swelling of the tongue, feeble pulse, coldness of the extremities, and even death (Morton 1981). Used externally (as it is in many folk remedies), it can produce redness, swelling and blisters (Morton 1981).

Ruta Graveolens L.

English Names

Rue
Also: common rue, garden rue, herb of grace (herb-of-grace), herb of repentance, herbegrass, herbygrass

French Names

Family: Rutacées, famille de la rue
Rue (f)
Also: cariero, herbe de grâce, herbe de la rute, peganion, rue commune, rue de(s) jardins, rue domestique, me fétide, rue odorante, rue officinale, rue puante

Warning

As described in the following, this species has been shown to have powerful physiological effects. It is potentially toxic and carcinogenic when consumed orally, and can produce dermatitis when touched. It is a well-known abortifacient that should never be taken when pregnant, except under the care of a physician. Although there has not been a general recommendation against using the plant as a condiment, the extent to which this can be done safely has not been determined, and consumption could be hazardous.

Description, Taxonomy, and History

Ruts graveolens is indigenous to meridional Europe, the Balkan Peninsula, the Crimea, and perhaps elsewhere in the Mediterranean region. This species was extensively naturalized in southern and south-central Europe, and was widely grown in herb gardens in Europe, Asia, Africa, and North America. It is occasionally collected as a garden escape in North America, often in old pastures, roadsides and waste places. The plants are aromatic, evergreen subshrubs ["nearly evergreen" according to Morton (1976), "semievergreen" according to Crockett and Tanner (1977)]. The foliage is an attractive blue-green. The plants grow from 0.2 to over 1 m in height, and have terminal clusters of small, greenish-yellow flowers. All parts of the plant have a strong, heavy, unpleasant smell and a bitter, acrid pungent taste due to a volatile oil. The stems and the leaves are covered with oil glands. On the leaves, the oil glands appear as translucent black dots.

The species is sometimes split into two, *R. hortensis* Mill. and *R. divaricata* Tenore (= *R. graveolens* var. *divaricata* (Ten.) Willk.), these alleged to differ in color and flavor.

Ruts graveolens was a popular healing and seasoning plant among the classical Greeks and Romans (Bois 1934; Morton 1976). It was also very popular during the Middle ages and the Renaissance. It has been used as an abortifacient since antiquity.

Uses

Ruta graveolens is grown as an ornamental; as bee forage; as a medicinal plant, especially in southern Europe where rue oil is distilled from the leaves; for the manufacture of cosmetics and perfume; and for use as a condiment.

For culinary purposes, the leaves, pickled fruits, and ripe fruits have all been used as condiments. The fresh or dried leaves have been employed to season cheese, meat, vegetable juice, salads, stews, vegetables, and wine. Rue often flavors sausage. Chopped leaves are sometimes added to salads as a strong seasoning, and the leaves are also employed in teas. The taste of the leaves is very bitter, acrid, and nauseous, which is probably a good thing, given the toxicity of the plant. Nevertheless, some like the taste of the freely chopped leaves in salads and sandwich fillings.

Rue was sometimes employed to flavor mead, and has been used in an Italian distilled grape spirit known as grappa; however, because it is so bitter, other species are sometimes substituted for *R. graveolens* (Stobart 1977).

Oil of rue is apparently used as a flavor component in various food products in the U.S., including alcoholic and nonalcoholic beverages, baked goods, candy, frozen dairy desserts, gelatin, and pudding (Duke 1985). The plant and its oil are registered (No. 412) as a natural aromatic product authorized by the European Council (Petit-Paly et at. 1988).

Recipe Sources

Consuming this plant in inadvisable. As a tea, it is rather bitter. Excessive dosage can result in gastric difficulties, stupor, trembling, coma, and death. Loewenfeld and Back (1974) present a recipe for tea, but note that "not more than one teacupful should be taken during the day."

Importance

The chief economic value of *R. graveolens* is as a commercial source of rue oil and as a drug plant. The size of the rue oil market is difficult to evaluate. Verlet (1993) estimated the annual world value of rue essential oil to be $100,000.00 (U.S.). About 1500 kg are produced annually, mainly in Spain, but also in Portugal and Bulgaria [Petit-Paly et al. 1989; rue oil is not presently produced in Bulgaria (Vitkova, personal communication)].

Cultivation Notes

Soil

In much of Europe the plants are grown for extraction of medicinals on dry, stony soils, and rue has a reputation for growing well in the poorest of soils. Indeed, rue can be grown on almost any soil that is well drained. The plant grows naturally on dry, limy, hilly terrain with a pH of 7-7.5 (Vitkova, personal communication). Consistent with this, Crockett and Tanner (1977) recommend a sandy, slightly alkaline soil within the pH range of 7.0-7.5. The pH range tolerated is 5.8-8.3 (Duke and Hurst 1975).

Climate

Rue grows best in full sunlight but tolerates partial shade. It is fairly drought-resistant. Its level of cold tolerance is reflected by the northernmost sites where it has been collected as a garden escape in North America: southern Alberta, southern Ontario, and southern Quebec. Growth occurs between 4 and 30°C, optimally about 17° C.

Propagation and Cultivation

The plants are propagated primarily by seeds. They can also be reproduced by division of roots, and from cuttings. Old plants will layer their own branches, which trail on the soil surface and take root. Vitkova (personal communication) provides the following notes. Seedlings may be sown in fall or spring in cold climates. They should be planted at a depth of 4-10 mm. Seedlings usually emerge in 10-15 days, and grow slowly during the first year. Rue begins to blossom in the second year after sowing. The plant has an average life expectancy of 10-12 years.

Harvest and Storage

The plant may be harvested in the same manner as most other herbs discussed in this book, although as repeatedly stated in this chapter its use is highly inadvisable. Dried

Fig. 344.
Rue *(Ruta graveolens)*, from Köhler (1883-1898).

stems and flowers retain considerable pharmacological potency, although Loewenfeld and Back (1974) note that the material loses some of its active principle during drying.

Example Cultivars

Blue Cud, Blue Mound, Curly Girl, Jackman's Blue, Variegata (the "blue" in several of these names refers to blue-green foliage). Simmons (1969) recommends the compact cultivar Blue Beauty as an ornamental house plant.

Additional Notes

Chemistry

The chemistry of rue has been extensively studied. Constituents include essential oils, furanocoumarins, alkaloids, flavonoids, and limonoids (Petit-Paly et al. 1982, 1989; Gandhi et al. 1991). The essential oil is 90% methyl nonyl ketone and methyl heptyl ketone, odorous compounds used in dog and cat repellents (Rinzler 1990). The bitter furocoumarins bergapten, psoralen and xanthotoxin are present (Rinzler 1990).

Medicine

In classical herbal medicine dating back to the ancient Greeks and Romans, rue was used to treat numerous medical conditions, both externally and internally. It was employed as an antidote to poisons (see Curiosities), to stop bleeding, reduce inflammation, relieve headache and eyestrain, and to remove warts.

In China, rue is used for various ailments, including bugbite, cancer, colds, fevers, snakebite, toothache, and malarial poisoning (Duke and Ayensu 1985). Rue oil from the leaves is presently used for medicinal purposes, especially in Spain, Algeria and France. The herb and its oil are currently employed to treat stomach and menstrual problems, worms, hysteria, epilepsy, and a wide variety of other medical conditions (Petit-Paly et al. 1989; Gandhi et al. 1991). In large doses it has been used to induce criminal abortions (Gandhi et al. 1991).

The rue alkaloid arborinine is strongly abortive, while fagarine, graveolinine, and skimmianine are weakly so (Duke and Ayensu 1985). A class of alkaloids, the acridones, known only from the Rutaceae plant family, has been found to have antiviral, antibiotic, antifungal, and antispasmogenic effects, all useful in medicine. At the same time, there is concern that they are mutagenic (Paulini et al. 1991).

Contact with rue causes dermatitis in some individuals, due to very high surface concentrations of furanocoumarins (Zobel and Brown 1990). "Rue may well be unique in the ease with which it can cause contact dermatitis, owing to the relatively large amount (≤1800 g/g fresh weight) of psoralens deposited on its leaf surface" (Zobel and Brown 1991). The chemicals sensitize the skin to light and, upon exposure, blistering may result. These chemicals on the leaves of rue may protect the plant against pathogens (Zobel and Brown 1990). Because of the danger of dermatitis, arm and hand protection are worn during commercial harvest of the plant. Wet plants and higher temperatures (in the range 20-36°C) are conducive to the development of dermatitis (Zobel and Brown 1991). According to Crockett and Tanner (1977), rue "should be planted in the garden with caution, for many people have violent reactions to it, similar to those of poison ivy." Ironically, the chemicals extracted from rue are often useful in treatment of skin diseases, although the possible carcinogenic danger has decreased therapeutic applications (Petit-Paly et al. 1989).

The fresh plant consumed internally may cause gastric upsets (Tyler 1993). Dried leaves are much less toxic, having lost much of their essential oil, but large doses can also cause upset stomachs (Tyler 1993).

Nutrition

Since consumption of only 2.5-5 g at one time may result in toxic symptoms (Petit-Paly et al. 1989), me cannot be viewed as a nutritional source. Rutin in rue is considered to be a compound with "vitamin P" (citrinin) activity (supposedly anti-vital), also present in some other members of the Rutaceae family, notably lemons and oranges (Weiss 1988).

Curiosities

• According to Perry (1974), The name *Ruta* comes from the Latin *ruta*, bitter, a reference to the taste. According to Grieve (1931), however, it comes from the Greek, *reuo*, to set free, a reflection of the belief that the herb was so effective medically that it could free the sick from their diseases.

• The English word "rue," meaning "to be sorry for," seems to have played a role in the plant being labelled as the herb of repentance and the herb of grace (Northcote 1971). At the Sunday ceremony celebrating High Mass, holy water was sprinkled from brushes made of rue, giving rise to its name, herb of grace (Grieve 1931). The name reflects the God-granted grace following true repentance (Lust 1974).

• The classical Greeks and Romans thought that if rue were stolen from a neighbor's garden it would develop better than if simply grown from seed (Fox 1933).

• King Mithridates VI (132-63 B.C.) of Pontus (an ancient country of northeast Asia Minor), was a charming man who came to power by eliminating his brother and throwing his mother into prison. In the widespread

belief that rue prevented poisoning, he is said to have begun every day by eating 20 leaves of rue (Fox 1933). If true, it seems clear that he was poisoning himself. *Mithridate* was a Greek all-purpose antidote to poison (Bremness 1988).

• Aristotle (384-322 B.C.) recorded that rue discouraged evil and witches (Lust 1974). Down to recent times, peasants in many countries commonly suspended branches of rue from their ceilings to ward off evil spirits and witches (Fleury de la Roche 1924). Rue was one of several herbs that if carried "you may know every woman for a witch who is one, no matter how plain or otherwise she may appear" (Moldenke and Moldenke 1952). However, witches were reputed to make use of it themselves in their enchantments (Lust 1974).

• The Roman writer and naturalist Pliny (23-79 A.D.) recorded that painters, carvers, and engravers of his time ate rue to improve their eyesight (Lust 1974). Leonardo da Vinci and Michelangelo claimed that rue improved their eyesight and creative inner vision (Bremness 1988).

• The Greek physician Dioscorides (50 A.D.-100 A.D.) claimed that weasels ate rue before fighting snakes, which led to the herb being used as a cure for snakebite (le Strange 1977).

• Because of its penetrating odor, rue was considered a disinfectant (Fox 1933). Accordingly, it was one of the bunch of herbs that judges used to carry into court to protect them against jail fever (infection, particularly typhus), fleas and lice from prisoners (Grieve 1931).

• In 1665, during the Great Plague of London, thieves often entered the houses of plague victims to steal from corpses. To protect themselves from the plague, the robbers used an alleged antidote known as the "Vinegar of the Four Thieves" (red wine vinegar infused with rue, wormwood and camphor) (Byrnes 1995). [For a variation of this legend with a different herbal recipe, see garlic (*Allium sativum*) Curiosities. For another herb protecting against the plague, see angelica (*Angelica archangelica*) Curiosities.]

• Rue acquired a reputation for discouraging rats from entering buildings, if placed near entrances (Fleury de la Roche 1924).

• The sight of rue was reputed to "keep maids from going wrong with love." In Lithuana and Poland, it was a symbol of virginity, and brides pinned it to their wedding gowns. It was said to wither when worn by the unchaste (Simmons 1969).

• The leaves of rue served as the model for the suite of clubs in playing cards (Lust 1974).

• According to an old belief, if gun flints for a flintlock muzzleloader were boiled in a mixture of rue and vervain, the shot would hit its mark no matter how poor the marksman (Moldenke and Moldenke 1952).

Problems and Potential

The bitter taste of rue has prevented it from ever becoming popular as a culinary herb. The toxicity of the plant also strongly limits its use as a culinary herb. It is also limited as a garden ornamental (because of its capacity to produce dermatitis), although widely grown for the purpose. On the positive side, extensive medical research is underway towards determining the useful pharmacological properties of rue oil. This research presently appears promising, and suggests that the market may expand in the future. However, since cultivation and markets are well ensconced in Europe, any development of the industry in North America is faced with well established competition.

Selected References

Petit-Paly et al. (1989).

Fig. 345.
Greek sage *(Salvia fruticosa)*, from Curtis (1787-present; #999).

Salvia

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

Salvia has 900 or more species of annual or biennial herbs, shrubs or subshrubs, found around the world. In addition to garden sage discussed in detail below, many other members of the genus are useful for culinary purposes. Most of the following species can be grown as potted edible plants, overwintered indoors in North America (Mansfeld 1986; Huxley et al. 1992).

The Mexican *Salvia divinorum* Epling & Játiva ("salvia of the gods"), known exclusively from cultivated plants that are vegetatively propagated, is the only one of the 4000-5000 species of the Labiatae family that is known for sure to be hallucinogenic (Schultes and Hofmann 1980; Richardson 1992).

Salvia fruticosa Mill. (*S. triloba* L.) is commonly called Greek sage (also Turkish sage and three-lobe sage). This species is native to the Canary Islands, North Africa, and the Middle East. It is a tender perennial shrub growing to 1 m tall. There are two small leaflets at the base of each leaf, and the foliage is much woollier and stronger in odor than that of garden sage (Morton 1976). A spontaneous hybrid is known between this species and garden sage (Prakash 1990). Much of imported dried sage leaves are of this species and not garden sage. Indeed, Tucker et al. (1980) found that the commercial sage imported into the U.S. was 50-90% Greek sage and 5-50% garden sage. This suggests that Greek sage likely represents the majority of sage commonly reported in economic statistics for garden sage. By comparison with garden sage, Greek sage has a harsher flavor and the quality of the leaves is considered inferior. Greek sage is now cultivated for its essential oil in parts of Algeria, Italy, Albania, and the former Yugoslavia. Wild plants of Greek sage are collected for their oil in Turkey and Lebanon (Mansfeld 1986). The essential oil is obtained by steam distillation of fresh leaves. The major constituent chemicals are 1,8-cineole, camphor, -pinene, ß-pinene, borneol, and ß-caryophyllene (Putievsky et al. 1986; Prakash 1990). Greek sage leaves are used in the Mediterranean region for tea and as a spice in meat and poultry dishes. The plant has been used in traditional folk medicine as a remedy for stomach pains, coughs, and colds (Prakash 1990). Living plants are available through some Canadian and U.S. garden catalogs. The plant is best taken indoors over the winter in Canada and the northern U.S.

Salvia clevelandii (A. Gray) Greene is known as blue sage, or sometimes Jim sage. A native of California, this tender perennial shrub grows to 60 cm tall. It can be

Fig. 346.
Blue sage *(Salvia clevelandii)*,
prepared by M. Jomphe.
(Based on Wiggins & Thomas 365
at Agriculture and Agri-Food Canada herbarium,
Ottawa.)

cultivated indoors over the winter months in Canada and the northern U.S. The leaves possess a warm pleasant flavor. The dried leaves are used as a culinary herb like garden sage. According to Tucker (1994), most cultivated plants identified as "*S. clevelandii*" are hybrids, mostly with *S. leucophylla* Greene.

Salvia elegans Vahl. (*S. rutilans* Carrière) is known as pineapple sage, for the distinctly pineapple aroma of the foliage. Pineapple sage is native to parts of Mexico and Guatemala. It is a perennial subshrub, 70-150 cm tall. Outdoors as a perennial, it is hardy only to United States Department of Agriculture Climatic Zone 9 (Barash 1993). It can be cultivated as an annual in northern North America, or as a tender potted plant taken indoors over winter. It prefers light, sandy, well-drained soil and full sun. This herb is grown mostly from cuttings, but also from seeds and by layering. Pineapple sage is a mild-tasting herb whose leaves can be added to jellies to give them an extra scented sweetness (Garland 1979). The leaves also impart a pleasant flavor to cold drinks and are added to chicken dishes and cream cheese. The leaves can be used in cookery

Fig. 347.
Pineapple sage *(Salvia elegans)*, flowering branch,
from Curtis (1787-present; #6448).

like garden sage, and are not as overwhelming in flavor (Morton 1976). The red blossoms are extremely attractive to the ruby-throated hummingbird (Krueger 1993). Unlike garden sage, which does not grow well indoors, pineapple sage makes a handsome house plant. It should be kept away from freezing widows, and given direct sunlight (Crockett and Tanner 1977). According to Barash (1993), who presents five recipes, "the flavor of the flowers is wonderful - sweet and fruity with a hint of spice and mint."

Salvia viridis L. is known as bluebeard sage, Joseph sage, and red-topped sage. This annual or biennial herb is native to the Mediterranean area. It was the principal sage grown by the classical Greeks and Romans, who used the leaves and seeds to spice wine, and the seeds as a condiment (Morton 1976). The leaves can be used as a flavoring for cooked greens and soups. The plant has also been cultivated in central Europe for flavoring in beer and wine. Several cultivars have been selected for use as ornamentals. Bluebeard sage is available from some Canadian and U.S. garden catalogs.

Salvia sclarea L. is known as clary, clary sage, clary wort, cleareye, and muscatel sage. This perennial herb is native from southern Europe to central Asia. It is cultivated in parts of Europe for its essential oil used in perfumes and cosmetics. About 72 t of clary sage oil are produced annually, including about 47 t from the former USSR, 10 t from the U.S., and 5 t from France (Lawrence 1992). Verlet (1993) estimated the annual value of clary sage essential oil to be $5,400,000.00 (U.S.). Seeds soaked in water produce a mucilaginous substance which has been used in traditional folk medicine to remove particles from eyes, that is to clear eyes, hence its name "clary." It is added to some wines to produce a musky bouquet (e.g., muscatel), hence the name muscatel sage. The oil is also used in beverages, baked goods, candy, gelatins, puddings, relishes and spices (Duke 1985). The leaves are occasionally used for flavoring in cookery. This plant is available in Canadian and U.S. garden catalogs.

Salvia columbariae Benth. is known as golden chia. This Western American species has seeds that were consumed by American Indians. The leaves are occasionally used as a sage-like seasoning, and the sprouted seeds can be eaten in salads and sandwiches. Although little-known as a crop,

Fig. 348.
Clary sage *(Salvia sclarea)*,
from Vilmorin-Andrieux et C^{ie} (1883).

its agronomic characteristics are recorded in Hackett and Carolane (1982). The seeds of this and several other species of *Salvia* known as chia's have been eaten for centuries by native North Americans, and are being considered for development as new crops in the southern U.S. (Gentry et al. 1990). [Plants of some species of the genus *Hyptis* are also known as chia's. The chias of *Salvia* and *Hyptis* have a long history of medicinal and culinary use in the Americas. For additional information, see Heinrich (1992).]

Salvia hispanica L. is native from Mexico to Peru. Like the above, this is another cultivated chia. Its uses have been described by Facciola (1990). The seeds are ground into meal and then processed into breads, biscuits, muffins, and cakes. Soaked in water, the seeds form a gelatinous mass used to flavor fruit juices and make a cooling drink. Gelled seeds are made into gruel and pudding. Sprouted seeds are consumed in salads, sandwiches, soups and stews. The mucilaginous seeds are widely sprouted on clay or other porous materials in the shape of animals, and sold as "chia pets."

Salvia pratensis L. is called meadow sage or meadow clary. This native of Europe and North Africa was once used to flavor beer and wine, to tan leather, and as a source of brown dye (Morton 1976).

Salvia lavandulifolia Vahl. is a perennial herb known as Spanish sage. This is native to Spain and southern France. It is collected in the wild for its essential oil, used commercially to flavor ice cream, candy, baked goods, chewing gum, soft drinks, alcoholic beverages, and in the perfume industry (Morton 1976). About 3.0 t of essential oil are produced annually worldwide (Lawrence 1992).

Salvia pomifera L. is called apple sage. This species is a woody shrub indigenous to the Greek islands. It was named apple sage because gall wasps produce fleshy galls about 2 cm wide, reminiscent of apples, on the young branches. These are crystallized in sugar to make a kind of sweetmeat (with real meat, since larvae are present!), regarded by the Greeks as a great delicacy (Morton 1976; Facciola 1990).

In addition to most of the above, the following *Salvia* species are offered in both Canadian and U.S. seed catalogs, primarily for use as ornamentals, often with scented leaves: *S. coccinea* Juss. ex Murray (red sage), *S. discolor* Kunth. (Peruvian sage, this has a fruity, eucalyptus scent), *S. dorisiana* Standl. (known as fruit sage for its strong aroma of mixed fruits), *S. farinacea* Benth. (mealy sage), *S. fulgens* Cav. (known as cardinal sage for its scarlet flowers, this has a pungent scent), *S. greggii* A. Gray (autumn sage, this has fruit-scented leaves), *S. involucrata* Cav. (roseleaf sage), *S. lyrata* L. (cancer weed, lyreleaf sage; this is an American folk remedy for cancer), and *S. splendens* Sell ex Roem. (scarlet sage). An extensive description of various *Salvia* species and cultivars available in the U.S. is given in Facciola (1990).

The common name "sage" is applied to members of genera other than *Salvia*, including "sage brush" (*Artemisia* species) and wood sage (*Teucrium* species).

Warning

Habitual consumption of sage tea is inadvisable (See *Salvia officinalis*, Medicine).

Salvia Officinalis L.

English Names

Garden Sage
Also: common (garden) sage, Dalmatian sage, red sage, sage, true sage
[French sage is an obsolete name for costmary, *Tanacetum balsamita*, also discussed in this book.]

French Names

Family: Labiées, famille de la menthe
Sauge (f)
Also: grande sauge, herbe sacrée [the English "sacred herb" refers to *Ocimum sanctum*, treated in this book; *Verbena officinalis* L. is sometimes also referred to as herbe sacrée (Maghami 1979)], serve, petite sauge, saouvia, sauge balsamique, sauge commune, sauge cultivée, sauge de Catalogne, sauge officinale, thé de Grèce, thé de Provence, toute bonne

Description, Taxonomy, and History

Garden sage is a perennial, more or less sprawling subshrub, 15-80 cm tall. The leaves are woolly and pebbled, and in some garden forms are variegated with red, yellow, or white. The fragrant flowers are usually purple or blue, sometimes pink or white. Several cultivated selections have been made which differ in form and/or the chemical makeup of the essential oils (Tucker and Maciarello 1990). The appearance of garden sage may differ, even in the same field, due to climatic and soil conditions (Greenhalgh 1979).

Garden sage is native to the Balkan area of the Mediterranean, as well as adjacent parts of the Adriatic Sea (Embong et al. 1977*c*). It is frequent on dry banks and in stony places. The plant has become naturalized through much of southern Europe.

Garden sage was likely first cultivated by the ancient Greeks who used it primarily as a medicinal plant. It has been grown as a culinary and medicinal plant in central Europe since the Middle Ages. Before Chinese tea became

Fig. 349.
Sage *(Salvia officinalis)*, from Köhler (1883-1898).

popular in England, sage tea was widely consumed (Hanson and Hocking 1957). Sage is now grown in many regions of the world, primarily as a culinary herb (Mansfeld 1986).

"Dalmatian sage," obtained particularly from the coast of the former Yugoslavia, is a term used to denote forms commercially preferred for preparation of both culinary herb and oleoresin. It is unclear whether or not this refers to particular cultivars or even a homogeneous class of cultivars.

Uses

Commercially dried sage is available whole leaf, "chopped" (cut but not ground), "rubbed" (slightly ground and coarsely sieved), and "ground" (well pulverized and sieved to a fine powder). The dried leaves of garden sage are used sparingly and are popular in poultry stuffings, gravies, sausages, pickles, soups, and stews. The taste of the leaves is warm, bitterish, and slightly astringent. The flavor has an unusual affinity for fats and sage is therefore commonly used for meats such as pork, duck, and sausage (Rosengarten 1969). The leaves are often added to omelets, cheese, and bean dishes, and bean and minestrone soups. Garden sage can also be added to cream cheese. It is a zesty addition to vegetables including eggplant, lima beans, onions, and tomatoes. The dried leaves are a popular seasoning in the Middle East for lamb and onion dishes. In Germany sage leaves are wrapped around pieces of eel for flavoring during cooking (Stobart 1977). Fresh garden sage leaves can be brewed into a pleasant tea (see Warning!) when combined with two other herbs treated in this book, lemon balm (*Melissa officinalis*) and spearmint (*Mentha spicata*). The fresh leaves can also be dipped in flour and egg batter and deep-fried as appetizers. Ground garden sage is added to biscuits or corn bread, which go well with chicken or fish dishes. Sage is also an important ingredient of "mixed herbs." The flowers can be added to prepared foods for color, fragrance, and a mildly spicy flavor (Facciola 1990; Rinzler 1990).

Despite the dominance of sage in the herb market (see Importance), Holt (1989) makes the following telling comment: "Sage alway seems to me to be the poor relative in the herb garden... But in all fairness, the herb has more virtue than solely as a culinary stop-gap." Sage should be used with caution because the strong aromatic smell and somewhat bitter, astringent taste can overwhelm foods (Bryan and Castle 1974). One leaf or a small pinch of rubbed sage suffices for one portion of meat, fish, or omelet (Farrell 1985).

The essential oil is used in the pharmaceutical and cosmetic industries and is employed to scent some insecticides. The oil is employed in tooth paste and mouth wash, and deodorants (for its anti-sweating property) (Franz, personal communication). It is added to many commercial products as a seasoning, including soups, sauces, sausages, preserves, meats, baked fish, fried chicken, pickles, cheeses, candy, ice cream, chewing gum, baked goods, and vermouth wine (Morton 1976; Farrell 1985; Mansfeld 1986; Facciola 1990).

An oleoresin, usually derived from Dalamation sage, is widely used to provide a spicy taste. This is probably the second most important of herb oleoresins. It is added to commercial prepared meats such as sausages, and to stuffings (Greenhalgh 1979).

Sage flowers are rich in nectar, and are attractive to bees. Sage honey is spicy and much in demand in Europe (Morton 1976).

Recipe Sources

Day and Stuckey (1964) give recipes for Dry sage stuffing and Savory kale. Bryan and Castle (1974) have recipes for Pork chops and vegetables with sage sauce, and Venison sage sausage. Owen (1978) gives recipes for Sage and cheddar biscuits, Veal scallops with sage, Pork chops with sage dressing, and Hog sage sausage. Belsinger and Dille (1984) present 12 recipes, notably: Eggplant au gratin with sage, Kohlrabi with sage cream, Light whole wheat sage muffins, Sage applecake, Goat cheese marinated with fresh sage and garlic, and Chestnuts and apple with sage. Hutson (1987) gives the following recipes: Festive sage cheeseball, Apple stuffed pork chops in cider-sage-mustard marinade, Skillet sage and peppered cornbread, Savory sage butter, and Texas cider sage vinegar. Holt (1989) has recipes for Venison fillet with sage and Miraculous sage liqueur [with leaves and flowers]. Richardson (1991) has six sage recipes, notably Saltimbocca (which in Italian means "Leap into your mouth"), Sage three-liver pâté, and Roast duck with sage and apple stuffing. Barash (1993) has seven recipes for sage flowers, including Sage pesto, Sage mushrooms and Sage crusted lemon sole.

Other recipes are: Sage tea (Gibbons 1966; Marcin 1983; Belsinger and Dille 1984); Sage wine (Gibbons 1966); Sage-stuffed turkey (Rosengarten 1969); Sage sauce (Sanecki 1974); Sage and onion stuffing (Sanecki 1974; Stuart 1979); Sage honey (Rose 1979); Liver pâté with sage (Boxer and Back 1980); Sage Welsh rarebit (Hemphill and Hemphill 1984); Pumpkin soup with sage flowers (Leggatt 1987); Banana, lime, and pineapple sage yoghurt ice (Holt 1991).

Importance

Garden sage is sometimes considered to be the world's most popular flavoring and seasoning herb, with large quantities used by the commercial food industry (*Capsicum*

peppers are usually thought to be the world's most important condiment plant). It is the leading culinary herb in the U.S. according to Morton (1976). Plants are cultivated particularly in the former Yugoslavia (in Dalmatia), Italy, Greece, Turkey, the former USSR, western Europe, and the U.S. (Roecklein and Leung 1987). Dalmatian sage, the preferred commercial form of leaf sage, is often adulterated with other species such as Spanish sage (*S. lavandulifolia*) and Greek sage (*S. fruticosa*).As noted earlier, most of the "sage" leaves imported into the U.S. are from Greek sage (Tucker et al. 1980). Limited commercial domestic sage production occurs in the U.S. - in California, Oregon, and Washington (Greenhalgh 1979). Domestic production was estimated at around 100 t in 1979 (Greenhalgh 1979). In 1988, the U.S. imported 1658 t of whole leaves valued at $5,603,500.00 and over 7 t of ground or rubbed garden sage valued at $17,500.00 (Anon. 1989*a*). Imports averaged $4.8 million annually over the period 1990-94 (Buzzanell et al. 1995). The majority of this was from Albania and the former Yugoslavia. The U.S. is the major producer of garden sage oleoresin. A new development in the U.S. is the cultivation of garden sage for its extractable antioxidants, approved for use as a food additive in the early 1990's (Motes, personal communication). Six ha of a clone yielding high amounts of antioxidants were cultivated in 1995 in Oklahoma (Motes, personal communication; cf. similar information for rosemary).

About 35 t of garden sage oil are produced annually in the world, about 15 t along the Adriatic coast of the former Yugosolavia and 16 t from Albania (Lawrence 1992). Verlet (1993) estimated the annual value of garden sage essential oil to be $2,000,000.00 (U.S.) (an estimate for clary sage oil is provided in the Genus Notes).

Cultivation Notes

Soil

Garden sage grows best in a well-drained, nitrogen-rich clay loam (Roecklein and Leung 1987). Reported ranges of tolerance of pH are 4.2-8.3 (Duke 1978) and 4.9-8.2 (De Baggio 1987). Crockett and Tanner (1977) recommend a pH of 5.5-6.5. Garden sage is highly suited to rock gardens (Rosengarten 1969). The application of nitrogen, phosphorus, or potassium fertilizers affects the concentrations of constituents of the essential oil (Piccaglia et al. 1989).

Climate

Garden sage will survive winter temperatures down to -15°C (Huxley et al. 1992). This perennial is winterhardy in the warmer parts of Canada; domesticated forms have overwintered as far north as southern Ontario and

Fig. 350.
Sage *(Salvia officinalis)*,
from Hallier (1880-1888).

southwestern Quebec (Scoggan 1978-79). However, studies in Brooks, Alberta showed that 80% of garden sage plants without a protective winter mulch died (Embong et al. 1977*c*). Growth of garden sage occurs between 3 and 29°C, optimally about 13°C. In harsh climates, it is advisable to place the plant in a sunny but sheltered area, such as near a wall. Garden sage requires full sunlight for best development (Lima 1986), but will also grow in light shade. Generally, sage is a long-day plant (Franz, personal communication). Overwatering will stunt growth and may

kill the plants (Kublick 1990). Crockett and Tanner (1977) recommend against harvesting after early fall in U.S.D.A. climatic zone 6 and northwards, to allow the plant to maintain reserves to survive the winter. The essential oil yield of borneol and camphor are increased by warm temperatures (27/17°, day/night) and high light conditions as compared with cool temperatures (21/11°C) and low light conditions (Bernath 1992).

Propagation and Cultivation

Garden sage can be propagated by seeds, cuttings, and layering. If seeds are used, they should be planted at a depth of 13 mm or less. The seedlings usually emerge in 14-21 days (Wang et al. 1993). If particular cultivars are desired then cuttings are recommended, as seeds often do not reproduce desired traits. Some commercial crops, therefore, are multiplied from cuttings. This half-shrubby plant does not divide well. Instead, cuttings of new growth can be rooted, or branches may be layered by bending them over and anchoring a portion under the soil to promote rooting. This often takes a month (Lima 1986). Light cultivation to control weeds is beneficial. Plants become woody after 3 or 4 years, and should be replaced as they produce poorer quality sage (Rosengarten 1969).

Harvest and Storage

In commercial production, a single harvest is taken the year of establishment. Two harvests are made in subsequent years (Rosengarten 1969). Late fall harvest should be avoided in cold climates, or winter kill can occur (Motes, personal communication). Commercial harvesting is carded out just before flowering, by hand or by mechanical mower set to cut the top 75-125 nun of the plants. Hand picking the leaves consistently produces a higher quality crop. Harvesting is preferably done in the afternoon, when essential oil content is highest (Prakash 1990). Yields of 30 t/ha fresh weight (3 t/ha dry weigh) were obtained in southern Alberta (Ference 1989). Usually 2t/ha dried leaves the first year, and 3-4 t/ha dried leaves in the second to the fifth year are obtained in commercial production in Europe (Franz, personal communication). Yields of essential oil are typically of the order of 100 kg/ha (Franz, personal communication).

The harvested crop is often washed. It is dried to about 12% moisture in 38°C air for 4 hours in dehydrators. Garden sage is marketed as soon as possible to ensure good flavor.

The home gardener may collect young shoots near the tops of the plants just before mature flowers are produced, tie them in bunches, and dry them in a warm location. However, this leads to a dark-colored product. Bryan and Castle (1974) advise that the leaves should not be exposed to the air for too long a period or they will lose their aroma. Freezing the leaves is preferable to drying them.

Example Cultivars

Aurea, Holt's Mammoth, Purpurea, Tricolor. Facciola (1990) and Huxley et al. (1992) list additional cultivars. According to Marcin (1983), sage comes in 700 varieties.

Additional Notes

Chemistry

Steam distillation of the freshly harvested leaves produces a pale-yellow or almost colorless oil with a strong aroma and spicy, camphorous, slightly bitter flavor. The yield is about 2.5%. The essential oil shows tremendous variability in the quantity of its principal components (Tucker and Maciarello 1990; Bezzi et al. 1992; Putievsky et al. 1992). The oil usually contains 40-60% - and ß-thujone, 5-15% 1,8-cineole, up to 16% borneol, and 3-35% camphor, as well as other constituents (see Lawrence 1992 for additional information). The commercial oil is sometimes adulterated with oil from Greek sage (*S. fruticosa*) and the hybrid between it and garden sage. An oleoresin is also produced commercially, about 1 kg of it equivalent to 13.4 kg of freshly ground sage in aroma and flavor (Farrell 1985). Several chemical races of domesticated garden sage have been recognized (Tucker and Maciarello 1990). Garden sage oil with a combined - and ß-thujone content of >30% and a camphor content of <20% are most valued (Lawrence 1992).

Fig. 351.
Sage *(Salvia officinalis)*,
from Vilmorin-Andrieux et C^{ie} (1883).

Medicine

Garden sage has been employed since antiquity in folk medicine. It has been used as an astringent and tonic to stimulate the digestion and cleanse the blood, and as a disinfectant or fumigant. Garden sage was employed to treat bleeding gums, colds, cancer, diarrhea, excessive perspiration, enteritis, headaches, measles, mouth ulcers, nervous tension, rheumatism, snake bite, sore throat, toothache, tonsillitis, and venereal disease (Garland 1979; Simon et al. 1984; Duke 1985).

The essential oil of sage has some limited bactericidal properties, considered useful in mouth washes and gargles (Rosengarten 1969). The astringent value of the tannin of sage and the stimulation of blood flow resulting from the irritant properties of sage oil could explain the value of sage in treating mouth and throat irritations (Tyler 1993*a*). Sage contains estrogenic substances (Duke 1985), and sage oil has been employed to treat female disorders since ancient times (Prakash 1990). However, the usefulness of sage in this respect has not been satisfactorily demonstrated (Tyler 1993*a*). Sage has been found by some investigators to reduce sweating, and it is sometimes prescribed for this purpose, although once again the medical reliability of this use has not been unambiguously demonstrated (Tyler 1993*a*).

As noted above, sage volatile oil consists mainly of - and ß-thujones. These can be extremely poisonous (see discussion of *Artemisia absinthium* in the genus notes for tarragon). Tyler (1993*a*) concludes that even if sage does have some medicinal value, it cannot be recommended for internal medicinal use because of the toxic potential associated with the thujones. Franz (personal communication) cautions against overestimating the toxicity of sage essential oil, which he attributes mainly to ß-thujones, which may be present in lower amounts in some forms. Ingestion of sage tea has caused inflammatory lip and mouth disease in some individuals (Duke 1985). Tyler (1993*a*) recommends against the prolonged consumption of sage tea. However, he says that adding the leaves as a spice or flavoring agent to cooked foods is probably not dangerous, since the heat apparently drives off most of the volatile thujone.

Nutrition

The dried herb contains about 10.6% protein, vitamin A, thiamin, riboflavin, niacin, and ascorbic acid (Duke 1985).

Curiosities

• The generic name *Salvia* comes from the Latin verb *salvere*, meaning to heal or to save, and is the root of the words salve and salvation (Lima 1986). During the Middle Ages a proverb said "Why should a man die if sage flourishes in his garden" (Kublick 1990). Its use was said to impart wisdom and improve memory, hence a wise person is a "sage." This is also the origin of the French word *sage*, meaning wise.

• In ancient Britain, the Druids believed that a potion made with sage could revive the dead (Holt 1989).

• An old legend says that sage follows the fortunes of the household, dwindling during days of evil and reviving miraculously when things are better (Lima 1986).

• The Chinese once valued garden sage so highly that they exchanged about 4 kg of black tea for about 1 kg of garden sage from Dutch traders (Fox 1933).

• Sage was considered to have the power to reduce grief, and was sometimes planted on graves (Hemphill and Hemphill 1984).

• Sage was thought to repel ants and toads (Fox 1933).

• According to an old saying, sage thrives only when the wife rules (the same was said about rosemary; Lust 1974).

• It used to be customary to clean teeth with sage leaves (Morton 1976). According to Perry (1974), "the leaves when rubbed on the teeth have a whitening action."

Problems and Potential

Garden sage can be grown as far north as the warmer parts of Canada as a limited crop for local markets. However, prospects for commercial production in North America are limited because of the relatively cheap, high quality product from Albania, and possibly still from the former Yugoslavia. Establishing a crop is expensive (Greenhalgh 1979).

Domestic production was significant in the U.S. during the Second World War but declined as superior-flavored European imports became available. The U.S. produces some garden sage but the amounts are negligible compared to imports. While garden sage can be grown well in the U.S and some areas of Canada, it appears that the foreign supply is more competitive.

Selected References

Embong et al. (1977*c*); Garland (1979); Greenhalgh (1979); Lima (1986); Prakash (1990).

Sanguisorba

Family: Rosaceae (rose family)

Genus Notes

Sanguisorba is a genus of about 18 rhizomatous perennial herbs or small shrubs native to the temperate northern hemisphere (Huxley et al. 1992). According to Morton (1976), the two species treated in detail below are evergreen, except in very severe winters.

Sanguisorba Minor Scop. Subsp. Minor

Scientific (Latin) Synonyms

(of *S. minor*, not just subsp. *minor*): *Sanguisorba dictyocarpa* (Spach) Franchet, *Poterium sanguisorba* L.

Fig. 352.
Salad burnet *(Sanguisorba minor subsp. minor)*,
from Hallier (1880-1888).

English Names

Salad burnet
Also: burnet, burnet saxifrage (Grieve 1931; but note below), common burnet, garden burnet, Italian pimpernel, lesser burnet, little burnet, pimpernel, small burnet
[Hyphens in the common names composed of two words are optional. Salad burnet should not be confused with greater burnet saxifrage, *Pimpinella major*, or burnet saxifrage, *P. saxifraga*, herbs grown as ornamentals and as pharmacological plants (see *Pimpinella* Genus Notes.]

French Names

Family: Rosacées, famille de la rose (famille du rosier)
Sanguisorbe mineure (f)
Also: bipinelle, petite pimprenelle, petite sanguisorbe, pimprenelle, pimprenelle commune, pimprenelle des jardins, pimprenelle ordinaire, pimprenelle sanguisorbe

Description, Taxonomy, and History

Salad burnet is a long-lived perennial herbaceous plant native to much of Europe, northern Africa, and southwestern to central Asia (Huxley et al. 1992). In the first year of growth, a low-growing clump is formed, the stems bending over and trailing. Flowering and fruiting occur late in the first year, or in the second year, the plants usually reaching 30-70 cm in height. The fruit is hard and dry, usually with two seeds; the true seeds are difficult to extract, and the fruits are commonly referred to as "seeds." These are usually used to reproduce the plant. Five sub-species have been described (Nordborg 1967; Proctor and Nordborg 1968). Two, subsp. *minor* and subsp. *muricata* Briq., are commonly found in cultivation (Sheppard and Wills 1985). Subspecies *minor* is salad burnet, the subject of this chapter. Subspecies *muricata*, commonly known as "sheep's burnet" (e.g., Douglas and Foote 1993), is cultivated in central Europe eastwards into Asia, as a forage, soil stabilizer, and cattle feed. It is also cultivated in western North America, and used in New Zealand for soil conservation and forage in seasonally dry areas (Sheppard and Wills 1985). Like alfalfa, sheep's burnet usually re-sprouts after being grazed down to ground level.

Salad burnet has escaped from cultivation in many temperate parts of the world including North America. It is naturalized from Nova Scotia to Ontario, south to North Carolina and Kentucky; and is locally found in Washington, Oregon, and California (Robertson 1974). It also grows as an escape in southwestern British Columbia (Scoggan 1978-79).

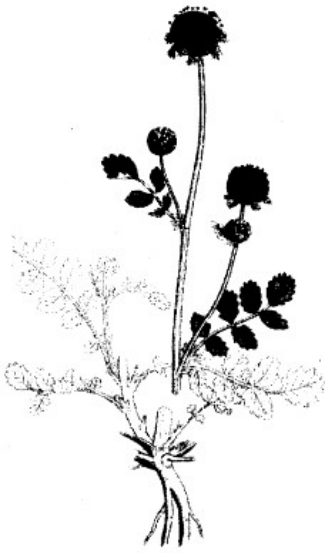


Fig. 353.
Salad burnet (Sanguisorba minor subsp. minor), from Syme et al. (1863-1886).

Salad burner has been known and perhaps cultivated since ancient times. It was first regarded as a medicinal plant and later became an important food plant. It was brought by early European colonists to North America (Halpin 1978).

Uses

The young leaves are eaten in salads with French dressing or mayonnaise (older leaves are rather tough in texture). The leaves smell like cucumber when crushed and impart a delicate, slightly sharp cucumber taste to other greens. Salad burnet is a flavorful addition to casseroles, fish dishes, herb vinegars, herb butters, and cream cheeses. The leaves are especially delicious cooked in cream soups such as asparagus and mushroom. Salad burnet combines well with other herbs, particularly tarragon and rosemary (Bremness 1988).A fresh sprig of salad burnet can be used to top a cup of hot or cold soup. In Germany, finely chopped salad burnet leaves are added to leaves of other herbs and sold in markets. Made into "green-sauce," it is added to such dishes as "quark," a simple dairy product similar to yogurt. The sauce is also served over boiled potatoes or hard-boiled eggs. Chopped leaves can be added to softened butter for a gourmet sandwich spread. Salad burnet was once an important ingredient of ale, and can be steeped in wine or added fresh to a cool summer drink (Mansfeld 1986).

Salad burnet makes an attractive ornamental, with blue-green, fernlike foliage, and (in second-year plants) clusters of white or rose-colored flowers in late spring and early summer. In gardens, it is perhaps best presented in clumps, and as a background for colorful annuals (Fisher 1984).

Sheep's burnet, the close relative of salad burnet, has been used as feed for sheep and calves. It has a fodder value similar to that of alfalfa (Sheppard and Wills 1985). Only light grazing is recommended during the first season. Established stands can be grazed on a rotational basis. Sheep's burnet has been used in Chile since 1943 for erosion control (Mansfeld 1986). Trials in New Zealand have also shown its value for erosion control (Sheppard and Wills 1985), as a ground cover (Douglas et al. 1990), and as a short-term forage source (Douglas and Foote 1993).

Recipe Sources

Crowhurt (1973) presents recipes for Iced burnet soup and Burnet sauce. Rose (1979) has recipes for Mead and Burnet vinegar. Boxer and Back (1980) have recipes for Creamed chicken with burnet and Burnet and cheese sandwich. Michael (1980) gives recipes for Salad burnet with cottage cheese, Salad burnet with drinks, and Salad burnet vinegar. Launert (1981) has recipes for Flambéed snails with fresh herbs and *Sanguisorba* leaf salad. Hutson (1987) has recipes for Salad burnet sandwiches, Grilled salmon with salad burnet/shallot crème fraîche, Burnet vinegar, and Gin and tonic with salad burnet sprigs. Gilbertie (1988) has recipes entitled: Couscous salad with burnet, and Sweet potato slices with burnet and crème fraîche.

Other recipes are: Burnet vinegar (Grieve 1933); Early spring salad (Garland 1979);Tennis-party cucumber sandwiches [with salad burnet] (Rodway 1979); Burnet tea (Marcin 1983); Salad burnet dip (Adams 1987); Hock cup (Bremness 1988); Spring rolls (Schofield 1989).

Importance

Salad burnet (*S. minor* subsp. *minor*) is cultivated in Europe in England, France, and Germany. It is also planted in Asia and in North America (Mansfeld 1986). Although

Fig. 354.
Salad burnet *(Sanguisorba minor)*,
from Lamarck and Poiret (1791-1823).

grown for local markets in several European and Asian countries (Mansfeld 1986) salad burnet is of marginal importance in North America, where it is mostly a plant of home gardens. Salad burnet is an old-fashioned culinary herb that was popular in the past.

By far, sheep's burnet (*S. minor* subsp. *muricata*) is more important economically than its close relative salad burnet. Sheep's burnet has been widely used in New Zealand, Australia, India, Pakistan, North Africa, Spain, U.S., and other countries as forage for grazing animals under dryland conditions, and for soil stabilization (for erosion control).

Cultivation Notes

Soil

The natural habitat of *S. minor* is on dry grasslands or rocky ground, generally on alkaline or almost neutral soils, with soil textures varying from clay to gravel and stone (Nordborg 1967; Proctor and Nordborg 1968). In its native range it is often found on limestone; pH ranges that have been reported to be tolerated are 6.3-8.2 (Duke and Hurst 1975) and 4.8-8.2 (Duke 1978). Crockett and Tanner (1977) recommend a pH of 6.0-8.0. Salad burnet (subsp. *minor*) performs best on well-drained, fertile soils (Lima 1986). However, sheep's burnet (subsp. *muricata*) has been found to survive well and produce moderately healthy foliage under low to moderate soil fertility levels (Douglas, personal communication).

Climate

Salad burnet is tolerant of heavy winter frosts and high summer temperatures (Sheppard and Wills 1985). The species is winter hardy in most of North America. Growth occurs between 4 and 22°C, optimally about 13°C. Nordborg (1967) found that *S. minor* subsp. *minor* grows naturally in Eurasia in dry to moist meadows; subsp. *muricata* is found in much the same habitats, with a tendency to be in somewhat moister meadows. In New Zealand, accessions of *S. minor* subsp. *minor* have generally proven to be less drought tolerant than those of *S. minor* subsp. *muricata* (Douglas, personal communication). The drought tolerance of sheep's burner is due particularly to its well-developed taproot, which will grow to a depth of at least 4 m (Sheppard and Wills 1986). Salad burner benefits from supplemental water during dry periods (Lima 1986), and can wilt quickly in hot, dry weather. Semi-shade is tolerated but the plants grow best in full sun.

Propagation and Cultivation

Propagation is by seeds or division of plants. The seedlings do not transplant well if the root systems are disturbed. Seeds can be started indoors in individual pots several weeks before transplanting. It is better to start seeds in the garden after danger of frost. Salad burner can be grown as an annual or a perennial. If it is grown as an annual the plant should be allowed to self-seed before cutting the top growth at the end of the season. Otherwise, most of the plants should be cut back just after flowering to encourage new growth, leaving only a few tops to produce seed (Lima 1986). New growth will follow providing garden greens throughout the growing season. Plants are tastier earlier in the season than late; and younger plants are less tough and bitter than older ones, so plantings should be renewed every few years.

Harvest and Storage

Leaves can be picked at any time after the plants have become established and have developed several side branches. Fresh leaves are considered far superior to dried or frozen ones, and drying salad burnet for culinary purposes is not recommended. The leaves should be picked immediately before use (Halpin 1978). In warmer regions, fresh leaves can be obtained throughout the colder months

Fig. 355.
Salad burnet *(Sanguisorba minor subsp. minor)*,
from Vilmorin-Andrieux et C^{ie} (1883).

if the plants are well protected with a thick winter mulch (Halpin 1978). The lower leaves tend to stay green all winter (Crockett and Tanner 1977). In cold regions the leaves can be harvested for fresh use until covered by snow. The harvest potential of salad burnet is indicated by harvests achieved for its close relative, sheep's burnet. Douglas et al. (1990) observed a herbage production of sheep's burnet in New Zealand averaging 6.3 t dry matter/ha within the first 7 months of sowing.

Salad burnet can be grown as a potted indoor plant. It requires at least 5 hours of direct sunlight daily, and old leaves should be periodically removed to keep the plant compact (Crockett and Tanner 1977).

Example Cultivars

No information on cultivars of salad burnet (*S minor* subsp. *minor*) was found. Delar is a forage cultivar of sheep's burnet (subsp. *muricata*). Cockayne is a germplasm stock studied by Douglas et al. (1993). [Named germplasm stocks, although often registered, are usually less distinctive than named cultivars, and are used primarily for breeding and experimentation. They may eventually be given the status of named cultivars.]

Additional Notes

Chemistry

Extracted tannin/polyphenol components include hydroquinones, resorcinol, catechol, pyrogallol, and gallic acid (Prakash 1990).

Medicine

Salad burnet was used in traditional medicine. The early Anglo-Saxons employed it as a key ingredient of their green-salve, as well as in other medicines and ointments. During the 15th-17th centuries A.D. it was used to heal wounds, cure gout, and protect people from the plague (Halpin 1978). An infusion of salad burnet leaves has been used to treat sunburn and skin problems. The leaves were employed in facial treatments to improve the skin (Garland 1979). Rinzler (1990) notes that high-tannin plants such as the burnets have commonly been used in folk medicine to treat diarrhea, skin irritation, and staunch the flow of blood, since the astringent action of tannin affects internal mucous membranes (and therefore diarrhea), and surface skin (and therefore burned skin and bleeding wounds). Douglas (personal communication) notes that sheep's burnet has low concentrations of condensed tannins in the foliage.

Nutrition

Little nutritional analysis of salad burnet has been carded out (Rinzler (1990). An analysis (dry weight basis) gave the following results: protein: 16.2%, fat: 3.4%, fiber: 14.1%, phosphorus: 0.35%, potasssium: 2.4% (Salmerón 1966). Yamawaki et al. (1993) found that ascorbic acid content was quite high - nearly 300mg/100g, fresh weight. Sheep's burnet, the close relative of salad burnet, has a high content of minerals such as calcium and magnesium (see references in Douglas and Foote 1993), and salad burnet is likely similar.

Curiosities

• After a terrible battle with his brother, King Chaba of Hungary is said to have cured the wounds of 15 000 of his soldiers with the juice of salad burnet (Fox 1933). In Hungary, salad burnet is known as *chabairje*, Chaba's slave (Fox 1933) or Csaba's balsam (Nordborg 1966).

• As noted earlier, most fruits or *S. minor* have two seeds which are very difficult to extract from the hard fruit. As a result, an extreme sibling rivalry occurs, because both seeds usually germinate and emerge more or less locked together like Siamese twins. One normally dominates the other (Nordborg 1967; Sheppard and Wills 1986).

• According to Schofield (1989) "Burnet leaves have an interesting surface, which totally repels water. When submerged, a thin layer of air adheres to all surfaces, giving the leaves a fascinating appearance of having been silver-coated."

• The lower flowers of salad burnet are male or hermaphrodite, the middle hermaphrodite, and the upper female (Huxley et al. 1992).

• The Italians have a saying about salad burnet (Sanecki 1974):

L'Insalate non e buon, ne bella,

Que non e la Pimpinella!

(The salad is neither good nor fair

if Pimpinella is not there!)

• Another Italian saying (Hutson 1987): "a salad without *pimpinella* is like love without a girl."

Problems and Potential

In North America salad burnet is likely to remain a curiosity of home gardens. There is potential to market the young leaves in combination with other salad greens in plastic bags as a specialty salad.

Selected References

Nordborg (1967); Halpin (1978); Garland (1979); Lima (1986); Hutson (1987); Douglas (1991) (a doctoral thesis, which is the basis of several published papers by Dr. Douglas, but which contains an excellent literature review and bibliography not available in published form).

Sanguisorba Officinalis L.

Scientific (Latin) Synonyms

S. polygama E Nyl.

English Names

Great burnet
Also: burnet bloodwort, common burnet, English wild burnet, garden burnet

French Names

Grande pimprenelle (f)
Also: grande sanguisorbe, pimprenelle (commune), pimprenelle des montagnes, pimprenelle des prés, pimprenelle d'Italie, pimprenelle officinale, sanguisorbe, sanguisorbe officinale

Great burnet is a perennial herbaceous plant native to the temperate parts of the Northern Hemisphere. The height of the plant varies from 30 to 110 cm, generally 60-80 cm (Nordborg 1963). It is found in Eurasia, Iceland, and from northern Alaska and the Yukon to the northwestern District of Mackenzie, south to California. It is sometimes found as a garden escape in eastern North America as far north as Nova Scotia (Scoggan 1978-79). The species tends to occur in damp, base-rich habitats (Proctor and Nordborg 1968). Great burnet was occasionally cultivated in Europe and is now more frequently grown in central Asia and Japan (Mansfeld 1986). It remains primarily a wild, meadow herb, usually confined to relatively moist environments (Halpin 1978).

The young leaves are cooked and eaten as a soup herb, salad, and occasionally a vegetable. Leaves and young shoots are tastiest before the plants flower. According to

Fig. 356.
Great burnet *(Sanguisorba officinalis)*,
from Hallier (1880-1888).

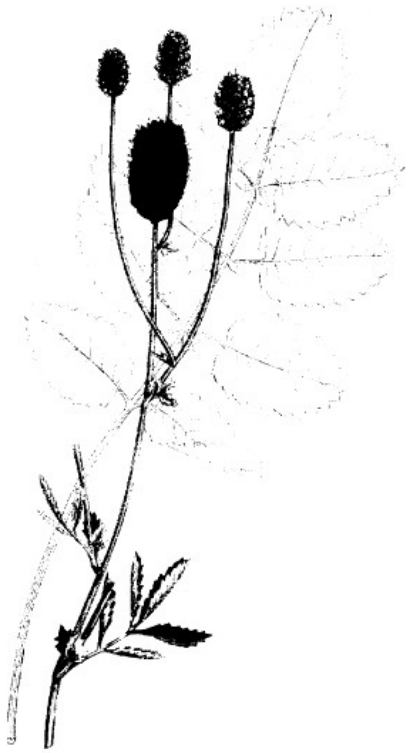


Fig. 357.
Great burner *(Sanguisorba officinalis)*,
from Syme et al. (1863-1886).

Bunney (1992), however, great burnet should never be taken in large doses, while salad burnet is much to be preferred for culinary purposes.

The rootstalk was used in medicine as "Radix pimpinellae italicae," and is still occasionally used in folk medicine (Mansfeld 1986). In Chinese medicine, the leaves continue to be used to treat fever, and the roots for a variety of ailments, including nausea, diarrhea, dysentery, wounds, fevers and snakebite (Duke and Ayensu 1985). The species was listed 19th in effectiveness of 250 potential anti-fertility plants (Duke and Ayensu 1985). The rootstalk has been used to treat inflammation and control bleeding (Ishimaru et al. 1990). It was once employed to staunch wounds on the battlefield, reflected in the common name "bloodwort" (Stobart 1977). A chemical responsible for controlling bleeding (3,3',4-tri-*O*-methylellagic acid) has been found in the roots (Kosuge et al. 1984). The powdered root has been employed clinically for second- and third-degree bums, but this use is not accepted in Western medicine because of the high tannin content (Foster and Duke 1990).

Curiosities

• The genus *Sanguisorba* derives its name from the Latin *sanguis*, blood, and *sorbo*, to soak up (Steam 1992a), named for *S. officinalis*; the presumed ability to stop bleeding was suggested by the reddish (sometimes purple-black) flowers, according to the Doctrine of Signatures, whereby plants suggest their usefulness by their appearance.

• American soldiers drank great burnet tea before battles of the Revolutionary War in the belief that this would prevent bleeding, if wounded (Foster and Duke 1990).

Selected References

Nordborg (1963).

Satureja

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

Satureja is made up of 30 or more species of annual herbs or perennial subshrubs, native to temperate regions of the Northern Hemisphere. Its delimitation from Other genera such as *Micromeria* and *Calamintha* (both presented in this book) requires study (Davis 1980; Codd 1985). Although the common name "savory" is usually understood to apply to species of *Satureja*, it has also been applied to other plants, including *Micromeria juliana* discussed in this book.

In addition to the *Satureja* species discussed in detail below, *S. thymbra* L. is also important economically (Mansfeld 1986; Facciola 1990). This is a small, woody perennial, 20-40 cm tall. The most common name is thryba (note the change in spelling compared to the scientific name). The plant is also known as barrel sweetener, and Roman hyssop. It is native to Crete, the nearby Aegean region, the southern area of Sardinia, and Asia Minor. Thryba was alleged to be cultivated as a kitchen herb in Spain by Stobart (1977), but Whallon and Whallon (1977) doubted that this was accurate. It has a flavor resembling thyme or savory, and an almost perfumed aroma. The leaves are used as a seasoning for brine-cured olives, grilled meat, meat ragouts, and vegetables. A strong infusion of the herb is used to clean wine barrels before starting a new vintage. Thryba is regarded as one of the best-tasting herbal teas in Crete (Whallon and Whallon 1977).

Other *Satureja* species of minor economic value (Mansfeld 1986; Facciola 1990) include: *S. bzybica* Woron., a native of Transcaucasia that has been cultivated experimentally for essential oil in Crimea; *S. douglasii* (Benth.) Briq., Oregon tea, a native of western North America from southern British Columbia to southern California, where leafy stems were dried and rolled into a ball for use as a tea by Native Americans; *S. spicigera* (K. Koch) Boiss. (sometimes listed as *S. reptans*, an invalid horticultural name), a native of the Middle East and the Caucasus, cultivated as a rock garden plant (Phillips and Foy (1990) call this creeping savory, and note that it has a good strong flavor for culinary use); *S. brownei* (Sw.) Briq. [*Micromeria brownei* (Sw.) Benth.], used as a culinary and tea herb in Florida, and for various medicinal purposes in Middle America (Morton 1981). Other members of the genus may be collected in the wild and used locally for food or ornament.

Satureja Hortensis L.

English Names

Summer savory
Also: garden savory, pepper-wort, savory

Fig. 358.
Summer savory *(Satureja hortensis)*,
from Hallier (1880-1888).

French Names

Family: Labiées, famille de la menthe
Sar(r)iette (f)
Also: herbe de Saint-Julien (herbe de Saint-Julien, herbe de Saint Julien, herbe de St.-Julien), poivrette (Switzerland), sadrée, sariete (des jardins), sarriette (annuelle), sarriette commune, sar(r)iette des jardins, sarrière des jardins, savourée, sentibon (Switzerland)
[Herbe de Saint-Julien should not be confused with sarriette de Saint-Julien, *Micromeria juliana*, discussed in this book.]

Description, Taxonomy, and History

Summer savory is a white- or pink-flowered, aromatic, shrubby annual, 10-35 cm in height. It is native from the eastern Mediterranean to western Iran and the Caucasus. Cultivated forms are indistinguishable from wild plants. The plant has escaped from cultivation and grows wild in much of Europe, Asia, South Africa, and North America (Mansfeld 1986). In North America it has become fetal as far north as parts of Ontario, Quebec, and New Brunswick (Scoggan 1978-79). It is naturalized in the eastern U.S. (Morton 1976).

Summer savory was used as a condiment by the ancient Romans and they likely introduced it into much of Europe, including Britain. It arrived in North America with early European colonists (Rosengarten 1969).

Uses

The leaves of summer savory are used as a culinary herb. They are marketed commercially fresh and whole, dried and whole, or ground (Prakash 1990). The flavor is biting, sweet-resinous, peppery, and somewhat reminiscent of thyme. The herb should be added just before the end of the cooking cycle to preserve its flavor. Fresh leaves and shoots are used to garnish salads, and are rubbed on meat before cooking. The dried leaves are employed to flavor soups, stews, stuffings, gravy, egg dishes, poultry, chili, sausages, cakes, herb bread, and puddings (Facciola 1990; Prakash 1990). It is recommended when cooking with frozen summer savory to use twice the amount that would normally be used with the dried herb. This herb goes well with soups or sauces containing tomatoes (Farrell 1985). The savories diminish the unpleasant odors of strong-smelling vegetables like cabbage, turnips, and Brussels sprouts (Crockett and Tanner 1977). Summer savory blends nicely with cheddar cheese sauce for use on cooked vegetables (Lima 1986). It is often added to "bouquet garni" and "fines herbes" combinations. The herb is sometimes used as a substitute for parsley. In France summer savory is a component of white "bamon" cheese (Greenhalgh 1979). The leaves are brewed into a tea with a flavor similar to sweet marjoram (*Origanum majorana*, discussed elsewhere in this book).

The essential oil of summer savory is used commercially as a seasoning (Mansfeld 1986), and to a lesser extent in the perfume industry (Roecklein and Leung 1987). Both the spice and essential oil are added to commercial dry soup and gravy mixes, liqueurs, bitters, vermouths, and some baked goods (Prakash 1990).

Summer savory is grown as bee pasturage as it produces excellent honey (Mansfeld 1986).

Recipe Sources

Owen (1978) has recipes for Savory bean salad, Green beans in savory sour cream sauce, and Beans baked with savory. Belsinger and Dille (1984) present 11 savory recipes, notably: Baked beans with savory,. Pork chops with savory stuffing, Savory meat cakes, Savory peach butter, Savory Swiss crackers, Black and white bean soup with savory, Savory pepper roast, Summer savory potato corn fritters, Savory corn relish, and Savory apple custard.

Other recipes are: Savory fish seasoner (Day and Stuckey 1964); Braised fava [faba] beans with summer savory (Garland 1979); Savory tea (Marcin 1983); French beans and savory (Hemphill and Hemphill 1984); Savory cheese biscuits (Hutson 1987); Barbecued anglerfish with savory (Bremness 1988); Fava beans with summer savory cream (Holt 1989); Green beans with summer savory and crème fraÎche (Richardson 1991).

Importance

It is unclear which species of "savory" are encountered on the export market Greenhalgh (1979) notes that summer savory may be the major species, and Simon et al. (1984) state that summer savory is the principal savory of commerce. Winter savory (discussed below) and summer savory are both grown in France. Winter savory is the most common type in Spain, Morocco, central Europe, and the former Yugoslavia. France and the former Yugoslavia are the major exporters of "savory." The U.S., the world's major importer of the herb, brought in over 194 t of unprocessed "savory" valued at $107,000 in 1988 (Anon. 1989a).

Winter savory is a minor source of essential oil, with about 1500 kg produced annually in the world (Lawrence 1992).

Cultivation Notes

Soil

In its native habitats in the Mediterranean area, summer savory tends to occupy dry, chalky soils, relatively high in pH (Svoboda and Hay 1990). A pH tolerance range of 5.6-8.2 has been reported (De Baggio 1987), but in

Fig. 359.
Summer savory *(Satureja hortensis)*,
from Lamarck and Poiret (1791-1823).

cultivation the plant does better on alkaline soils (Huxley et al. 1992). It grows best on well-drained, light soils, and does not tolerate soggy substrates (Huxley et al. 1992). The addition of well-rotted manure will improve growth (Lima 1986). The species is well-suited to rock gardens (Huxley et al. 1992).

Climate

Growth of summer savory occurs between 4 and 24°C, optimally about 12°C. Svoboda et al. (1990) showed that summer savory can be grown well in the cool, wet regions of northwest Europe. The species requires full sunlight.

Propagation and Cultivation

This species is reproduced by seeds. Germination is quite slow. The crop is best started indoors where watering and temperature can be carefully monitored until seeds germinate. Summer savory can be grown indoors for winter use if supplemental light is provided. The minimum growing temperature is 7-10°C (Huxley et al. 1992).

Harvest and Storage

For dried herb production the flavor is considered best when the leaves are harvested just before flowering. For essential oil production in Scotland the quantity and quality of the oil is best during early- to mid-flowering (Svoboda and Hay 1990). The whole plant is harvested at ground level (Greenhalgh 1979). Before drying the leaves should be washed to remove any sand and other contaminants (Prakash 1990). Summer savory retains its flavor well upon drying. Quality of air-dried summer savory did not prove to be adversely affected by several packaging methods (Pääkkönen et al. 1990). However, freeze-dried summer savory is sensitive to storage conditions, especially when placed in air in glass jars. This results in loss of aroma after only a short time. Experimental plantings for oil in southern Alberta produced 15 t/ha fresh weight, or 3 t/ha dry weight, but the oil content of ca. 0.6% was considered low (Ference 1989). Commercial oil yields of 61-110 kg/ha have been obtained in Poland (Svoboda et al. 1990).

The home gardener can pick summer savory at any time for fresh use. The tops can be cut and left to dry in a warm, shaded location and then stored in air-tight containers. The fresh leaves can also be washed, dried, and frozen in plastic bags for later use (Lima 1986).

Example Cultivars

Cultivars of summer savory do not seem to be offered in Canadian and U.S. garden catalogs.

Fig. 360.
Summer savory *(Satureja hortensis)*,
from Vilmorin-Andrieux et C^{ie} (1883).

Additional Notes

Chemistry

The essential oil of summer savory is obtained by steam distillation of the leaves and flowering tops. The oil content is highest during flowering. The yield of oil is between 0.10 and 0.15% of the air-dried herb (Prakash 1990). The oil is a golden-yellow color and has an odor reminiscent of thyme or oregano. The major chemical constituent is carvacrol (30-50%), and there may be 20-30% *p*-cymene. There may also be substantial amounts of thymol. Other chemicals found in the essential oil are ß-caryophyllene, linalool, -terpineol, camphene, myrcene, and other terpenoids (Simon et al. 1984). The plant also contains 4-8.5% tannins (Tyler 1993). The relative proportion of chemicals in the oil varies according to the source used.

Medicine

The leaves have been used in traditional folk medicine to expel gas from the alimentary canal, as an expectorant, for complaints of the liver and lungs, and as a bleach to achieve a tanned complexion (Farrell 1985; Prakash 1990). The crushed leaves of summer savory supposedly bring instant relief to the stings of bees or wasps (Phillips and Foy 1990).

The herb has an antioxidant property (Prakash 1990). Chemicals in the essential oil of summer savory have shown some antibacterial activity against common foodborne bacteria. Carvacrol, eugenol, and thymol are most effective in this regard (Deans and Svoboda 1989). This antiseptic property, combined with the astringent effects of the tannin, may have some value in treating simple diarrhea (Tyler 1993). However, summer savory is now rarely used medicinally.

Nutrition

Summer savory is a rich source of calcium and vitamin A (Prakash 1990).

Curiosities

• The genus name comes from the Latin *satyrus*, a satyr, alluding to the ancient reputation of summer savory as an aphrodisiac (Phillips and Foy 1990). It was believed that eating savory gave the satyrs their extraordinary sexual stamina (Whallon and Whallon 1977). One old guide to using herbs suggested that "it is forbidden to use it [summer savory] much in meats since it stirreth him to use lechery" (Farrell 1985).

• Savory was one of the herbs brought to America by the Pilgrims (Hutson 1987).

• The traditional use of summer savory in Europe was to flavor peas and beans (Stobart 1977). Because of this association of savory and beans, in Germany it is locally known as "Bohnen kraut" and in the Netherlands as "boonen kniid," both meaning bean herb (Greenhalgh 1979).

• Because summer savory is so well suited to bean dishes, some gardeners grow it right beside their bean rows so that the two can be picked together (Richardson 1991).

Problems and Potential

Prospects are limited for commercial production in northern North America, although small quantities of the herb might be sold in local markets. The market for savory has been relatively stable in the U.S. compared to demand for other herbs, so that them is little chance for increasing sales (Greenhalgh 1979).

Selected References

Greenhalgh (1979); Lima (1986); Prakash (1990).

Comparison of summer and winter savory (after Crockett and Tanner 1977)

Character	Summer savory	Winter savory
Longevity	annual	perennial
Size	slightly larger, narrower	slightly smaller, wider
Leaves	narrow, covered with short, downy hairs	very narrow (only 1-2 mm wide), smooth & shiny
Taste	sweeter, less piquant	less sweet, more piquant

Fig. 361.
Winter savory *(Satureja montana)*,
from Hallier (1880-1858).

Satureja Montana L.

English Names

Winter savory
Also: savory, Spanish savory, white thyme

French Names

Sarriette vivace (f)
Also: pebre d'ase (Launguedoc region of France), pebre d'aï (pébré d'aï), poivre d'âne (Provençe region of France), sarriette de(s) montagne(s), sarriette sauvage, savourée (also used for *S. hortensis*)

Description, Taxonomy, and History

Winter savory is a hardy perennial dwarf shrub usually growing 15-40 cm in height, occasionally as tall as 70 cm. It is native to southern Europe, the Ukraine, North Africa, and Turkey. Several subspecies are recognized (Ball 1972*a*, Mansfeld 1986) including: subsp. *illyrica* (Host) Nym., native to the Balkans; subsp. *montana*, native from Spain to the Balkans, the kind most commonly found in cultivation; subsp. *taurica* (Velen.) P. W. Ball, native to Crimea where it is under experimental cultivation for its thymol-rich essential oil; and subsp. *variegata* (Host) P. W. Ball, native to northeastern Italy and the western parts of the former Yugoslavia, cultivated mostly in the Adriatic countries. Subspecies *kitaibelii* (Wierzb. ex Heuff.) P. W. Ball, is native to the northern part of the Balkan peninsula and southwestern Romania and is used as a rock garden plant.

Uses

Winter savory has a flavor similar to summer savory, although considered inferior to the latter by many. Richardson (1991) described the flavor of winter savory as similar to the strong taste of sage or thyme, and more suited to heavier dishes such as soups, stews and baked beans, by comparison to its more delicate sister, summer savory. The leaves and flowering tops are added to soups, stuffings, fish, egg dishes, pizza, meats, poultry, and salads. The herb is sometimes a component of a bouquet garni for soups (Prakash 1990). In France winter savory is used on trout, and in the Netherlands and Belgium it is employed in pickling and marinating. The dried leaves are used in Italy in vermouths and bitters (Greenhalgh 1979). The leaves are also brewed for tea (Facciola 1990).

Winter savory is cultivated in France for its essential oil (Mansfeld 1986). Winter savory oil is a flavoring of condiments, relishes, soups, sauces, sausages, canned and prepared meats, table sauces, and in perfumes (Greenhalgh 1979; Duke 1985).

A 10 cm high dwarf winter savory; called *Satureja montana "pygmaea"*, is ideal for rock gardens (Barash 1993; for dwarf cultivars, see Example Cultivars).

Recipe Sources

Winter savory is used like summer savory (see Recipe Sources for summer savory). Michael (1980) gives the following recipes specifically for winter savory: Rice stuffing for chicken with winter savory, and Savory with beans. Richardson (1991) has a recipe entitled Pork chops with apples and winter savory, and Barash (1993) has a recipe called Swordfish with winter savory.

Importance

Winter savory is not as important economically as summer savory. However, it is popular in North America and Germany. The U.S. imports about 80-90 t annually (Prakash 1990). Additional information is presented in the section Importance for summer savory.

Fig. 362.
Winter savory
(Satureja montana),
from Engler and Prantl
(1897).

Cultivation Notes

Soil

Winter savory grows fairly well in poor soils. In cultivation it prefers well-drained, light soils, although in nature in Europe it has been collected on a wide range of soil types (Pellecuer 1973). Reported tolerance ranges of pH are 6.5-7.3 (Duke 1978) and 6.5-7.0 (De Baggio 1987). Pellecuer (1973, 1985) reported that it grows naturally in Europe on soils as acidic as 5.5, and as basic as 9.0, but most abundantly between 7.5 and 8.5. Barash (1993) recommends light, sandy, well-drained soil with a minimum of organic matter.

Climate

Growth of winter savory occurs between 6 and 27°C, optimally about 13°C. This species prefers sunny locations, but will grow in slight shade. Winter savory tolerates dry periods. According to Barash (1993), winter savory can experience winter kill if the soil is too rich or too moist.

Propagation and Cultivation

Winter savory can be propagated by seeds, by division of plants in spring, by rooting of softwood cuttings in summer, and by layering of branches that are bent to the ground and allowed to root (Lima 1986; Huxley et al. 1992). The seeds are slow to germinate, and plants are commonly started from root division or stem cuttings (Crockett and Tanner 1977). For good growth, winter savory should be divided and replanted every 2 or 3 years (Crockett and Tanner 1977). Dead wood should be removed, and in the fall the plants growing in colder areas should be clipped back to 9-15 cm above the ground (Crockett and Tanner 1977). Winter savory is available as seeds or living plants in Canadian and U.S. seed catalogs.

Both summer savory and winter savory can be grown as house plants provided that they get at least 5 hours of direct sunlight daily (Crockett and Tanner 1977). Mature plants of winter savory from the garden can be cut back to half their size, and allowed to recover outside for 2-3 weeks before being brought indoors. The soil for both savories should be allowed to become moderately dry between waterings indoors, and the plants can be fed an all-purpose fertilizer at half-strength every 3 or 4 weeks (Crockett and Tanner 1977). Winter savory is slower to recover from pruning, so it should be harvested more sparingly than summer savory.

Harvest and Storage

Plants are harvested just before flowering and dried in dehydrators for commercial marketing. As with summer savory, the home gardener can pick winter savory any time, and the herb can be used fresh, dried, or frozen. Only the tender tip growth of winter savory should be harvested by the home gardener.

Example Cultivars

Creeping (= Dwarf, Trailing, Nana, Repandra), Purple (Purpurea) [described by Facciola (1990)].

Fig. 363.
Winter savory *(Satureja montana)*,
from Vilmorin-Andrieux et C^{ie} (1883).

Additional Notes

Chemistry

The essential oil is derived by steam distillation of the air-dried leaves and flowering tops. The yield is about 0.1-0.2%. The major constituent is carvacrol, which comprises 35 to 40% of the essential oil of wild plants, up to 65% of the essential oil of cultivated plants (Duke 1985). However, there is considerable variation in constituents, and some collections have been found to be richest not in carvacrol, but other components (Duke 1985). Some varieties contain, in addition to carvacrol, large amounts of thymol (Furia and Bellanca 1975). Simon et al. (1984) list thymol, *p*-cymene, 1-linolool, 1-terpineol, *d*-borneol, dihydrocuminyl alcohol, 1-carvone, 1-menthone, and various organic acids. The leaves contain ursolic acid (Duke 1985). The composition of the essential oil of *S. montana* var. *kitaibelii* Briq. was reported by Genova and Balinova (1970).

Medicine

Winter savory has been used in traditional folk medicine to expel gas from the alimentary canal, as an appetizer, laxative, sedative, stimulant, tonic, and vermifuge (Duke 1985; Prakash 1990). It has been considered to be both an aphrodisiac (Stuart 1979) and an anaphrodisiac (see below).

Nutrition

No information found. Since relatively little herb is used it is unlikely that there is an appreciable contribution to human nutrition.

Curiosities

• Both winter and summer savory have a peppery tang, hence a common name in Germany is "Pfefferkraut" (pepper herb), and in Provençe it is known as "poivre d'âne" (donkey pepper) (Greenhalgh 1979).

• Massage creams with winter savory are "believed by some European natural healers to work miracles with the frigid female" (Duke 1985).

• Despite the above, winter savory has a reputation for acting as an anaphrodisiac (decreasing the sex drive). It has been suggested that this helps explain why it is less popular than summer savory, long considered an aphrodisiac (Tyler 1993).

Problems and Potential

Winter savory has very limited potential as a commercial crop in North America. There is some possibility for supplying local markets but summer savory is more marketable.

Selected References

Greenhalgh (1979); Lima (1986).

Fig. 364.
Lemon savory
(Satureja biflora),
prepared by
M. Jomphe.

Satureja Biflora (Buch.-Ham. ex D. Don) Briq.

English Names

Lemon savory

French Names

Sarriette citron (f)
[Name coined and suggested by H.S. MacKee (personal communication).]

Lemon savory is a perennial shrub native from India, along the mountains of east Tropical Africa, to southern Africa. Some species of *Satureja* native to southern Africa, including lemon savory, might best be transferred to the genus *Micromeria*. In this case the scientific name for lemon savory would likely be *M. imbricata* (Forssk.) Christen (Codd 1985).

Lemon savory has leaves with a pleasant lemon scent and flavor. It can be used in teas, baked fish, or other foods requiring a lemon flavor. The volatile oil contains as much as 60% citral, as well as camphor, menthone or pulegone (Watt and Breyer-Brandwijk 1962; Pande and Gupta 1971). This species must be taken indoors overwinter in Canada and the colder regions of the U.S. It requires well-drained soil and the stems should be occasionally trimmed to keep the plant vigorous. In its native habitats lemon savory is often observed growing in shade (Pande and Gupta 1971). Lemon savory is offered as living plants in some Canadian and U.S. garden catalogs.

Satureja Viminea L.

Scientific (Latin) Synonyms

Micromeria obovata Benth., *M. viminea* (L.) Urb.

English Names

Jamaican savory
Also: all heal, Costa Rican mint bush (Martin 1987), Jamaican mint, Jamaican peppermint, savory, wild mint [Morton (1981) gives peppermint, savory, and thyme as common names in Middle America.]

French Names

Sarriette de la Jamaïque (f)
[Name coined and suggested by H.S. MacKee (personal communication).]

Satureja viminea is native to Jamaica, Cuba and Hispaniola. It grows in thickets on steep shale or serpentine banks, in stony ravines, and gravelly streambeds (Adams 1972; Morton 1981). This species is an aromatic shrub up to 4 m high, with small flowers that are light blue, lavender or white.

In Costa Rica this herb it is employed as a tea for colic (Martin 1987). It is used in Jamaica for teas (Richters 1994) and to relieve indigestion (Morton 1981). In Trinidad it is employed as a flavoring for meats (Martin 1987).

This tender perennial can be maintained in a tub, moved indoors during the winter in cold climates. The soil should be well-drained.

Selected References

Martin (1987).

Fig. 365.
Jamaican savory *(Satureja viminea)*, vegetative branch, prepared by B. Brookes. (Based on greenhouse plant from Richters.)

Sinapis

Family: Cruciferae (Brassicaceae) (mustard family)

Genus Notes

The number of species in *Sinapis* depends on authority: four according to Warwick and Francis (1994) or eight according to Baillargeon (1986). The species are annual or perennial plants native to southern Europe, northern Africa, and southwestern Asia. *Sinapis alba*, discussed below, is grown for its seeds used for mustard and oil. *Sinapis arvensis* L. [= *Brassica kaber* (DC.) Wheeler], known as wild mustard or charlock, is native to parts of Europe and Asia, and has become a persistent weed in the temperate regions of the world. It was cultivated to a small extent for its seed oil in some European countries and has been used as a cover crop, vegetable, and an adulterant of poor-quality table mustard (Vaughan and Hemingway 1959).

Brassica juncea, brown mustard or oriental mustard, is also commonly used as a source of mustard seed, and is also discussed in this book.

Sinapis Alba L.

Scientific (Latin) Synonyms

Brassica hirta Moench, *B. alba* (L.) Rabenh. (not *B. alba* Gilib.)

English Names

Yellow mustard
Also: white mustard
[Stobart (1977) states this is called yellow mustard in North America, usually white mustard elsewhere. However, the name white mustard is also now widely used in North America. The names yellow mustard and white mustard are used interchangeably in the following discussion.]

French Names

Family: Crucifères (Brassicacées), famille de la moutarde Moutarde, moutarde blanche (f)
Also: moutarde anglaise, moutarde cultivée, moutarde jaune, moutarde rude, petit bouquet jaune, sénevé
["Moutarde noire" can be difficult to interpret. It once was generally accepted as referring to *Brassica nigra* (L.) W.D.J. Koch (Bois 1934), a species which dominated the mustard market in the past. Now it sometimes also designates brown-seeded forms of *S. alba* (Fournier 1947-48) (but not what is called brown mustard in North America, *Brassica juncea*, treated in this book).]

Description, Taxonomy, and History

Sinapis alba is an annual, herbaceous, yellow-flowered plant, 20-150 cm tall (mostly 20-60 cm tall as a weed). It is native to the Mediterranean, central Asia, and North Africa. The center of origin is believed to be the eastern Mediterranean. The cultivated form of commerce is subsp. *alba*, now grown in many parts of the world. Subspecies *alba* has become a widespread weed in the world. In Canada, it has been introduced or has escaped in all provinces and the Yukon Territory (Scoggan 1978-79). In the U.S., it occurs in most of the northern states (Fernald 1970). It is abundant in some localities, and is often found in fields, roadsides and waste places (Rollins 1993). This is the only subspecies that grows outside of cultivation in North America (Baillargeon 1986; Mansfeld 1986).

Two wild forms have been found around the Mediterranean (Baillargeon 1986). Subspecies *dissecta* (Lag.) Bonnier was found in parts of Europe and North Africa as a weed of flax but is now apparently extinct. Subspecies *mairei* (H. Lindb.) Maire is found in the Middle East and around the Mediterranean coastline, especially the Aegean. The wild plants are typically low-growing and much-branched. They often have brown or black seeds unlike the cultigen, which has only white or yellow seeds. Wild forms often have a single seed in the "beak" (the narrowed tip of the fruits), a feature that has disappeared from cultivated varieties (Hemingway 1995).

Sinapis alba has been used since ancient limes for its seeds. It was considered to have medicinal properties in classical Greece. The Roman Emperor Diocletian (245-313 A.D.) mentioned mustard in an official price-fixing edict, alluding to it as a condiment and food from the eastern part of the empire. In 812 A.D., the French King Charlemagne decreed that mustard be grown on the imperial farms in Central Europe. By the 12th century its use had spread throughout Europe. Apparently Vasco de Gama carried mustard in his provisions when he sailed from Lisbon on his first voyage around the Cape of Good Hope in 1497. In the 17th century, English mustard was sold in the form of balls of mustard paste. In 1720, a Mrs. Clements of Durham, England, invented a dry, pale-yellow mustard flour known as "Durham mustard," produced by hulling, grinding, and sifting the seeds in a mill (Rosengarten 1969).

Unlike the seeds of brown mustard (*B. juncea*) or black mustard (*B. nigra*), the seeds of yellow mustard have no odor when crushed, and the taste is relatively mild (Farrell

Fig. 366.
White mustard *(Sinapis alba)*, from Köhler (1883-1898).
The fruits of almost all plants of white mustard are hairy, unlike those pictured here.

1985). The seeds of the other two species are smaller, and give off a characteristic irritating odor, which when moistened intensifies and becomes even more irritating (Farrell 1985). The odor and taste differences between white mustard on the one hand, and brown and black mustards on the other, are due to chemical differences. In white mustard, the enzyme myrosin causes the glycoside sinalbin to produce *p*-hydroxy benzyl isothiocyanate, glucose and sinapine bisulfate. In the black and brown mustards, the glycoside is sinigrin, and the active constituents produced are allyl isothiocyanate, glucose, and potassium hydrogen sulfate. The very irritating odor and sharply acrid flavor of the latter two species is due to allyl isothiocyanate (Farrell 1985).

Uses

Three types of mustard are available (Rosengarten 1969; Lewis 1984; Farrell 1985), as noted below.

Powdered mustard is primarily made from yellow mustard seed in North America. It is also known as mustard flour or ground mustard. This is made by finely grinding the seeds and then removing the hulls by repeated milling, screening, and sifting. If a "hot" mustard is desired, the pungency is increased by pressing the ground mustard to remove some of the fixed oil. Wheat flour may be added to the mustard powder. Powdered mustard has no aroma when dry and must be mixed with warm water, which allows enzyme activity to develop the pungent principle in about 10 minutes. Once the desired aroma has developed, the mustard should be used within an hour or the flavor is gradually lost. The enzyme myrosin in mustard reacts badly to boiling water, leaving a bitter, unpleasant taste, so fresh mustard is best prepared with cold water (Pailler 1993). To keep the paste for an extended period it should be acidified (by adding lemon juice, vinegar, or wine) to arrest the enzymatic action, and the mixture should be refrigerated. This product in used commercially and in the home on hot dogs, sandwiches, cheese, eggs, prepared meats, pork and ham, curries, seafood cocktail and barbecue sauces, spice cakes, many Chinese dishes, and in salad dressings. Canned devilled ham owes much of its flavor and spreadable consistency, as well as color, to the abundant use of powdered mustard.

Prepared mustard, also called "mustard paste," is a mixture of ground mustard seed, salt, vinegar, and spices. Most *American mustard* is bright yellow, mild, sometimes sweet, and usually made from white mustard. The brilliant yellow color of prepared mustard in North America is due to the addition of ground Alleppey (Indian) turmeric. In North America it is sold in glass or plastic jars while in Europe it is generally packaged in tubes like tooth paste. So-called "English prepared mustard" is a mixture of crushed white mustard, vinegar, and salt in water (Arctander 1960).

Whole seeds are utilized in pickling or are boiled with vegetable dishes such as sauerkraut or cabbage. Whole seeds are also used on pot roasts and other meats. Yellow mustard seeds are most commonly found in pickling spice mixes (Stobart 1977).

White mustard seeds are often used to produce edible sprouts, more commonly than the species of *Brassica* used for the same purpose (Pailler 1993). These are frequently put into sandwiches and used as a garnish. *Sinapis alba* is also grown as a fodder crop and as a green manure (Huxley et al. 1992). White mustard oil has been used as a lubricant, illuminant, and an edible oil (Vaughan and Hemingway 1959).

White mustard was widely grown in Sweden as an oil crop in the 1940s and 1950's (Hemingway 1995), and this use has potential for the future (see Problems and Potential).

Sinapis alba seed coats have been found to produce a polysaccharide mucilage with possible applications in industry and as a food ingredient (Hemingway 1995). The cultivar Viscount, which is high in mucilage, has been registered in Canada (Hemingway 1995).

Recipe Sources

Rosengarten (1969) has recipes for Bread and butter pickles and Cheese sauce. Mazza (1976) gives recipes for Herb mustard sauce and Sweet mustard. McCormick (1979) presents recipes for Sweet-sour mustard sauce, Sour cream mustard sauce, Creamy mustard sauce, and Hot Chinese mustard. Leggatt (1987) has recipes for Cheese rarebit with mustard flowers and Scallops in wine sauce with mustard flowers.

Other recipes are: John's own herb and honey mustard (Lima 1986); Rack of lamb with mustard and herbs (Creasy 1988); Lemon and mustard vinaigrette with garlic (Ornish 1990); Baked fish with mustard sauce (DeWitt and Gerlach 1991); Calf kidneys in mustard sauce (Swahn 1991); Scallops with mustard beurre blanc (made with mustard flowers; Barash 1993).

Importance

Mustard is one of the best known and most widely used of condiments. Specialty stores and supermarkets stock a variety of jars and fancy pots containing smooth or grainy, wine-soaked or honey-sweet, hot or mild mustards. In North America, Britain, and most Commonwealth countries, most mustard is sold in both the powdered and paste

forms. In Europe, South America, and other parts of the world the demand is almost exclusively for paste mustards (Vaughan and Hemingway 1959).

White mustard is cultivated in Austria, China, Chile, Denmark, India, Italy, Japan, Great Britain, the Netherlands, North Africa, Canada, and the U.S. (Farrell 1985). Canada is the major producer of mustard seed in the world. Over the period 1984-93, western Canada annually provided an average of 147.7 thousand t for all types of mustard, of which about 75% was produced in Saskatchewan, 18% in Alberta and 7% in Manitoba (compiled from Statistics Canada 1993, and reports from previous years). Some recent production statistics for Canada are: 1989/90: 139 600 t; 1990/91: 225 000 t; 1991/92: 109 200 t; 1992/93: 120 000 t (Dull 1994*b*). In 1994, 216 000 000 t were produced from 186 200 ha, a mean yield of 1160 t/ha (Statistics Canada 1993). Generally about half of the crop is white mustard, most of which is exported whole to the United States where it is used as a prepared mustard (Anon. 1977). However, the proportion of white mustard grown in Canada seems to have decreased in the early 1990's. The contract prices averaged $265 (U.S.)/t for white mustard. The wholesale prices for white mustard averaged $650 (U.S.)/t. In 1991, about 637 ha of mustard were sown for certified seed production, of which 138 ha was the white mustard cultivar Ochre (Anon. 1992*e*).

The U.S. grows mustard seed commercially in Montana, North and South Dakota, Washington, Oregon, and California (Dull 1994*a,c*). North Dakota, Montana, and South Dakota are the principal producers. The U.S. produced 6579 t worth $1.55 million in 1992, and 7594 t worth $1.75 million in 1991. In 1992, 7325 ha were grown, and in 1992 5989 ha (Dull 1994*c*). In 1993 an estimated 5616 t worth $1.34 million were produced (Dull 1994*a*). In 1994, the U.S. produced 5896 t valued at $1.4 million (Dull 1995). The U.S. obtains most of its mustard seed from Canada, with imports in the 1990's averaging about 55 000 t annually.

Cultivation Notes

Soil

Mustard performs best on loamy soils which are not prone to crusting. The Brown and Dark Brown soils of the Canadian prairies are excellent for mustard growing (Forhan and Tisdale 1988).A pH range of 7.1-8.5 has been found to be best (Hackett and Carolane 1982), although a range of tolerance of 4.5-8.2 has been reported (Duke 1979). For additional information see notes on "Soil" under brown mustard (*Brassica juncea*).

Fig. 367.
White mustard *(Sinapis alba)*, from Syme et al. (1863-1886).

Climate

Mustard is fairly tolerant of cool spring temperatures and will germinate at a soil temperature as low as 4.4 °C (Forhan and Tisdale 1988). If a spring frost occurs, 4-5 days may pass before the extent of damage is known. If the growing point of the plant is not killed, it will recover (Dean 1987). For additional information see notes on "Climate" under brown mustard (*Brassica juncea*).

Propagation and Cultivation

Propagation is by seeds planted early in the spring. The seed bed should be firm, level, and free of plant growth. A seeding rate of 8-11 kg/ha is recommended for yellow mustard (Dean 1987; Forhan and Tisdale 1988). Yellow mustard is susceptible to various disease and insect

pathogens, which may require appropriate control measures (Dean 1987). For additional information see brown mustard (*Brassica juncea*).

Harvest and Storage

Yellow mustard is resistant to seed shattering and can be combined if the crop has matured uniformly and is free of weeds. Full seed maturation (with no green seeds) is necessary for a good quality harvest. If swathing is necessary, the crop should be cut just below the level of the lowest pods. This enables the swath to settle into the short plant stubble and reduces the danger of it being blown away by wind. Alternate wetting and drying can cause a whitish deposit to form on the seeds, reducing seed quality. Desiccants can be used when there are immature patches of mustard plants or green weeds present in the fields. Desiccation allows the crops to be combined without swathing. Harvests of 2.4 t/ha are typical (Hackett and Carolane 1982). Brown mustard (*Brassica juncea*) has smaller seeds than yellow mustard but the yield is generally 10-30% greater.

For information on preparation of home-style mustard and mustard storage see brown mustard (*Brassica juncea*).

Example Cultivars

Ochre, Gisilba, Kirby, Ochre, Sabre, Tilney, Viscount, AC Pennant.

Bettencourt and Konopka (1990) listed institutions in various countries conserving *Sinapis alba* germplasm. Genetic diversity is discussed in Anon. (1981).

Additional Notes

Chemistry

Water activates the enzyme myrosinase, inducing the glycoside sinalbin to yield *p*-hydroxybenzyl isothiocyanate, glucose, and sinapine bisulfate (Lewis 1984; Farrell 1985). Unlike chile (*Capsicum* species, discussed in this book), the sharp pungent flavor of mustard is not persistent. It does not impair the detection of delicate flavors. Blending of yellow mustard with brown mustard (*Brassica juncea*) is often done to obtain both a sharp and pungent aroma. Where only mild pungency is desired, yellow mustard is used.

The oils of mustard seeds are extracted in various ways. The cold pressed method is employed to extract the fixed oil of mustard seed. The fixed oil is 30-35% of the weight. The remaining product is called "press cake." The essential oil of yellow mustard is obtained by solvent extraction of the press cake, which contains little or no volatile oil. The press cake must first be hydrolysed to release the desired chemicals that provide the mustard flavor. A pleasant oleoresin is obtained by blending yellow, brown (*Brassica juncea*), and sometimes black mustard (*B. nigra*).

When added to mayonnaise, curries, or salad dressings, mustard tends to act as a preservative because the essential oil inhibits the growth of yeast, moulds, and bacteria. Mustard also stabilises oil-in-water type emulsions in mayonnaise and salad dressings. In the manufacture of meat products like bologna and frankfurters, soluble protein from ground mustard helps emulsification (solidifying the meat paste). Mustard flour absorbs liquids like water and oils in foods, preventing separation (Rosengarten 1969; Lewis 1984).

Medicine

Mustard has been used in western medicine as a stimulant, to promote urination, and for various ailments. It has been employed as a purgative, its effectiveness due to hydrolytic liberation of hydrogen sulphide (Duke and Ayensu 1985). Its most recognizable use today is in mustard plasters for rheumatism, arthritis, chest congestion, aching backs, and sore muscles (Alpine 1978; Lewis 1984). Mustard plasters can be made of equal parts of flour and powdered mustard, spread as a paste on a doubled piece of cloth, and applied to the body, in no case for longer than 20 minutes. The heat that a mustard plaster produces can readily bum skin, and patients who fall asleep are potentially in considerable danger. With sensitive skin, four parts of flour can be added to one part mustard. In China the seeds are a remedy for toothache, ulcers, neuralgia, bronchitis, and other conditions (Duke and Ayensu 1985).

Nutrition

Yellow mustard supplies significant quantities of fat, oil, and protein (Hackett and Carolane 1982). An analysis of nutritional components is found in Duke and Ayensu (1985).

Curiosities

• The origin of the word mustard or moutarde is usually thought to come from the Latin *mustum ardens*, meaning burning must, because the ground seeds were beaten with grape must (unfermented grape juice) to develop a burning heat (Pailler 1993). When mustard seeds are mixed with liquid, the glycoside sinigrin combines with the enzyme myrosin to produce glucose and isosulfocynate of allyl, which causes the heat (Pailler 1993). Another possible derivation is *moult ardre* (much burning). An even more interesting explanation comes from Dijon, France where the Dukes of Burgundy had the motto *Moulte tarde*, which with typical Burgundian wit is said to mean burn everything.

• In the New Testament, St. Matthew 13: 31-32 refers to mustard (cited in Farrell 1985):

> Another parable put he forth unto them, saying, The Kingdom of Heaven is like to a grain of mustard seed, which a man took, and sowed in his field: which indeed is the least of all seeds: but when it is grown, it is the greatest among herbs, and becometh a tree, so that the birds of the air come and lodge in the branches thereof.

[For a Buddhist parable based on mustard seed, see brown mustard (*Brassica juncea*) Curiosities.]

• In the 13th century, the Earl of Conway executed vikings who had attacked the Isle of Man by drowning them, upside-down, in a barrel of mustard (Swahn 1991).

• In Denmark, a combination of mustard, ginger and spearmint was consumed to cure frigidity (Swahn 1991).

• The French humorist Anatole France noted in *La Révolte des Anges* (1914) that "a tale without love is like beef without mustard: an insipid dish" (Rosengarten 1969).

• Strains of *S. alba* appear capable of stimulating the hatching of sugarbeet eelworm, a phenomomenon which may have practical applications (Hemingway 1995).

Problems and Potential

The demand is increasing for exotic mustards for use with meat, poultry, and game dishes. The considerable production of mustard seed in North America is likely to remain high. Hemingway (1995) suggests that *S. alba* has potential as a protein crop (the seeds have 30-32% protein), but glucosides need to be eliminated to improve palatability.

Selected References

Rosengarten (1969); Hackett and Carolane (1982); Farrell (1985); Baillargeon (1986); Hemingway (1995).

Smyrnium

Family: Umbelliferae (Apiaceae) (carrot family)

Genus Notes

Smyrnium has seven biennial species, native to western Europe and the Mediterranean. In addition to Alexanders (*S. olusatrum*) discussed in detail below, the most notable is *S. perfoliatum* L. This is also known as Alexanders (Hedrick 1972), but more commonly as biennial Alexanders (Phillips and Foy 1990) and perfoliate Alexanders (Facciola 1990). It has been eaten in much the same way as *S. olusatrum*. *Smyrnium perfoliatum* grows wild from southern Europe to the Czech Republic, and was cultivated for its edible stems in parts of Europe from the 16th to 19th centuries (Mansfeld 1986). Some believe that its quality is superior to that of *S. olusatrum*, because it blanches better, is more crisp and tender, and is not as harsh in flavor (Bois 1927; Facciola 1990).

Fig. 368.
Alexanders *(Smyrnium olusatrum)*, from Hallier (1880-1888).

Smyrnium Olusatrum L.

English Names

Alexanders
Also: Alexander, Alexandrian parsley, alisander, black angelica, black lovage, black potherb, horse parsley, monk's salad, stanmarch, wild celery
[Alexanders and variations of the name are often spelled with a small initial a. The capital A is used in this discussion as the name is a reference to a person, Alexander the Great (356-323 B.C.), although it must be admitted that such capitalization is not consistently followed for the common names of herbs.

As noted in the discussion of Angelica (*Angelica archangelica*) in this book, the name Alexanders has also been applied to *A. atropurpurea* L. It is also used for Scotch lovage, *Ligusticum scoticum* (see Genus Notes for lovage, *Levisticum*). As the name black lovage suggests, Alexanders is sometimes mistaken for true lovage, *Levisticum officinale*. Golden Alexanders is *Zizia aurea* (L.) W.D.J. Koch, a wild plant found from New Brunswick to Florida and Texas. Although this species is not mentioned in wild food books, Crowhurst (1973) gives a recipe for it entitled "Alexanders buds with cheese sauce."]

French Names

Family: Ombellifères, famille de la carotte
Maceron (m)
Also: grande ache, (gros) persil de cheval, (gros) persil de Macédoine, gros persil (de Macédonie), macéron, maceron commun, maceron potager, smyrnium

Description, Taxonomy, and History

Alexanders is a native of Mediterranean Europe, from Algeria to the Caucasus, and Turkey. It is a coarse, stout, biennial, yellow-flowered, herbaceous plant growing to 1.5 m tall. The species produces yellow-green flowers and aromatic black seeds. Alexanders grows naturally on moist or rocky soils and cliffs, especially near the sea.

Alexanders was cultivated in southern and western Europe from Antiquity to the Middle Ages. It was mentioned in 322 B.C. by the Greek naturalist Theophrastus (371-287 B.C.), who described it as a delicious plant (Hedrick 1972). The ancient Romans introduced it to England. Alexanders was a popular monastery plant throughout the Middle Ages; it is often found growing in the ruins of old abbeys and castles in Ireland and the west of England (Michael 1980). It was taken to North America in the 16th century and it was still used in England in the 17th century, remaining a popular and widely cultivated pot herb until displaced by celery (Garland 1979; Mansfeld 1986; Phillips and Foy 1990). Alexanders was particularly enjoyed in fish and seafood dishes in Elizabethan Britain (Garland 1979). By the mid-18th century, this herb largely disappeared from gardens (Stuart 1979).

Uses

Alexanders has celery-flavored young shoots, leaves, stems, and roots, which have been eaten sparingly as vegetables and combined in salads. The young shoots and leafstalks are particularly flavorful, and can be eaten in soups, sauces, and stews (Facciola 1990). They may be cut into pieces, peeled with a knife, boiled for 6-8 minutes, and served hot with butter and perhaps pepper. The flavor is similar but more pungent than that of celery. The young stems can also be braised (Garland 1979). Leftover pieces can be served cold in vegetable salads (Phillips and Foy 1990). The leaves can be added to salads or used as a pot herb. The dark brown seeds can be added to salads and vegetable dishes for flavoring, or ground up and used like pepper (Bremness 1988). The leafy seedlings have been used as a parsley substitute (Facciola 1990). The flower buds can bring color and flavor to a salad. The roots are sometimes boiled and eaten as a parsnip-tasting vegetable, or candied in sugar (similar to angelica, discussed in this book). The roots are said to be more tender if maintained during the winter in a cool place (Facciola 1990).

Alexanders has been used as a feed for cattle (Mansfeld 1986).

Recipe Sources

Michael (1980) gives the following recipes: Alexanders stems as a vegetable, Alexanders buds as salad, Alexanders sauce.

Other recipes are: Braised Alexanders (Garland 1979); Pickled Alexanders buds (Bremness 1988).

Importance

Alexanders is not commercially cultivated, and indeed is of very limited importance.

Cultivation Notes

Soil

Alexanders grows best in a well-drained but moisture retentive soil. The soil should be enriched with well-rotted manure (Huxley et al. 1992).

Climate

Alexanders is winter-hardy to -15°C (Huxley et al. 1992). This biennial overwinters as far north as the warmer parts of Canada. In colder areas it is best covered with a mulch before freezing occurs. Alexanders requires full sunlight (Huxley et al. 1992). Supplemental water is beneficial during dry periods.

Propagation and Cultivation

This species is propagated by seeds, which are very slow to germinate. It is best to sow them as soon as they ripen in late summer or early fall as this allows sufficient time for germination and establishment. Seeds may also be planted in early spring. For spring planting the seeds are best started indoors and transplanted after danger of frost (Huxley et al. 1992). A lightproof material, soil, or straw can be placed around the stems for 3 weeks in early spring to blanch them before harvest, in order to improve the taste.

Harvest and Storage

Leaves are gathered during the summer, before flowering, and used fresh or dried. New shoots and leafstalks can be picked in late spring from second-year plants, before they flower. Young stems are cut dose to the ground.

Fig. 369.
Alexanders *(Smyrnium olusatrum)*,
from Lamarck and Poiret (1791-1823).

Example Cultivars

No cultivars are available.

Additional Notes

Chemistry

The roots and seeds of Alexanders contain furanoeremophilane and furanoeudesmane compounds (Ulubelen and Öksüz 1984; Ulubelen et al. 1985).

Medicine

Alexanders is a mild urine-promoting agent, and was used in traditional medicine to aid digestion (Phillips and Foy 1990). Seeds soaked in wine were employed to promote menstruation (Stuart 1979). The seeds were also thought useful for asthma (Stuart 1979). Dried leaves were taken on long sea voyages to prevent scurvy (Bremness 1988). The species is not used in modern medicine.

Nutrition

The leaves contain considerable vitamin C, consistent with its use in preventing the development of scurvy (Stuart 1979).

Curiosities

• The generic name *Smyrnium* is derived from smyrna, the Greek word for myrrh, referring to the scent of some members of the genus (Steam 1992*a*). Alexanders itself has a myrrh-like aroma (Sanecki 1974). In ancient times myrrh was imported from Smyrna in Macedonia, the country of Alexander the Great (Macleod 1968).

• The common name Alexanders is generally thought to refer to territory related to Alexander the Great, either to ancient Macedonia (in the Balkan Peninsula), home of Alexander the Great, or to the coastal regions around the port of Alexandria in Egypt (Sanecki 1974).

• Charlemagne (742-814), the Frankish king who came to be Emperor of the West, included Alexanders among the edible plants that he ordered be planted on his estates (Hedrick 1972).

Problems and Potential

Alexanders has no commercial potential, given the success of celery, with which it must compete. It will remain a curiosity of the home garden.

Selected References

Garland (1979); Phillips and Foy (1990).

Fig. 370.
Betony *(Stachys officinalis)*, prepared by B. Steiner-Gafner for a thesis by M. Jeker, and used with her permission and that of M. Baltisberger.

Stachys

Family: Labiateae (Lamiaceae) (mint family)

Genus Notes

Stachys is composed of about 300 species of herbs and subshrubs of temperate and subtropical areas and tropical mountains. The genus is quite variable, and some groups perhaps deserve to be recognized as distinct genera (Baltisberger, personal communication). One of these well separated groups is often recognized as *Stachys* section *Betonica* (e.g., Ball 1972b); as *Stachys* subgenus *Betonica* (Bhattacharjee 1980); or as the distinct genus *Betonica* (e.g., Baltisberger 1989). *Stachys officinalis*, treated in detail below, is a member of this group, which includes about 12 species centered in Europe and Turkey (Jeker et al. 1989).

Stachys affinis Bunge, Chinese or Japanese artichoke, is grown as a vegetable in Asia and to a minor extent in Europe for its edible tubers. The plant has been experimentally grown successfully on the Canadian prairies (Kiehn and Reimer 1993). *Stachys floridana* Shuttleworth ex Bentham, rattlesnake weed, a native of the southeastern U.S., also produces edible tubers, but has yet to be exploited as a significant food source (Nelson, personal communication). Some species of *Stachys* are grown as ornamentals, and several have been used medicinally.

Stachys Officinalis (L.) Trevisan

Scientific (Latin) Synonyms

S. betonica Benth., *Betonica officinalis* L.

English Names

Betony
Also: bishop's wort, bishopwort, purple betony, wood (betony), wood betonica, woundwort

French Names

Family: Labiées, famille de la menthe
Bétoine (f)
Also: beltête, bétoine officinale, bétoine pourpre, bétoine vulgaire, broutoniba, épiaire

Warning

The culinary use of this plant is as a tea. An excessive dose can produce pain, nausea, and vomiting.

Description, Taxonomy, and History

Stachys officinalis is a strongly scented, erect perennial, growing from 15 to 60 cm, occasionally to 100 cm in height. It usually produces spikes of small crimson, red-purple or rose (sometime white) flowers. The white-flow-ered subspecies *balcanica* (P.W. Ball) Bhattacharjee occurs in Turkey, Greece and Bulgaria (Bhattacharjee 1982); this is often considered a separate species, *S. balcanica* P.W. Ball (= *S. haussknechtii* (Uechtr. ex Hausskn.) Hayek). *Stachys officinalis* is native to the Mediterranean region, Europe north to Great Britain and southern Sweden, Morocco, Algeria, Tunisia, northern Turkey, northern Iran, and the Caucasus. It occurs in a variety of habitats, including maritime sands, marshy lake

Fig. 371.
Betony *(Stachys officinalis)*, from Hallier (1880-1888).

sides, damp meadows, grassland heath, open woodland, and forest clearings. It has occasionally been collected in North America as a garden escape.

Betony was known to the ancients as a medicinal panacea (Morton 1976). The plant was revered as a holy herb, effective against all manner of witchcraft as well as a cure for numerous maladies (Michael 1980). It was cultivated during the Middle Ages in Europe for use in herbal medicine. The leaves were employed during the medieval period to dye wool a dark yellow (le Strange 1977). Betony was taken to North America by settlers (Michael 1980).

Uses

Betony is grown primarily as an ornamental. Its employment as a culinary herb is limited to occasional use as a herb tea, although the leaves have also sometimes been used as a spice with meat (Duke 1985). The leaves have a somewhat bitter and salty flavor (Morton 1976).

Recipe Sources

Botanic beer (Grieve 1933; Stuart 1979); Meadowsweet beer (Macleod 1968); Betony tea (Crowhurt 1973; Loewenfeld and Back 1974; Michael 1980; Marcin 1983) [see Warning]; Conserve of betony (Leyel 1938; Michael 1980).

Importance

Betony is grown occasionally as an ornamental. It is of no commercial economic significance.

Cultivation Notes

Soil

Betony grows well in well-drained, moderately fertile soil.

Climate

Betony is a moderately cold-tolerant perennial that can be grown as far north as southern Canada. The plants thrive in full sun (Crockett and Tanner 1977), although they grow naturally in shady locations (reflected by the name "wood betony").

Propagation and Cultivation

Betony can be propagated by seeds and by division of the creeping roots. When grown from seeds the plants require 2 years before they flower. Root division is the usual means of reproduction. Clumps should be divided every 2 or 3 years to prevent overcrowding (Crockett and Tanner 1977).

Fig. 372.
Betony *(Stachys officinalis)*, from Bulliard (1784).

Harvest and Storage

The whole herb can be collected, dried and preserved as with other leafy plants. Michael (1980) gives detailed instructions: tie betony into bundles of five or six stems and hang upside-down in a warm airy room; when quite dry, strip the leaves and flowers and crumble finely; store in a tightly closed jar away from light.

Example Cultivars

Alba, Grandiflora, Rosea Superba.

Additional Notes

Chemistry

The leaves contain about 15% tannins, 0.5% betaine, 0.5% caffeic acid, and other compounds (Duke 1985). The chief alkaloids present are betonicine and stachydrine (Stuart 1979). The plants also contain several different iridoids (Jeker et al. 1989).

Medicine

Betony was very widely used in classical herbal medicine, so much so that it "was once the sovereign remedy for all maladies of the head" (Grieve 1931), and "with the possible exception of vervain, no herb was more valued in olden times than betony" (Macleod 1968). Powdered flowers were used as a laxative. An infusion of flowers, leaves, or root was used against fever. The leaf infusion was also used to treat headache, backache, migraine, toothache, eye problems, bronchitis, asthma, women's ailments and wounds. In medieval times, it was claimed that betony would cure 47 ailments (Duke 1985). Betony is not used in modern Western medicine.

Betony leaves contain considerable tannin, which is astringent, hence may have some value in treating diarrhea and various irritations of the mucous membranes (Duke 1985). One research study suggested that glycosides in betony lowered blood pressure (Tyler 1993).

According to Tyler (1993), "in normal usage, betony should not cause any notable side effects, but overdosing may result in excessive irritation of the stomach." Morton (1975a) warned of the carcinogenic potential of tannin overconsumption, which might be a problem for anyone addicted to betony tea. Bunney (1992) stated that in large doses betony can be purgative and emetic.

Nutrition

No nutritional value has been demonstrated, although modern herbalists sometimes use the plant to treat digestive disorders (Loewefeld and Back 1974).

Curiosities

• The name betony (and the alternative genus name *Betonica*) has been speculated to have arisen from the Bettones - a people of Spain; or perhaps from the primitive Celtic *bew* (head) and *ton* (good) - a reflection of the use of the herb to cure headaches (Macleod 1968).

• The name bishopwort originated from the practice of cultivating the herb in monastery herb gardens and churchyards in the belief that it repelled evil spirits and provided powerful protection against witches and enchantments (Grieve 1931; Garland 1979).

• The name wood likely arose because wild betony was usually found in woods.

• An old German name for betony was Zehrkraut, meaning wasting herb, a reflection of its use as a remedy for children who lost weight without apparent cause (Loewenfeld and Back 1974).

• According to the classical Roman writer Pliny (23-79 A.D.), "The roots will kill serpents, indeed the serpents shut up and confined in a circle or ring made of betony will fight and kill each other" (Michael 1980).

• Betony was commonly carded in amulets, and was one of the six "amulet herbs" recognized in early herbalism (the others were vervain, peony, yarrow, plantain, and rose) (Macleod 1968).

• Another reflection of the esteem held for betony in the past is an old Italian proverb, "Sell your coat and buy betony" (Macleod 1968).

• It was believed in the Middle Ages that the magical powers of betony would be lost if it were collected with iron implements (Macleod 1986).

Problems and Potential

Betony is of extremely limited importance economically, and is encountered both in the garden and in the kitchen merely as an occasional curiosity.

Selected References

Michael (1980).

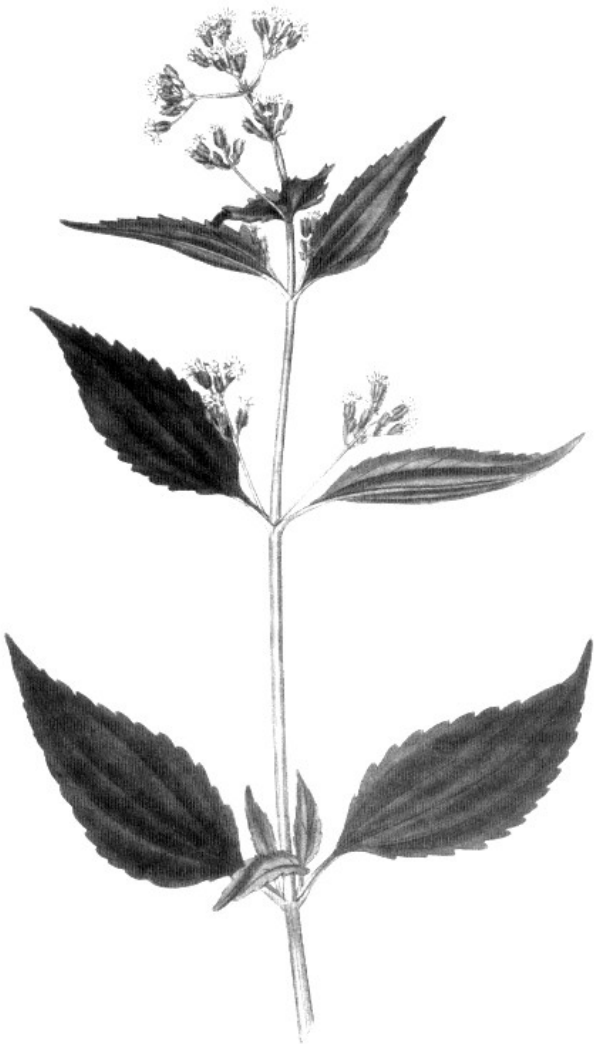


Fig. 373.
Florist's stevia *(Piqueria trinervia)*,
from Curtis (1787-present; #2650).

Stevia

Family: Compositae (Asteraceae)

(sunflower family)

Genus Notes

Estimates of the number of species in *Stevia* vary from 150 to 300 (Handro and Ferreira 1989). The species are annual or perennial herbs and shrubs of tropical and warm North and South America, from the southwestern U.S. to northern Argentina. "For a group of its extent *Stevia* has exceedingly little claim to economic importance" (Robinson 1930*a*). Occasionally a few of the species are grown as ornamentals.

The florist's "stevia" is another species of the sunflower family, *Piqueria trinervia* Cav. ("*Stevia serrata*" of some authors, but not *S. serrata* Cav.). Robinson (1930*a*) accounts for the lack of popularity of true *Stevia* species as ornamentals as due in part to the wide popularity of the so-called stevias in the cut-flower trade.

Stevia Rebaudiana (Bertoni) Bertoni

Scientific (Latin) Synonyms

Eupatorium rebaudianum Bertoni

English Names

Stevia
Also: honey grass, honey-yerba, Rebaudi's stevia, sweet herb (of Paraguay), sweet plant (of Paraguay), sugar leaf [Most of the alternative names for stevia are based on translations of Indian names that have appeared in journal articles. This species should not be confused with *Phyla scaberrima* (A. Juss.) Mold. (*Lippia dulcis* Trév.), Aztec sweet herb, the source of a non-carbohydrate sweetener, hernandulcin, which is about 1000 times sweeter than sucrose (Compadre et al. 1985). For additional information (and a wanting about using this plant), see *Lippia dulcis* in the Genus notes of *Lippia*. Another sweet plant of the sunflower family obtainable in Paraguayan markets, like stevia, is *Tessaria dodeneifolia* (Hook. & Arn.) Cabrera (Kinghorn 1987).]

French Names

Family: Composées, famille de la marguerite
Stévia (m)
[The French name is from Brandle and Rosa (1992), where it was probably coined. Bois (1934), an extensive treatment of culinary herbs in French, discussed the species but did not note a French common name.]

Warnings

This species has been alleged by some to be potentially toxic, mutagenic, and contraceptive (preventing pregnancy) when consumed; others contend that its products are safe (see Medicine). Importation and sale for food purposes in the U.S. is prohibited (see Uses).

Description, Taxonomy, and History

Stevia rebaudiana is a slender, perennial herb with semi-woody, weak stems 30-60 cm tall in the wild. In cultivation, the plants are much more vigorous than natural populations, and may exceed a metre in height. Branching and tillering of cultivated plants are also relatively profuse. In its native area, purple and white flowers are produced in December and January. Shoots usually die after maturing, or are killed by frost, with new growth arising by tillering at the base of the plant (Shock 1982*b*). The species is indigenous to the highland regions of northeastern Paraguay (Robinson 1930*b*; Brandle and Rosa 1992). Handro and Ferreira (1989) give the range as between 22° and 24°S, and 53° and 56°W. However, Hemsley (1909) cited a collection at 55°W and 25°30'S, and Duke and duCellier (1993) reports the herb's presence at 21-22°S. Duke and duCellier (1993) state the plant may possibly be present in contiguous regions of Brazil and Argentina. Handro and Ferreira (1989) and Facciola (1990) give Brazil as part of the range; the indigenous occurrence in the northeastern corner of Paraguay is adjacent to the frontier with southern Brazil. The plants grow naturally on the edges of marshes and in grassland communities, on mountain slopes and in valleys (Soejarto et al. 1983; Brandle and Rosa 1992). Normally the soils occupied have shallow water tables. Stevia has been heavily grazed, harvested, and transplanted to cultivated areas, so that its areas of natural occurrence have been reduced (Shock 1982*a*).

Stevia has been used for centuries as a sweetener by natives of Paraguay for bitter drinks such as maté (*Ilex paraguariensis* St.-Hil.) (Soejarto et al. 1983), apparently before colonization by the Spaniards in the sixteenth century (Kinghorn and Soejarto 1985). It has long been considered to have potential for wide production of a sweetening agent, like sugar cane and maple syrup, but a product with an acceptable taste was not produced until recently. Stevia was cultivated in southern England during the Second World War as a possible sugar substitute (Lewis 1992). In 1971, seeds of stevia were brought from Brazil to Japan (Crammer and Ikan 1986). In the 1970's a Japanese

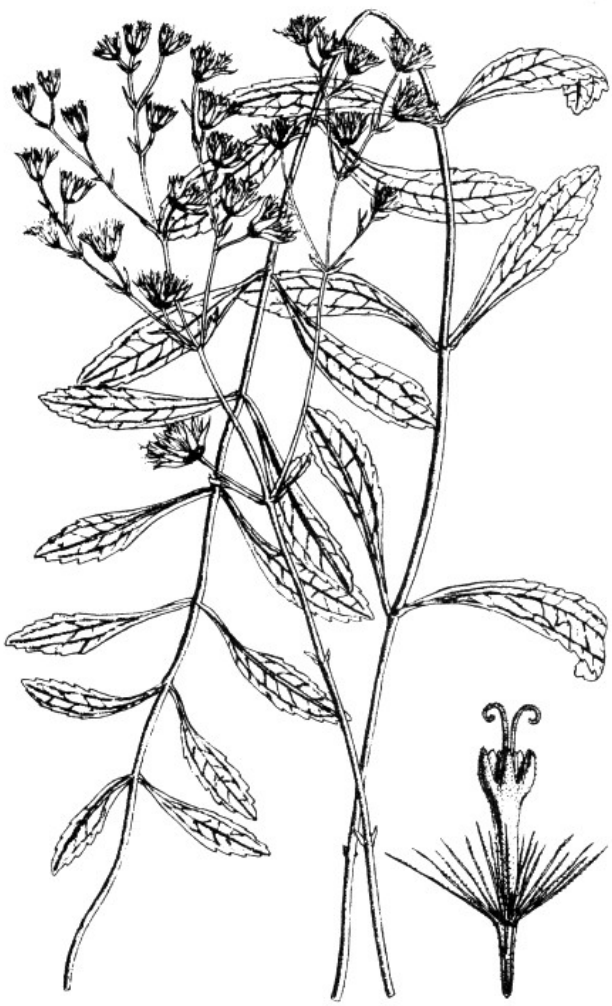


Fig. 374.
Stevia *(Stevia rebaudiana)*, from Hooker (1909).

consortium was formed to commercialize stevioside and extracts from *Stevia* (Kinghorn and Soejarto 1985), giving considerable impetus to the marketing of the plant.

Surveys of several dozen other species of *Stevia* have failed to turn up another species with the sweetening power of *S. rebaudiana* (Soejarto et al. 1983).

Uses

In South America, whole or ground dried leaves are employed as a sweetener, and the liquid obtained after soaking the leaves in water is used to make preserves (Facciola 1990). The leaves are sometimes chewed. Manufacturers have incorporated powdered stevia into herbal tea preparations (Facciola 1990). Two or three leaves are considered sufficient to sweeten a cup of coffee or tea, and it is recommended that once sweetened, the leaves be removed.

Stevioside from stevia is used commercially to prepare sweeteners. These tend to have a bitter metallic aftertaste, limiting their use. New technologies are under development to produce a more acceptable sweetener for use in beverages and baked goods. In Japan, stevioside is used to sweeten diet soft drinks, sugarless gum, soy sauce, pickled vegetables, and confectionary products, while in Brazil some yoghurts are sweetened with stevia (Crammer and Ikan 1986; Duke and duCellier 1993).

There is an active discussion on the internet concerning the prohibited status of stevia in the U.S., with frequent advice on where to obtain (from U.S. suppliers) and how to use stevia for culinary purposes. According to one internet listing, "The U.S. Food and Drug Administration's import alert allows stevia to be sold only if labeled as a dietary supplement - not as a sweetener. But (just between you and us) once you buy it, you can go ahead and use it however you'd like." [Stevia's alleged "dietary supplement" value is as a skin care tonic.] Some additional [June 1996] internet-obtained information follows. To some, stevia has a slight licorice flavor, which often requires getting used to. Stevia may be purchased as cut or powdered dried leaf; as a crude green powder; or as a brownish liquid extract with a strongly, unpleasant licorice-like taste. Using the powder directly is inadvisable because the sweetening power is so high people put in too much and find that it is just too sweet. The white powder may be made into a liquid concentrate by dissolving it in water (about a 10% solution by volume - 1 teaspoon powder: 3 tablespoons water), which is best stored in the refrigerator and dispensed from a dropper bottle. One teaspoon of this solution is approximately equal to a cup of sugar. Stevia-baked goods do not brown very much, and may be checked for doneness by touching and not by color. Stevia blends well with citrus fruit flavors such as lemon and cranberry.

Recipe Sources

None located, although Marsolais (personal communication) recalls having seen a recipe book devoted to stevia. The internet provides references to recipes for stevia in cookbooks of very limited availability.

Importance

Stevia is cultivated commercially in Taiwan, Laos, Thailand, Korea, Japan, Malaysia, Indonesia, China, Brazil, occasionally in Paraguay, and to a minor extent in the southeastern U.S. (Handro and Ferreira 1989; Duke and duCellier 1993). Stevia sweetening agents are consumed in Brazil, China, Israel, Japan, Korea, and Paraguay (Crammer and Ikan 1986). Several industrial procedures for extraction, purification, improvement of taste, and use of stevia extracts in food were patented in Japan, where stevia sweeteners are used in a wide range of foods (Handro and Ferreira 1989). About 2000 t of stevioside sweetener are produced annually in Japan, at a price of at least $80.00/kg (U.S.). Considerable research and commercialization efforts are underway in Canada. About 4 ha were grown in the Delhi area of Ontario in 1996.

Cultivation Notes

Soil

In its native habitats, stevia occurs typically on infertile acid sands and mucks with shallow water tables (Shock 1982*a*) and a pH of 4-5 (Duke and duCellier 1993). However, it will grow well on less acid to neutral soils; a pH of 6.5-7.5 has been found to grow stevia well (Shock 1982*a*). Duke and duCellier (1993) reported the pH tolerance range as 4.0-8.0. Stevia has a low nutrient requirement, and the plants are intolerant of salt (Shock 1982*a*). In its native habitats, characterized by infertile soils, stevia competes well with other vegetation adapted to infertile substrates. However, in cultivation weeds grow faster, and stevia is accordingly poorly adapted to compete with weeds.

Climate

The native climate of stevia is semihumid subtropical, with temperatures ranging from -6°C to 43°C, averaging 24°C (Brandle and Rosa 1992). Hard frost kills the roots, which will recover from mild frost (Duke and duCellier 1993). Frequent shallow irrigation is required (Shock 1982*a*). Stevia is a short-day plant (Brandle and Rosa

1992), flowering in the shortening days of fall in northern North America. The long daylight periods of northern climates prolong vegetative growth, which is agronomically advantageous in producing more leaf tissue compared to stem tissue (Brandle and Rosa 1992). Duke and duCellier (1993) stated that this tropical plant could only be grown in the U.S. in the extreme southern parts of the most southern and western states, but this is true only for growing the plants as perennials. Stevia can be grown as a perennial in some regions of Canada, for example in the Fraser Valley of British Columbia (Mazza, personal communication).

Propagation and Cultivation

Stevia can be propagated by seed and also by division of the crown (Bois 1934). Plants are most economically reproduced by seeds, but propagation by cuttings and suckers is easily achieved (Duke and duCellier 1993). In the wild, branches trampled by cattle often root and produce new plants. Seed production has been reported to be erratic (Duke and duCellier 1993). Cross-fertilization seems essential, and the plants will not serf-pollinate (Duke and duCellier 1993). Handro and Ferreira (1989) reported that about 10-15% of the seeds germinate, but Marsolais (personal communication) notes that up to 80% germination occurs. In its native Paraguay stevia shoots usually die after maturing, or are killed by frost, with new growth arising from tillering at the base of the plant. While stevia is a perennial crop in its native area and in some other areas of the world, it is grown as an annual crop in temperate regions (Brandle and Rosa 1992).

Yield of sweet compounds differs depending on agronomic practice (Shock 1982*a*) and method of propagation (Tamura et al. 1984). Experimental plants at Delhi, Ontario, Canada produced concentrations of stevioside that were higher than those obtained in subtropical regions, but comparable to levels produced in Japan (Brandle and Rosa 1992). This may have been related to the long daylight period in Japan and Canada relative to the shorter days of stevia's native homeland of Paraguay. Long days have been shown to produce up to a 50% increase in stevioside concentration compared to plants grown under short days (Metivier and Viana 1979).

For those contemplating growing and harvesting their own plants, the dangers of residues from pesticide use should be noted, as with other herbs.

Harvest and Storage

Grown as a perennial, maximum leaf production occurs in 3 or 4 years, and multiple harvests are possible (Duke and duCellier 1993). Leaf yields as high as 3000 kg/ha have been achieved in Canada (Brandle and Rosa 1992). In 1996, weather conditions were considered favorable in Ontario, and the yield was 2500 to 3000 kg/ha. In California, a single cutting harvested 9 t/ha dry matter, equivalent to 250 kg/ha stevioside (Duke and duCellier 1993). In Paraguay, leaves are gathered just before flowering (Duke and duCellier 1993). Tobacco kilns can be used to dry stevia commercially (Van Hooren and Lester 1992). Once dried, stevia will keep indefinitely without loss of sweetening power. Duke and duCellier (1993) report that stevia leaves collected in 1940 still make a satisfactory sweetener of coffee.

Example Cultivars

Kakehashi (Japanese), Suweon 2 (these are not generally available and are only propagated by cuttings; Marsolais, personal communication).

Additional Notes

Soejarto et al. (1983) have pointed out the danger of genetic erosion and loss of germplasm as a result of developments in the native range of stevia in Paraguay. Large portions of the natural subtropical forests surrounding the natural populations of *S. rebaudiana* have been extensively and indiscriminately harvested for timber, and the cleared land used agriculturally. Thousands of individual plants have also been transplanted to start plantations.

Chemistry

Eight diterpene glycosides with sweetening properties have been found in leaves of *Stevia* (Brandle and Rosa 1992). The biosynthetic pathway of these has been partly worked out (Shibata et al. 1991). The four major components (with sweetness relative to sucrose in parentheses) are stevioside (210), rebaudioside A (242), rebaudioside C (30), and dulcoside A (30) (Kinghorn 1987). Stevioside is low-calorific, non-fermentable, stable at high temperatures (100°C) and over a range of pH (3-9), and does not darken when cooked (Kinghorn and Soejarto 1985; Crammer and Ikan 1986). It does not serve as food for mouth bacteria (Duke and duCellier 1993). Stevioside has an unpleasant aftertaste, but is converted to some extent in the plant to rebaudioside A, which has less of an aftertaste (Handro and Ferriera 1989). Canadian researchers have recently developed cultivars rich in rebaudioside A (Mazza, personal communication). The leaves contain 7.8% tannins (Duke and duCellier 1993), so that raw leaves used as a sweetener in teas could contribute significant tannin. The natural plant hormone gibberellic acid is also present in the leaves, but not in commercial quantities (Duke and duCellier 1993). However, steviol can be used to produce

gibberellic acids, and several patents for the use of stevioside and derived compounds as plant growth regulators have been registered in Japan (Handro and Fereira 1989).

The essential oil (not of commercial importance) of stevia was examined by Martelli et al. (1985). The essential oil (constituting only about 0.025% of the dried leaves) contained more than a hundred compounds; 43% of the oil was accounted for by caryophyllene oxide and spathulenol.

Medicine

In Paraguay *S. rebaudiana* is used as a tea for the treatment of diabetes, apparently following reports in the literature that the plant is hypoglycemic (reduces blood sugar levels) (Soejarto et al. 1983). A variety of other physiological effects have been reported, but not confirmed (Duke and DuCellier 1993). Haebisch (1992) accepted literature reports that stevia is useful for treating obese diabetics and heart patients, but recommended that high doses should be avoided in the pharmacological control of diabetes and cardiovascular disorders.

Kinghorn and Soejarto (1985) concluded that stevioside and extracts of *Stevia* are safe for human consumption. Adverse reactions from human use of stevia products had not been reported as of 1985 (Kinghorn and Soejarto 1985). Planas and Ku (1968) found that an extract of the leaves had an antifertility effect in female rats, but this could not be confirmed by Akashy and Yokoyama (1975), or Oliveira-Filho et al. (1989). These authors stated that Paraguayan Matto Grosso Indian tribes use stevia as an oral contraceptive. The women daily drink a decoction in water of powdered leaves and stems to achieve this purpose. This alleged contraceptive activity of the plant "remains a controversial issue" (Duke and duCellier 1993). Crammer and Ikan (1986) suggested that the antifertility effect is due to certain flavonoids and their monoglycosides, and not to stevioside. Toskulkao et al. (1994) reviewed and provide evidence that stevioside caused nephrotoxicity (liver damage) in experimental rodents. Pezzuto et al. (1987) found the aglycone steviol could be mutagenic in bacteria. Tateo et al. (1990) stated that although the glycosides of stevia do not appear to show toxic or mutagenic activity they may degrade to aglycone steviol in vivo (i.e. in the body), which may be both toxic and mutagenic. There is no evidence that stevioside is metabolized into steviol in humans. Stevioside has reduced the blood pressure of rats (Melis and Salnatl 1991).

Nutrition

There are no reports of stevia adding significant nutrients to diet, and of course this sweetener makes a virtue of being low-calorific.

Curiosities

• *Stevia* was named for P.J. Esteve (died about 1566), a Professor of Botany at Valencia Spain (Huxley et al. 1992). The specific epithet *rebaudiana* commemorates the chemist Rebaudi, the first to study the chemical characteristics of the species (Handro and Ferreira 1989).

• There is intense competition for the sweetener market between natural and synthetic sweetening agents. The possible economic advantages of chemically synthesized sweeteners are indicated by cyclamates which, before they were banned in the U.S. in October of 1970, reached a production figure of 272 000 t/year. Ten cents worth of cyclamate had the sweetening power of a dollar's worth of sucrose (Crosby and Wingar 1979).

• A wild bramble of China, *Rubus suavissimus* S. Lee (*R. chingii* Hu), produces *rubusoside*, an intensely sweet compound structurally related to some of the sweetening chemicals of stevia (Kinghorn 1987).

• Still another interesting species with potential as a natural sweetener is *Thaumatococcus daniellii* (Benn) Benth., a herbaceous perennial of Sierra Leone and Guinea. Proteins extracted from its fruit are 2000-3000 times sweeter than sugar (Verlet 1990).

• One of the most interesting plants known for its sweetening properties is *Synsepalum dulcificum* (Schum. & Thonn.) Daniell ex. S. Bell, a shrub native to tropical West Africa, known as the miraculous fruit. Its "miraculous berries" contain a glycoprotein called miraculin, that is not sweet, but changes the flavor of acid foods such as lemon and rhubarb into a delicious sweetness (Crosby 1976). An ambitious attempt to market miracle fruit chewing gum and other products in the U.S. ended in 1974 when the Food and Drug Administration banned the sale of all miracle-berry products (Tripp 1985).

Problems and Potential

Stevioside from stevia appears to have considerable potential as a base for manufacturing of sweeteners. Diet-conscious consumers could be attracted to stevia sweeteners since they are derived from a natural source, in contrast to

synthetic sweetening agents. In Canada the species is under investigation as a new diversification crop by Agriculture and Agri-food Canada, particularly at the Pest Management Research Centre, Delhi, in southern Ontario, where the plant has potential as a tobacco replacement crop for sandy soils. Considerable breeding and technology development are required to turn stevia into a commercial crop suited to North America. Yield improvements are possible by selection and breeding for stevioside content, leaf to stem ratios, and plant response to fertilization (Shock 1982*a*). The low fertility and great variability of the plants pose difficulties for generating a uniform, high-quality crop; these difficulties can be overcome by vegetative production, which requires development. Because of a general suspicion about possible harmful effects of alternative sweeteners, stevia will have to meet health regulatory requirements. In 1991, the American Food and Drug Administration (FDA) issued an import alert, stating that stevia leaf was an unsafe food additive, thereby banning it from importation and use in the U.S. (Blumenthal 1992*b*). The alert read "Available toxicology information on *Stevia* is inadequate to demonstrate the safety of this substance as a food additive or to affirm its status as GRAS" [Generally Recognized as Safe]. The American Herbal Products Association has petitioned the FDA, stating that "stevia is not a 'food additive,' but a food ingredient used in foods before 1958 and so exempt from the FDA alert" (Blumenthal 1992*b*).

Selected References

Kinghorn and Soejarto (1985); Handro and Ferreira (1989); Brandle and Rosa (1992); Duke and duCellier (1993).

Symphytum

Family: Boraginaceae (borage family)

Genus Notes

Symphytum has about 35 species of perennial herbaceous plants native from Europe to the Caucasus and Iran. The closely related *Borago* (borage) is also discussed in this book.

Warning

The comfreys are potentially highly toxic and should not be consumed. Recommendations in texts and by herbal suppliers to eat or use these plants internally for medicinal purposes should be disregarded.

Symphytum Officinale L.

English Names

Comfrey
Also: alum, ass ear, back wort, black root, black wurt, blackwort, boneset, bruisewort, common comfrey, consoleda, consound, great(er) consound, greater comfrey, gum plant, healing herb, knitback, knitbone (knit-bone), slippery root, wallwort
[Many of the above names are from Hyde (1974). Some species of *Eupatorium* are also called boneset. One of these, *E. perfoliatum* L., is found in eastern North America and, like comfrey, is sometimes used to brew a herbal tea.]

French Names

Family: Boraginacées, famille du myosotis, famille de la bourrache
Consoude officinale (f)
Also: confée, confière, consire, console, consolide, consoude, consoude commune, consyre, grande consire, grande consoude, grande consyre, herbe à la coupure, herbe aux charpentiers, herbe aux coupures, herbe du cardinal, langue de boeuf (langue-de-boeuf), langue de vache (langue-de-vache), oreille(s) d'âne (oreille-d'âne), oreille d'asne (oreille-d'asne), oreille(s) de vache (oreille-de-vache), paquête, peton, pecton, symphyte officinal

Description, Taxonomy, and History

Symphytum officinale is a perennial herb that can grow to 1.2 m in height. The flowers may be white, blue, yellow, purple or rose, and are produced in curling flower clusters. Leaves and roots have been considered to be the important parts of the plant. The leaves at the base of the plant are often about 30 cm long by about 12 cm wide, and become progressively smaller up the plant. Loewenfeld and Back (1974) described the taste of comfrey leaves as somewhat bitter but quite edible. The root is oblong, fleshy, black on the outside and whitish within. Stephens (1978) described the juice of the root as clammy and tasteless. Comfrey is a native of Europe, western Siberia and Asia Minor, and has been introduced into many temperate areas of the world. It commonly grows in moist habitats, near ditches, riverbanks, and edges of woods. It has become established along damp roadsides and in waste places in many American states and in most Canadian provinces.

Comfrey has been regarded as an important medicinal plant since ancient times. Indeed, the genus name has been attributed to the Greek *syn* (meaning "together") or *symphyo* ("to unite"), and *phyton* (meaning "plant") in allusion to the apparent healing powers of the plant (Phillips and Foy 1990; Huxley et al. 1992). Many common names also allude to the healing powers of comfrey, such as knitbone, bruisewort, and boneset.

Comfrey also has been used as a culinary herb, and was popular in past generations in Europe (Quelch 1946). It is not commonly consumed today, although its use as a tea has persisted.

Uses

In the past comfrey leaves were considered edible. Young leaves were chopped and added to salads, cooked as a potherb, or used in soups, sautés, pastas, and au gratin dishes (Facciola 1990). Mature leaves were used to flavor cakes and a sauce base called panada (Morton 1976). Blanched stalls were eaten like asparagus. In Germany a comfrey butter was made in Bavaria and the roots were used for flavoring country wine (Stobart 1977). Leggatt (1987) recommended comfrey flowers as an edible decoration in her recipe for cold cheese Alexander. Dried leaves and roots were used to brew tea, and roasted roots were mixed with those of chicory and dandelion and used as a coffee substitute (Facciola 1990). Wine was also made using comfrey (Quelch 1946).

Comfrey has a quick, lush growth and has been extensively used as a fodder plant (Mansfeld 1986). However, this practice is not recommended in light of the toxic chemicals. The plant is regarded as an excellent composting material, rich in potassium, phosphorus, calcium, and nitrogen (Huxley et al. 1992). The fresh foliage, mixed with water, and steeped for a week has been used as a green manure "tea" for watering tomatoes, root crops,

Fig. 375.
Comfrey *(Symphytum officinale)*, from Köhler (1883-1898).

cucumbers, and squash crops (Lima 1986). Such "comfrey water" is quite malodorous (Huxley et al. 1992). Fresh leaves and flowers of comfrey produce yellow and orange dyes, sometimes used in the past (Garland 1979). Comfrey is an attractive ornamental, the only really practical use for the plant in home gardens at present.

Recipe Sources

Muenscher (1978), Michael (1980), Sczwawinski and Turner (1978), and Launert (1981) each give several recipes for comfrey. In view of its toxicity, comfrey should not be used as a culinary herb.

Importance

Traditional culinary usage has largely been abandoned in view of the health problems associated with the toxicity of comfrey. Comfrey is still sometimes grown as a fodder crop, although Russian comfrey, treated below, is more popular.

Fig. 376.
Comfrey *(Symphytum officinale)*,
from Syme et al. (1863-1886).

Fig. 377.
Comfrey *(Symphytum officinale)*,
from Nicholson (1885-1889).

Cultivation Notes

Soil

Comfrey grows well on deep, well-manured soil (Huxley et al. 1992). It thrives in any moist, fairly rich garden soil (Crockett and Tanner 1977). Reported pH tolerance ranges are 5.5-8.7 (Duke 1979) and 5.3-8.7 (Simon et al. 1984).

Climate

Comfrey is reported to grow best between 6 and 25°C (Simon et al. 1984). Erichsen-Brown (1975) stated that the roots will survive -40°C in winter. The plant is often found wild near rivers, reflecting its adaptation to moist environments (Simon et al. 1984). Comfrey grows best in full sun, but tolerates partial shade.

Propagation and Cultivation

Comfrey is usually grown from seeds, but can also be reproduced from root cuttings. Even small pieces of severed roots can form new plants (Lima 1986). Comfrey is offered as seeds or living plants in Canadian and U.S. garden catalogs.

Harvest and Storage

Bubel (1972) provides advice on harvesting and storage of comfrey for culinary purposes. However, this information is not given here as comfrey should not be eaten.

Example Cultivars

Huxley et al. (1992) list the ornamental cultivars Bohemicium and Variegatum.

Additional Notes

Chemistry

The major constituent of comfrey is mucilage (Winship 1991). Comfrey contains pyrrolizidine alkaloids, including 7-acetolintermedine, lycopsamine, echimidine, and heliosupine (Huxtable et al. 1986). The roots contain up to ten times greater concentrations of the chemicals than the leaves. Accordingly, for many years in Canada comfrey root products were not accepted for medicinal applications, while leaf preparations were (Awang 1991). Mature leaves have been shown to have lower concentrations of the alkaloids than young leaves (Steuart 1987). The roots also contain allantoin, symphytine, echimidine, isobaurenol, ß-sitosterol, tannins, and lasiocarpine (Simon et al. 1984). Comfrey contains up to 27% -linolenic acid (gamma-linolenic acid, or GLA) in the seed oil (Hansen et al. 1991).

Medicine

The medicinal uses of comfrey in traditional folk medicine are numerous. It has been highly regarded for helping to set bones and heal wounds, cuts, swellings, ulcers, sprains, and bruises (Phillips and Foy 1990). Compresses were made from fresh, grated, or dried powdered roots mixed with water and applied to the afflicted area. Comfrey was also consumed internally. A decoction of comfrey root was used to treat ulcers and respiratory ailments. Numerous other ailments treated with comfrey are detailed by Awang (1987).

For many years comfrey was commonly taken internally and externally in traditional medicine for many medicinal purposes (Awang 1987). However, the pyrrolizidine alkaloids are hepatotoxic (harmful to the liver) and some have been shown to be carcinogenic (Huxtable et al. 1986). Deaths have resulted from consumption of comfrey herb and/or comfrey capsules, although it is often unclear whether comfrey or Russian comfrey was consumed (Awang 1991). Hepatic veno-occlusive disease (the Budd-Chiari syndrome, whereby veins in the liver block up with consequent severe damage to the liver) is a result of pyrrolizidine toxicity (Huxtable et al. 1986). Numerous brands of comfrey-pepsin capsules and tablets have been sold in health food stores in developed countries as a digestive aid. However, it is inadvisable to use comfrey or other species of *Symphytum* for any internal use.

Comfrey contains considerable tannin (ca. 2.4% of dried leaves, 8-9% in fresh leaves), so much so that it was once used to tan leather (Awang 1987). The tannins are responsible for the astringent healing properties of the plant (Simon et al. 1984). Tannins (also present in common tea) have been suspected of being linked to cancers of the digestive system (Morton 1975), providing another reason for avoiding comfrey consumption.

Legislation has been passed in Canada preventing the inclusion of comfrey in teas or medicines for internal use (Snider 1991). Similar legislation has more recently been passed in Britain (Anon. 1993*a*). In the U.S. and Germany, comfrey continues to be marketed, often in health food stores despite its well-documented toxicity (Tyler 1993). "It is most unfortunate that this poisonous herb continues to be sold to uninformed consumers by organizations that are ostensibly interested in promoting the good health of their customers" (Tyler 1993).

Comfrey contains allantoin, which promotes cell proliferation, and may be responsible for some healing capacity of the plant. Allantoin is demulcent (capable of soothing and protecting abraded mucous membranes) (Simon et al. 1984). The roots contain 0.6 to 0.7% allantoin, the leaves about 0.3% (Tyler 1993). The high mucilage content (up to 29% in the roots) is probably also responsible for the demulcent property of comfrey (Awang 1987).

Gamma-linolenic acid which is present in the seed oil is useful in the treatment of pre-menstrual tension, rheumatoid arthritis, and breast disorders, and is particularly effective for atopic eczema (Gibson et al. 1992). This chemical is obtained commercially mostly from cultivated evening primrose (*Oenothera biennis* L.) and borage (*Borago officinalis*). Much additional information on GLA is found in the discussion of borage in this book.

Comfrey is an ingredient of various cosmetic preparations, such as skin creams, bath oil, eye lotion, ointments, and hair products, and has been promoted as a skin conditioner (Awang 1987). As noted above, the allantoin content does have a healing action. "There appears to be little if any risk in the external use of comfrey preparations, since the potentially damaging pyrrolizidine alkaloids are converted into toxic metabolites only after ingestion" (Awang 1987). However, there has been some indication that pyrrolizidine alkaloids can be absorbed through the skin of animals (Huxtable et al. 1989).

Nutrition

Comfrey contains considerable vitamin B_{12}, though not as much as provided by the customary natural source, liver (Tyler 1993). This vitamin is rare in plants, and it was once suggested that comfrey might be invaluable for vegans (vegetarians who eat no animal products at all, and who should take supplements to obtain sufficient amounts of this vitamin) (Halpin 1978). Comfrey is also rich in

potassium, phosphorus, and calcium (Huxley et al. 1992). Given the poisonous potential of comfrey, the nutritional advantages seem academic.

Curiosities

• Exaggerated stories were told of the powers of comfrey to restore flesh and bone. Minced meat was said to become steak when boiled in a pot with comfrey, and virginity could be restored by taking a comfrey bath (Garland 1979). Mexican midwives still use comfrey to heal vaginal tears (Castleman 1991).

• As noted above, allontoin in the roots of comfrey may actually promote healing. In the past, some types of wounds that did not respond readily to medical treatment were healed by the application of the maggots of the sheep blow fly (*Lucilia sericata*) to the wounds. This revolting treatment was effective apparently because of the presence of allantoin in the maggots (Launert 1981).

• It has been estimated that about 3% of the world's flowering plants produce hepatotoxic (poisonous to the liver) pyrrolizidine alkaloids (Awang 1987).

• As pointed out above, both *Eupatorium perfoliatum* and *Symphytum officinale*, species which are quite unrelated, are called boneset. Both have an extensive history of use in herbal medicine, and as a tea. Curiously, like comfrey, *E. perfoliatum* is believed to have dangerously toxic levels of pyrrolizidine alkaloids (Locock 1990).

• In the introduction to this book it is noted that the foxglove plant (*Digitalis purpurea*) is the source of the drug digitalis, used in the treatment of heart disease; and cases of accidentally using it instead of comfrey to make tea have led to fatalities. Ironically, comfrey has been used deliberately to adulterate digitalis (Grieve 1931).

Problems and Potential

Comfrey should not be used as a culinary or forage plant in view of its toxicity. At present it does not seem to have legitimate culinary or medical commercial usefulness.

Selected References

Ingram (1961); Simon et al. (1984); Awang (1987, 1991); Huxtable et al. (1986); Winship (1991); Tyler (1993).

Fig. 378.
Russian comfrey *(Symphytum ×uplandicum)*,
from Nicholson (1885-1889).

Symphytum Xuplandicum Nyman

English Names

Russian comfrey
Also: blue comfrey, New Zealand comfrey, prickly comfrey, Quaker comfrey
[The name prickly comfrey is more commonly applied to *S. asperum* Lepechin. = *S. peregrinum* Ledeb., which grows naturally from Caucasia to Armenia and northern Iran.]

French Names

Consoude russe (f)
Also: consoude de Russie, consoude voyageuse
[*S. asperum* = consoude à feuilles rudes]

Russian comfrey is a natural hybrid between *S. officinale* and the rather similar *S. asperum*. It is a herbaceous perennial, and grows as tall as 2 m. This native of the Caucasus has become naturalized in many countries of Europe. It can be grown in colder, more northern climates than comfrey. Before it became widely known that comfreys contain toxic constituents, Russian comfrey acquired a reputation as an excellent fodder plant (Hills 1953). Like comfrey, it has been used for medicine and as a culinary herb. Facciola (1990) summarized culinary uses of the plant. Young leaves have been boiled or steamed and served like spinach, and have been used in tea. Liquidized leaves have been consumed as "green drink." Leaves have been dried to a green flour which has been used in gravies, soups, and stews. Hills (1953) gives recipes for (Russian) comfrey soup, soufflé, and comfrey au gratin. Two cultivars, Bocking 4 and Bocking 14 (= Webster's) are recorded by Facciola (1990), the first "recommended for use in liquidized *green drink*." Bocking 14 is a sterile clone that must be propagated by root cuttings (Huxley et al. 1992). **Russian comfrey contains similar toxic chemicals to those of comfrey, and should never be consumed.** Huizing et al. (1982) found that echimidine, likely the most toxic of *Symphytum* pyrrolizidine alkaloids, is not present in common comfrey (*S. officinale*), but is present in prickly comfrey (*S. asperum*) and its hybrid, Russian comfrey. Awang et al. (1993) found that nine of 13 commercial comfrey products sold in Canada contained echimidine, despite legislation forbidding the sale in Canada of products containing this alkaloid.

Russian comfrey can be grown as an ornamental, the only use that can be recommended at present. Seeds and living plants are obtainable through Canadian and U.S. garden catalogs.

Additional Notes

Curiosities

• The story of how Russian comfrey came to be called Quaker comfrey has been detailed by Mathieu (1978). Henry Doubleday (1813-1902), an American Quaker minister and farmer, read a report that the juice of *Symphytum peregrinum* was very mucilaginous and could be mixed with gum arabic to produce a glue for stamps; at the time, self-gluing stamps were unavailable. He wrote to the head gardener at the palace in St. Petersburg, Russia, requesting seeds, and by chance was instead sent the seeds of Russian comfrey, *Symphytum uplandicum*. The glue project failed, but Doubleday worked tirelessly in the hope of developing Russian comfrey into a major agricultural crop. A non-profit organization called the Henry Doubleday Research Association was formed in 1954 in honor of this Quaker who did so much for the crop that many until quite recently felt "could lift the world out of its chronic highgrade protein shortage." Some cultivars produce considerable protein, and it is possible to prepare pyrrolizidine-free protein extract (Awang 1987), so that comfrey retains the potential for one day becoming an important food crop.

• Echimidine, perhaps the most toxic of *Symphytum* pyrrolizidine alkaloids, was first isolated from *Echium plantagineum* L. (Patterson's curse, salvation Jane) in Australia, where concern has been expressed over the potential toxicity of honey from bees feeding on the plant's flowers (Culvenor 1956; Awang et al. 1993).

• A farmer in Spokane, Washington, disgusted with the poor crop he grew, sued the salesman who had convinced him that comfrey is a "miracle crop." The judge ordered the salesman to return half of the money he had charged, and advised the farmer to chalk the other half up to experience (Hart 1976).

Selected References

Hills (1953, 1954, 1976); Simon et al. (1984). (Also see references for comfrey.)

Tagetes

Family: Compositae (Asteraceae) (sunflower family)

Genus Notes

Tagetes has close to 60 species of annual or perennial herbs and shrubs, native to the cool tropics of the New World (Soule, personal communication). The genus is particularly diverse in two regions: south-central Mexico, and Argentina (Soule, personal communication). The flowering heads and leaves of all species are copiously dotted with glands which produce pungent oils, esters, thiophenes, and phenols (Neher 1968; Soule 1993*a*). Species of *Tagetes* possess chemicals that repulse or kill herbivorous insects, nematodes, fungi, and bacteria. "Marigold" is part of the name of species in several genera. In Canada and the U.S., most ornamental "marigolds" are species of *Tagetes*. Bailey and Bailey (1976), the most authoritative encyclopedia of horticultural plants of the U.S. and Canada, lists six species of *Tagetes* that are grown as ornamentals. As noted below, all of these are also used for culinary purposes.

Tagetes tenuifolia Cav., has some cultivars known as lemon marigold, which have a pleasant citrus-like flavor, and can be added sparingly to salads, sandwiches, desserts and wines (Facciola 1990; Richters 1994). This is sometimes called "striped Mexican marigold," a name which could be confused with Mexican mint marigold, discussed below. Belsinger (1991) and Barash (1993) calls this "signet marigold." Barash (1993) has seven recipes for this species. She notes that "the flavor of the signets is the best of any marigolds, almost like a spicy tarragon," and that "I have tasted other marigolds over the years, and the flavor of some is actually repugnant."

Tagetes erecta, African marigold, also known as American marigold, big marigold, and (occasionally) Aztec marigold, is widely grown as an ornamental. Flowers of African marigold are used to produce a yellow dye sometimes employed to color butter and cheese, and to adulterate saffron. In parts of the world, notably in Peru and Mexico, the species is cultivated as a source of pigment for poultry feed (Medina and BeMiller 1993), and is imported into the U.S. for this purpose (Morton 1981). In India and Pakistan the flowers and roots are employed extensively in home dyes among the poor (Neher 1968; Soule 1993*a*). The flowers of some cultivars, such as Yellow Climax, are edible (Facciola 1990), and the species is used in a beverage in parts of the southwestern

Fig. 379.
African marigold *(Tagetes erecta)*,
from Curtis (1787-present; #3830).

U.S. and Latin America (Soule 1993*b*). The adventurous may attempt to test the culinary merit of the petals of cultivars growing in their garden. In 1975, the Burpee Seed Company received a million dollars worth of publicity by awarding $10,000.00 to Mrs. Alice Vonk of Sully, Iowa, for discovering a white-flowered American marigold (Cox 1991).

Tagetes minuta L., known as Muster-John-Henry and stinking Roger, is native to South America, and naturalized in Africa, Australia, and the eastern U.S. Very rarely, it has been collected in Canada (Pringle 1986). The leaves

Fig. 380.
Mexican mint marigold *(Tagetes lucida)*, from Curtis (1787-present; #740).

are used to season soups, broths, meats, and vegetables, and an essential oil from the plant is employed commercially in ice cream, candy, baked goods, gelatin desserts, and soft (cola) drinks (Facciola 1990). The essential oil is known as "tagetes oil" (see Lawrence 1986*c* for detailed information). Verlet (1993) estimated the annual world value of "tagete" essential oil to be $225,000.00 (U.S.). This species is considered to merit investigation as a new herbal product for the U.S. (Soule 1993*b*).

Tagetes filifolia Lag., the Irish lace marigold found from Mexico to Argentina, is another ornamental marigold that is also used for flavoring. In Guatemala it is used to preserve "la concha," a clamlike mollusc sold in markets (Morton 1981). Venezuelans have used it to treat syphilis (Morton 1981). A beverage made with it is used to treat stomach complaints in Mexico and Argentina (Soule 1993*a*).

Species of *Tagetes* have been cultivated and extensively used by Native American tribes in Mexico, Central, and South America since pre-Columbian times, and almost every species of the genus has been used by Indigenous Americans in some practical way (Neher 1968; Soule 1993*a*). Some of the species were domesticated in pre-Columbian times (Soule 1993*a*).

Creasy (1988), apparently referring particularly to *T. erecta* and *T. tenuifolia*, and referring to floral not leaf material, stated "All marigolds are edible but most are unpalatable; the varieties best for eating are available only through mail-order seed companies," and "most marigolds taste awful." She recommends the cultivars Climax, Snowbird, Lemon Gem, Tangerine Gem, and Lulu. Barash (1993) wrote "Marigolds may be harmful in large amounts. Eat them occasionally and in moderation." She also noted that double marigolds are less flavorful than those with less showy flowers.

Tagetes Lucida Cav.

Scientific (Latin) Synonyms

T. florida Sweet, *T. schiedeana* Less.

English Names

Mexican mint marigold
Also: anisillo, chile marigold, cloud plant, false tarragon, marigold mint (the species superficially resembles mint, although the flavor is not similar), Mexican marigold mint, Mexican tarragon, mint marigold, sweet mace, sweet marigold, sweet-scented marigold, sweet-scented Mexican marigold, sweet-scented *Tagetes*, Texas tarragon, winter tarragon (England), yerba buena

French Names

Family: Composées, famille de la marguerite
Souci menthé du Mexique (m)
[French name coined for this book as none seemed available. Bois (1934), an extensive French work on condiment herbs, discussed this species but did not record a French common name for it.]

[In Mexico and Guatemala the plant is known as anisillo, coronilla, hierba anís, hierba de las nubes (from a Nahuatl word meaning cloud plant; the species grows in mountainous areas), pericón, and yerbanís. Morton (1981) presents an extensive list of foreign names.]

Description, Taxonomy, and History

Tagetes lucida is a sparingly branched herbaceous perennial, 30-80 cm (occasionally to a metre) tall, with glossy lance-shaped leaves and a somewhat woody base. In late summer a cluster of golden-yellow flower heads about 1 cm across are produced. The species is native to Mexico and Guatemala, and is cultivated in El Salvador, and Honduras. In the wild it occurs commonly in full sun in wet meadows, and occasionally in oak woods at elevations of 1000-3000 m (Soule 1993*a*). It is abundant during the wet season, and not evident during the drought season (Morton 1981). It has long been used in its native region for medicinal, culinary, ornamental, and religious purposes. Powdered Mexican mint marigold was added to the Aztecs' *chocolatl*, a foaming beverage made from cocoa beans (Morton 1976), The Tarahumara Indians of Chihuahua and the Huichol Indians of Jalisco and Nayarit employ the plant in healing rituals (Hutson 1987; Soule, personal communication). *Tagetes lucida* is still commonly associated with religious activities in Mexico and Guatemala (see Curiosities), and is often burned in ceremonies as an incense (Neher 1968). The species was cultivated in France and England in the 19th century as a tarragon substitute (Morton 1976; Soule, personal communication).

Uses

In the southern U.S., tarragon is often very difficult to grow because of its need for a cold winter period to break its dormancy, and because it dislikes hot, dry summers. Mexican mint marigold is often employed as a tarragon substitute (hence the name Texas tarragon). In Mexico the plant is used as a condiment in boiled green corn or chayote squash (Hutson 1987). The leaves are anise-scented, and complement salads, egg dishes, fish, quail, turkey, and other poultry dishes. The leaves are useful in vinaigrette

mixes, sauces, herbal butter, and herbal vinegar, and the sprigs make an attractive, edible garnish. The leaves can also be used to brew a pleasantly sweet and refreshing tea, and in fruit punches, sangría, and cider. The tea is diuretic (stimulating urination), taken without additions in Latin America, while "'gringos' usually prefer it with cream and sugar" (Neher 1968). Hutson (1987) notes that some dislike the taste of anise, and therefore the somewhat comparable flavor of Mexican mint marigold, which should accordingly be used sparingly by those wishing to experiment with the herb.

The smoke from burning flowers or plants has been used as a mosquito repellant (Morton 1981). In Mexico, dried, powdered plant material is used to repel or kill mosquitoes, hen lice, and other insects (Morton 1981).

Recipe Sources

Hutson (1987) gives recipes for: Tomatoes rellenos (tomatoes stuffed with corn and squash in mint marigold dressing), Mint marigold vinaigrette, Mustard and mint marigold chicken, Grilled catfish with smoked peppers and Mexican mint marigold, Pescado con hoja santa (red snapper or redfish fillets), Texas tarragon (Mexican mint marigold) vinegar (made with leaves and flowers), Mexican mint marigold butter, Quesitos, Mexican May wine, and Fiesta tequilla.

Importance

Mexican mint marigold is used as a native condiment in much of Latin America. Bundles of it are sold at public markets for use as a culinary herb and medicinal tea. The plant is cultivated in the U.S. and France as a garden flower (Morton 1981). In the southern U.S. it has limited but growing popularity. It has occasionally been used for food purposes in England since it was introduced in 1798 (Hedrick 1972; Morton 1981). It is employed in some specialty dishes in upscale restaurants in the southern U.S., and by a cheese company to produce a uniquely flavored gourmet cheese (Hutson 1987).

Cultivation Notes

Soil

Loose well-drained soil is required. Mexican mint marigold typically occurs on limestone soils, and grows well at a pH of 7.0-8.0 (Soule, personal communication).

Climate

Full sun is generally needed, although the plant will grow well in partial shade in very sunny areas such as Arizona and Texas (Soule, personal communication). Bois (1934) noted that when grown in temperate countries the plant needs to be sheltered during the winter. Tucker (1994) observed that the plant "just luxuriates in heat" and is hardy as far north as central Delaware.

Propagation and Cultivation

Mexican mint marigold is reproduced by seeds, which germinate in a few days [Hutson 1987; however, Richters (1994) says the seeds germinate slowly]. Seeds are available from nursery firms in Canada and the U.S. In northern climates the plants should be started early indoors, at least 6 weeks before planting. The plant is most easily established from root divisions. Cuttings rooted in water can also be used to reproduce Mexican mint marigold. In the warm climate of the southern U.S., where the species can be weedy, Mexican marigold mint left to go to seed will re-seed itself. In northern North America, the plants can be grown in pots, overwintered indoors.

Harvest and Storage

The herb can be picked fresh as needed, but can be dried, by hanging bunches in a well-ventilated room, and stored in jars. The plant is extremely gummy and resinous when dried (Morton 1981). According to Hutson (1987), some chefs prefer the dried form as the flavor is considered more "mellow."

Example Cultivars

Huichol (listed in Facciola 1990; a clone traditionally used by the Huichol Indians of Mexico)

Additional Notes

Chemistry

The essential oil of *Tagetes lucida* is primarily estragole (about 90%), with about 1% linalool (Tucker and Maciarello 1987; Tucker 1994). Arora (1989) reported that the oil has a pronounced odor and acts as a repellent to flies (see Uses). The plant contains acidic resin, gallic acid, tannins, glucose, pectin, gum, and mineral salts (Morton 1981).

Medicine

Tagetes lucida has been used medicinally in Mexico and Central America since before the time of the Conquistadores. In 1899 it was still one of the most widely used medicinal plants of western Mexico (Neher 1968). Mexican mint marigold is still more commonly used medicinally than for culinary purposes. As a tea, it is used to calm stomachs and nerves, cure colds, fever and hangovers, treat scorpion bites, and as an aphrodisiac (Neher 1968; Hutson 1987). Mexican marigold mint is used in Guatemala to treat gastrointestinal disorders (Cáceres et al. 1990; Girón et al. 1992) and respiratory diseases

(Cáceres et al. 1993). Other recorded uses include treating diarrhea, hiccoughs, spitting of blood, and removing ticks (Neher 1968), and aiding in childbirth and post-partum lactation (Soule 1993*a*). It has also been employed in folk medicine to treat malaria (Morton 1981). Experimental trials showed that it was ineffective in treating fever and diarrhea (Morton 1981).

Nutrition

No information found. Like essentially all other minty herbs, insufficients amounts are consumed to add to human nutrition.

Curiosities

• The generic name *Tagetes* is generally attributed to Tages, an Etruscan deity (Eutruscia was an ancient country of central Italy). The Romans changed the myth to state that the deity was a grandson of Jupiter, who is reputed to have taught the Etruscan priests the art of soothsaying (Bailey and Bailey 1976; Soule 1993*a*). Recent work indicates that Tages brought the Etruscians the religious and ritual codes for their entire civilization (Soule 1993*a*).

• According to a 16th century Aztec herbal, the following treatment was recommended for those struck by lightning (or who had used firewood struck by lightning - which was thought to cause some diseases): drink a hot potion of the leaves of six herbs, including *T. lucida*; and then cover the body with a plaster made of the six herbs plus the plants struck by the lightning (Neher 1968; Soule, personal communication).

• The ancient Aztec medical book mentioned above also gave instructions for crossing water without fear, which included rubbing the chest with juice from *T. lucida*, carrying the eyes of a large fish in one's mouth, and apparently carrying the head and viscera of an oyster (Neher 1968; Soule 1993*a*).

• The Aztecs used Mexican mint marigold in a mixture employed as a numbing powder blown on the faces of victims to calm them before their hearts were cut out and they were sacrificed to the sun god, in a great furnace (Neher 1968; Hutson 1987; Kubat 1988). The alleged anesthetic properties of the plant could not be verified by Neher (1968).

• Mexican mint marigold is significant in baptisms and other religious ceremonies in modem Mexico. It is also featured in the Mexican "Fiesta del Pericon," where it is offered and burned in churches, with bundles fastened in the form of a cross over doorways to repel the devil (Morton 1981).

• Dried leaves and flowers of Mexican mint marigold are smoked alone in pipes in Mexico, or with tobacco or hallucinogens, to reduce their harshness (Morton 1981).

• The respect with which Mexicans hold Mexican mint marigold is shown by their name *pericon*, meaning "fit for all uses" (Neher 1968).

Problems and Potential

Mexican mint marigold is a minor native culinary herb of Mexico that has aroused limited interest in the southern U.S. where it can be grown outdoors. In South America the plant is considered to have pharmacological potential. In the northern U.S. and southern Canada it can be grown as a garden curiosity and edible house plant. Conceivably it might have limited commercial potential in northern areas of North America as a greenhouse herb for the local restaurant market.

Selected References

Neher (1968); Hutson (1987); Soule (1993*a*).

Tagetes Patula L.

[J. Soule (personal communication; also see Soule 1993*a*) discovered that the type specimen of *T. erecta* L. is in fact a plant of *T. patula* L., and similarly the type specimen of *T. patula* L. is in fact a plant of *T. erecta* L. By the rules of nomenclature, this implies that the scientific names for the African and French marigold should be reversed from traditional, well-established usage. Taxonomists generally try to avoid such extremely disruptive and confusing name changes for well-known species, and although the technical process of conservation of the traditional names in question has not yet been proposed, the traditional usage is followed in this chapter.]

English Names

French marigold
Also: marigold
["Marigold" applies also to pot marigold (*Calendula officinalis*). See discussion ambiguity of the name "marigold" in Genus Notes.]

French Names

Souci (m)
Also: oeillet d'Inde français
[Souci refers both to species of *Tagetes* and to pot marigold, *C. officinalis*. See discussion of this in section on *Tagetes*.]

Description, Taxonomy, and History

The French marigold is an annual herb, 20-50 cm tall. It is a horticultural plant, originally bred in Mexico (Soule, personal communication). It was first introduced to Europe in 1573 (Perry 1974). Flowers of cultivars differ greatly in color and size. Hybrids with the African marigold are commonly grown as ornamentals. These are often called triploid varieties (since they have a double set of chromosomes from one parent and a single set from the other), and have relatively low seed germination rates (often 30-40%) (Cox 1991).

Uses

French marigold and its hybrids furnish numerous annual cultivars, among the most attractive and popular of all garden ornamentals. The species is considered ideal for rockery, edging, hanging baskets, and window boxes (Arora 1989). The petals of many cultivars are edible, and are consumed in the same manner as pot marigold, *Calendula officinalis*, discussed in detail in this book. The leaves are used in Latin America as a condiment, while the flowers are used to adulterate saffron, color butter and cheese, and prepare beverages (Facciola 1990; Soule 1993*a*).

In Hindu religious ceremonies in India, the French marigold is considered a "holy flower," and is used as an altar decoration (Neher 1968) and for ritual adornment (Soule 1993*a*).

Recipe Sources

Rose (1979) gives a recipe for Marigold wine. [Also see recipes for pot marigold (*Calendula officinalis*).]

Importance

French marigold is much less often used as food than pot marigold (*Calendula officinalis*), and is primarily grown as an ornamental. It is not grown commercially for culinary purposes, and is used only incidentally for food.

Cultivation Notes

Soil

French marigolds grow well in moderately fertile, well-drained soil, with a pH of 6.5-7.5. Very rich soils result in excess foliage and fewer blooms.

Climate

Plants should be grown in full sun, and watered during periods of drought or very dry conditions. Overwatering encourages disease and suppresses flowering. French marigold is not frost-tolerant.

Propagation and Cultivation

Plants are usually grown from seeds, started indoors in a warm (20-30°C), bright location. These should be transplanted outdoors after all danger of frost, when the soil is warm. Marigold seedlings tolerate being transplanted when small (5-10 cm tall). If starter plants in trays are purchased from a nursery, leggy, straggly plants with a flower or two should be avoided, while stocky young plants without open flowers are preferable. Once plants have reached the flowering stage, faded heads should be removed to prolong flowering.

Harvest and Storage

Recently opened flowers can be picked as needed.

Example Cultivars

A very large number of cultivars are available, many with doubled flowers, which as a rule are less suitable for culinary purposes than normal flowers. For descriptions of cultivars, see for example Bailey and Bailey (1976).

Fig. 381.
French marigold *(Tagetes patula)*,
from Nicholson (1885-89).

Additional Notes

Chemistry

Lawrence (1985*b*) provides an analysis of the chemistry of French and African marigolds. The principal components of the essential oil are tagetone, limonene, linalool, ocimene, and linalyl acetate. The French marigold possesses a class of compounds known as (acetylenic) thiophenes, which are found in many other species of the sunflower family (Bicchi et al. 1992). These chemicals kill insects, nematodes, fungi, and bacteria (Bicchi et al. 1992), as well as some viruses (Soule 1993*a*).

Medicine

In folk usage, an infusion of the whole plant has been used to treat rheumatism in Venezuela, and extracts of the plant have been employed to treat stomach problems in Mexico, Guatemala, Costa Rica and Argentina (Neher 1968; Soule 1993*a*). In India, leaf paste has been used externally against boils, carbuncles and earache, while flower extract has been considered to be a blood purifier, a cure for bleeding piles, and a remedy for eye diseases and ulcers (Arora 1989).

Nutrition

No information found. Such limited quantities are eaten that it is clear that there is no significant contribution to human nutrition.

Curiosities

• During the invasions of the Conquistadores in Mexico, marigolds were known as the "flower of death" (flor de muerto), springing up profusely on ground disturbed by war (Huxley et al. 1992). It was commonly believed that the herb arose from the blood of the natives killed by the Spanish invaders, who in fact had introduced the plant to the region (le Strange 1977). [The authors cited mistakenly refer to pot marigold, *Calendula officinalis* L., whereas the marigolds in question are likely *C. patula* and *C. erecta*.]

• The French marigold is one of the marigolds commonly associated with observance of All Saints Day (Nov. 1) and more especially All Souls Day (Nov. 2) in Latin America, and so is frequently called Flower of the Dead. The petals are often strewn on graves of relatives and on paths to guide the souls of dead family members to food and offerings placed on home altars (Neher 1968; Soule 1993*a*). Although part of the Catholic religious calendar, these celebrations coincide with indigenous religious practices retained from pre-Columbian times (Kaplan 1960).

• All species of *Tagetes* are American in origin. The "French marigold" (*T. patula*) was so-named because it became popular in France (Camp et al. 1957). Similarly the central American *T. erecta* acquired the name "African marigold" after it was imported to Africa and became popular in monastery gardens there (Camp et al. 1957).

Problems and Potential

The French marigold is primarily an ornamental, with a well-established commercial niche. The use of the flowers for food is confined to sophisticated home gardener-cooks. This herb has little prospect of increasing in culinary importance.

Selected References

Neher (1968); Lawrence (1985*b*); Cox (1991); Soule (1993*a*).

Fig. 382.
Feverfew *(Tanacetum parthenium)*, from Köhler (1883-1898).

Tanacetum

Family: Compositae (Asteraceae)

(sunflower family)

Genus Notes

There are about 70 species of *Tanacetum*, mostly scented annual or perennial herbs, some developing woody stems. The genus is native to north temperate regions of the world. A recent taxonomic revision of the genus *Chrysanthemum* has resulted in the transfer of several species to *Tanacetum*, including some of those mentioned below (Soreng and Cope 1991). Several species, including the following, are used as ornamentals or in traditional medicine.

Tanacetum parthenium (L.) Schultz-Bip. (= *Chrysanthemum parthenium* (L.) Berhn.), feverfew, is an aromatic perennial native to southeastern Europe. Several ornamental selections have been made. Feverfew has been used in traditional medicine to aid digestion and to relieve tension and pain from arthritis. Recent studies suggest that it may reduce the number and severity of migraine headaches (Awang 1989).

Tanacetum vulgare L., known as tansy and golden buttons, is an aromatic perennial native to Europe and temperate Asia. It is grown as an ornamental and has escaped from cultivation in North America. In Canada it is found along roadsides and fields in all Canadian provinces and the southwestern part of the District of Mackenzie (Scoggan 1978-79). In the U.S. it is a widespread weed from Canada to Mexico (Fernald 1970). The plant taints the milk and butter of dairy cows that consume it (Morton 1976). The leaves are said to repel insects. Teas of tansy leaves have been used for medicinal purposes, sometimes to induce abortion. In Victorian England, omelets, cakes, fritters, and other foods made with tansy were popular. Fox (1933) gives a recipe for tansy pudding. Michael (1980) gives 11 recipes. Unfortunately the plant contains a toxic essential oil (composed of monoterpenes, mostly thujone) that has a cumulative affect on the central nervous system. Continued internal use may lead to convulsions and death. In Victorian England, tansy tea was very popular as a tonic, but overdoses sometimes caused fatalities (Morton 1976). The oil has been used as a vermifuge and in some cosmetic preparations (Fuller and McClintock 1986), and is still used in some liqueurs (Morton 1976). There is considerable chemical variation, and there is interest in Europe in developing medicinal applications (Németh et al. 1994).

Fig. 383.
Tansy *(Tanacetum vulgare)*, from Bulliard (1784).

Tanacetum Balsamita L.

Scientific (Latin) Synonyms

Balsamita major Desf., *Chrysanthemum balsamita* (L.) L., *Chrysanthemum majus* (Desf.) Asch.

English Names

Costmary
Also: alecost, all spice [or allspice, a name reserved for *Pimenta diocica* (L.) Merrill], balsam herb, balsamita, bible leaf, costmarie, French sage, garden balsam, goose tongue, mace, mint geranium (mint-geranium), sweet Mary, sweet tongue
[Alecost is the only alternative name used today.]

French Names

Family: Composées, famille de la marguerite
Balsamite (f)

Also: balsamite à odeur sauve, balsamite du Levant, balsamite odorante, baum coq, baume des jardins, coq (des jardins), grande baume, grande tanaisie, herbe à omelette, herbe au coq, herbe coq des jardins, herbe Sainte-Marie, menthe à bouquet(s), menthe à coq, menthe de coq, menthe (de) Notre-Dame, menthe des jardins, menthe femelle, menthe grecque, menthe romaine, menthe-coq, pasté, paté, tanaisie baumière, tanaisie des jardins

Description, Taxonomy, and History

Costmary is an aromatic, rhizomatous, white-flowered, perennial herb which grows from 60 cm to as much as 2 m in height. It is native to western Asia, and was introduced to Europe several hundred years ago (Phillips and Foy 1990).A number of subspecies have been recognized. With cultivation, costmary has escaped throughout Europe and more recently parts of North America. In Canada, it

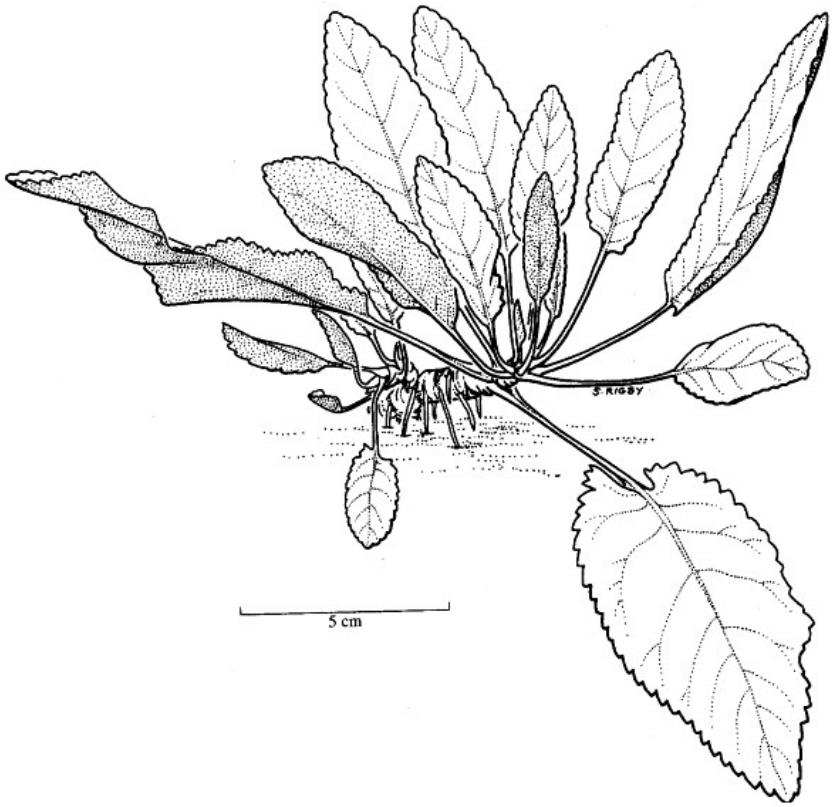


Fig. 384.
Costmary *(Tanacetum balsamita)*, vegetative plant, prepared by S. Rigby.
(Based on greenhouse plant from Richters.)

has become established in southwestern British Columbia, Saskatchewan, Ontario, Quebec, and Nova Scotia (Scoggan 1978-79). In the U.S. it is widely established in the southeast (Fernald 1970). Cultivated forms are indistinguishable from wild plants.

Costmary was popular in classical Egypt, Greece, and Rome, and by the 9th century it was commonly used in Spain, France, and Switzerland (Morton 1976). The species was apparently employed to flavor ale before hops became popular for the same purpose (see Curiosities). In the 15th century, leaves were exported from Spain (Morton 1976). The plant was often found in European kitchen gardens by the 16th century. In 16th century Elizabethan England, costmary was used as a strewing herb to improve the odor of floors, shelves, and closets (Macleod 1968). Costmary was introduced into North America by early European colonists but has largely disappeared from usage (Garland 1979). Only recently has it been offered in garden catalogs, sometimes as a "new" herb (Lima 1986).

Uses

Costmary leaves, picked before flowering, have a sweet balsam and lemon-mint aroma, and a similar but bitter flavor. The leaves are used sparingly in cooking and can be added to vegetable and fruit salads, sauces, stuffing, soups, game, meats, stews, casseroles, poultry dishes, cakes, and home-made beers and ales. The chopped leaves can be mixed with melted butter and served with new potatoes and carrots. Fresh leaves may result in a bitter aftertaste, reduced through cooking. The leaves can be placed in cake pans to flavor cakes while they are baking. The flavor of costmary is very dominant, and it is recommended that not more than a leaf be used for cakes and jellies, nor more than one leaf at the bottom of the baking pan for pound cake, venison, wild duck, roast beef, hamburgers, and chicken (Prakash 1990). Used sparingly the leaves complement cold beverages, and they can be steeped, often with other milder herbs, to brew a flavorful, slightly minty tea (Reppert 1987*b*). Costmary should not be steeped longer than 3 or 4 minutes as heat can turn the leaves bitter.

Costmary repels insects (Garland 1979). It was used traditionally as a strewing herb, with dried branches hung in cupboards or laid about to discourage moths and other insects (Garland 1979). Because the leaves retain a balsam fragrance after drying they are often added to potpourris, sachets, and herb wreaths (Reppert 1987*b*). An infusion of the leaves, or the fresh leaves themselves, were used to add a pleasant scent to "sweet washing water" used to rinse hair, linen, or added to bath water (Garland 1979; Huxley et al. 1992).

Costmary is an attractive foliage plant, especially when grown in partial shade, which makes for more substantial foliage.

Recipe Sources

Crowhurt (1973) gives recipes for Costmary ale, Costmary aspic, Costmary sauce, and Costmary tea. Mazza (1976) presents a recipe entitled Old-fashioned cocktail with costmary.

Importance

Costmary, a very minor herb, is apparently not grown for commercial harvest. It is essentially of no commercial interest except as an occasional offering of garden centres and plant supply houses.

Fig. 385.
Costmary *(Tanacetum balsamita)*, flowering branch, prepared by M. Jomphe. (Based on "F. Fyles, Sept 2, 1920" at Agriculture and Agri-Food Canada herbarium, Ottawa.)

Cultivation Notes

Soil

Costmary grows best in a well-drained soil (Reppert 1987*b*). Page (1980) recommends a light, moist soil. "The plant will thrive in almost every soil or situation, but will do best on dry land" (Grieve 1931). A pH tolerance range of 4.9-7.6 has been reported (Duke 1978).

Climate

This hardy perennial survives outside of cultivation as far north as southern Canada. Gansberger (1974) stated that it was hardy to -29°C during the winter. Costmary prefers a sunny location. It can tolerate light shade (Lima 1986), but tends not to flower in the shade (Grieve 1931; Roecklein and Leung 1987).

Propagation and Cultivation

Costmary is usually propagated by divisions of the plant because it seldom sets seed. It spreads rapidly by rhizomes. The plant should be divided after two growing seasons (Reppert 1987*b*). It can be grown in a large bottomless pot or other container set into the ground in order to prevent the rhizomes from spreading widely (Garland 1979). Costmary can be grown indoors in a sunny window (Crockett and Tanner 1977).According to Elbert and Elbert (1974), a single plant will suffice, as "there is no reason to take up additional room with a plant that has not too much to recommend it." A single outdoor plant is also sufficient to meet the culinary needs of most households. The soft should be kept moist but not soggy. Costmary is occasionally offered for sale as living plants in garden catalogs.

Harvest and Storage

The leaves can be picked at any time, but the flavor is best when the plant develops tall stalks covered with smaller leaves, just before the flowers are produced in mid to late summer (Reppert 1987*b*). At this stage the oils are most concentrated. The leaves can be used fresh in cooking but are often dried in a warm, shaded location, and stored in airtight jars.

Example Cultivars

No cultivars are available.

Additional Notes

Chemistry

Pérez-Alonso et al. (1992) examined three populations of Spanish costmary, and found the oil contained carvone (about 50%) as the main component. There were also minor amounts of ß-thujone, *trans*-dihydrocarvone, *cis*-dihydrocarvone, dihydrocarveol isomer *cis*-carveol and *trans*-carveol. Notably, the toxic ketone ß-thujone comprised about 10% of the essential oil. Some populations of costmary have been found to have camphor rather than carvone as the main component of the essential oil (Pérez-Alonso et al. 1992).

Medicine

In traditional medicine an infusion of the leaves was used to treat colds and upset stomachs, to aid menstruation, to expel worms from children, and as a general tonic. This herb was also employed for many uterine complaints and to ease childbirth. The crushed leaves were used to sooth insect stings and bites. Costmary oil was regarded as an antiseptic (Garland 1979). "Costmary is no longer considered to be of any importance in pharmacy" (Page 1980). Costmary is a member of the sunflower family, that includes plants such as ragweed and chamomile known to produce allergenic reactions in susceptible individuals. People who are sensitive to such plants need to keep in mind that there is at least a small chance of an allergenic reaction with costmary used in herb and drink preparations (Rinzler 1990).

Nutrition

No information found. Very little is used for culinary purposes and so there is no appreciable contribution to nutrition.

Curiosities

• "Cost" in costmary is derived from the Latin *costus*, an Oriental plant whose root was used as a spice (Grieve 1931). Mary in the name is usually interpreted as the virgin mary. "Costmary" and the alternative name "sweet Mary" have often been associated with the Virgin Mary since the Middle Ages (Grieve 1931). One of the French names is Herbe Sainte-Mairie. However, some believe that the Mary in question refers to Mary Magdalene, because the spicy fragrance resembles that of the ointment she used to bathe the feet of Christ (Kublick 1990).

• Costmary is sometimes known as alecost, because it was used to flavor holiday ale, or wassail (Madsen 1990), before the introduction of hops (*Humulus lupulus*, discussed in this book).

• Another common name, "bible leaf," derives from the practice in pre-colonial days of tucking the sweet fragrant leaves as a bookmark inside a prayer book,

which could be chewed in the event of a sleepy sermon (Reppert 1987*b*). It was often mixed with other herbs and flowers to form a "Sabbath posy" that would titillate the nose in church (Lima 1986).

• Costmary has been called "sweet tongue" because of the slender, tongue-shaped leaves (Kublick 1990).

Problems and Potential

Costmary has no commercial potential. It is likely to remain a curiosity of home gardens.

Selected References

Garland (1979); Lima (1986); Reppert (1987*b*).

Fig. 386.
Dandelion *(Taraxacum)*, from Köhler (1883-1898).

Taraxacum

Family: Compositae (Asteraceae) (sunflower family)

Genus Notes

Species of *Taraxacum* are perennial herbs, mostly native to north temperate and Arctic regions of the Northern Hemisphere. The genus occurs in Europe, Asia, and the arctic, antarctic, and montane regions of the Americas. One species occurs in New Zealand and two in Australia (Richards, personal communication). *Taraxacum* is an extremely complex genus of herbs. Many of the species reproduce mostly apomictcly, i.e., by a pseudo-sexual process that produces seeds without fertilization. Mutations in species of such genera tend to be preserved because apomixis resembles vegetative reproduction, so that numerous "microspecies" are generated, i.e., races differing slightly. Taxonomists outside North America have recognized many of the races as different species, others submerge most of the races into only a few species. As pointed out by Brunton (1989), some authorities recognize over 1200 European species; Richards (personal communication) advises that over 1500 European species have been described. "Nomenclatural problem in *Taraxacum* pose problems of a nature not encountered in other, non-agamospermous genera, and these have seemed at times impossible to resolve by conventional methods" (Richards 1985). To avoid the problem of recognizing many minor (some would say trivial) apomictic species, rather than referring to species, one can refer to the sections into which *Taraxacum* is divided. Almost all North American weedy dandelions, introduced from Europe, belong to one of two sections: *T.* section *Ruderalia* Kirschner, Ollgaard & Stepanek and *T.* section *Erythrosperma* (Dahlst.) Lindb.f. (previously known as "*T. laevigatum*" or "*T. erythrospermum*," a sexual species called the lesser dandelion). Despite the apparent lack of sexual reproduction in North American weedy dandelions, there is considerable genetic variation present (Taylor 1987). Away from boreal and temperate regions native kinds of *Taraxacum* are usually sexual and these (about 100 species) are comparable in distinctiveness to the kinds of species recognized by most botanists. In North America the native species are found in the Arctic or are alpine inhabitants rarely encountered below 3350 m; these belong to sections *Taraxacum* or *Borealia* HM (Richards, personal communication).

Several species of *Taraxacum* are grown as ornamentals and some are used medicinally. Hybrids of *T. kok-saghyz* Rodin., Russian dandelion (from Turkmenstan), have been grown in Russia and elsewhere as a source of robber, derived from the plant latex. Essentially abandoned as a crop, Russian dandelion has been reconsidered recently in Russia as a source of rubber in order to reduce dependence on imports.

Taraxacum Weber

[The above indicates the generic name *Taraxacum*, followed by Weber, the author who coined the name. The reason for giving just the genus name, not the species name (as with all other species treated in this book) is explained in the following. As pointed out by Huxley et al. (1992), *T. officinale* Weber, the name that has long been applied to the so-called common dandelion, is not the correct name. The "type species" of the genus, *T. officinale* Weber, a synonym of the name *Leontodon taraxacum* L., is localised to northern Sweden (Richards 1985). Accordingly, this books abandons the usual North American treatment of assigning the common dandelion to "*T. officinale* Weber." Since identifying the microspecies encountered in North America is an extremely difficult (and for almost all purposes an unnecessary) exercise, common dandelions of interest here are simply assigned to "*Taraxacum* Weber" (following the advice of Dr. A.J. Richards).]

English Names

Dandelion
Also: blow ball, blowballs, cankerwort, clock flower, common dandelion, dumble-dor, fortune teller, French dandelion, Irish daisy, lion-tooth, lion's tooth, milk gowan, monk's head (monk's-head), piss-a-bed (pissabed), piss-the-beds, pissenlit, priest's crown (priest's-crown, pries' crown), puffball, radicchiello, swine's snout, telltime, wet-a-bed, white endive, wild endive, witch gowan, witches' milk, yellow gowan
[Wijk (1911) lists additional old-fashioned English names. "Italian dandelion" (Italian Dandelion) is a generally large-rooted type of chicory (*Cichorium intybus*, discussed in this book) (Halpin 1978).]

French Names

Family: Composées, famille de la marguerite
Pissenlit (m)
Also: coq, chopine, cochet, couronne de moine, dandelion officinal, dent-de-lion, dent-de-lion commune, dent de lion, flori(o)n d'or, groin de porc, laitue de chien, liondent, pissenlit dent-de-lion, pissenlit officinal, salade de taupe

Fig. 387.
Dandelion *(Taraxacum)*, cultivar Very Early,
from Vilmorin-Andrieux et C^{ie} (1883).

[Wijk (1911) lists additional old-fashioned French names.]

Warning

Do not eat weedy dandelions from locations that may have been sprayed with herbicides, pesticides, or fungicides.

Description, Taxonomy, and History

The "common dandelion" encountered as a weed in North America, and probably also in the horticultural trade, mainly represents many of the apomictic species of *Taraxacum* section *Ruderalia*, as discussed above.

Dandelion is a herbaceous perennial with a rosette of jagged, irregularly lobed leaves produced from a long, thick, fleshy taproot that can descend more than 1 m (Morton 1981). The leaves may be nearly smooth-margined, saw-toothed, or deeply cut. The single flowering stalk, sometimes over 50 cm tall, is hollow and bears a head of tiny yellow flowers, the whole head referred to as a flower by non-botanists. The flowering stalk is hollow and elongates with age. When the sun shines, the flower heads are open, and when the weather turns dull, the flower heads close up. Although dandelion produces flowers particularly in mid-spring under moist conditions, plants often continue flowering right up to frost. Fruiting heads produce tiny (3-5 mm) brown "seeds" (technically, fruits called achenes), each carried by a "parachute" of white, fluffy hairs on a stalk. White, bitter, milky juice exudes from the plant where it is cut or broken; this stains hands brown and is difficult to remove. Cultivated selections differ in various respects from wild plants, some tending to have broader, more deeply-lobed leaves, others with a very high production of leaves, often semi-erect (Facciola 1990). Most weedy forms of dandelion in the U.S., and probably most if not all cultivated selections, probably originate from Europe and Asia. The dandelion is now a common weed throughout the world in temperate regions, often in pastures, meadows, gardens, and waste ground, and along roadsides, and in North America is regarded as a serious weed of lawns. It occurs in all provinces and territories of Canada (Scoggan 1978-79; Szczawinski and Turner 1978; Small and Catling 1996), and is also a ubiquitous weed in the U.S. [except for the warmest parts of California, Arizona and Florida (Morton 1981)].

Dandelion has been consumed for centuries in Eurasia. Anglo-Saxons, Celts, Gauls, and Romans used the dandelion as food (Duke 1992*a*). In Europe, it was widely used as a pot herb by the poor, who gathered it from nature. It was also grown in a blanched form and used in salads (Millspaugh 1974), and the roots were used as a coffee substitute. In Victorian England, dandelion was widely grown in kitchen gardens for use as a salad herb (le Strange 1977). Dandelion was brought to North America by early colonists as a pot herb. During times of war and famine, it was a much-valued emergency food (Halpin 1978; Splittstoesser 1990). As a medicinal plant, dandelion has been used at least since the time of the Arabian physicians of the 10th and 11th centuries (Grieve 1931).

Uses

Dandelions should be thoroughly washed in water and, for salads, spun-dry or wrapped in soft towelling to absorb all moisture (Schneider 1986). Almost all parts of the dandelion can be eaten. The leaves are consumed primarily as a cooked potherb, although young leaves are sometimes eaten raw in salads (Zennie 1987). The young leaves can be various cooked: boiled, steamed, sautéed, fried, and braised. When cultivated in a blanched form (i.e., protected from light to produce succulent, tender tissue) the leaf-stalks and crown (the central white portion of the rosette) can be eaten raw or as a cooked vegetable (Facciola 1990). The crown of the plant can be dipped in batter and deep-fried. The flowering buds and heads can be prepared in the same manner. Dandelion greens can be substituted for spinach in recipes such as quiche, eggs florentine, and creamed spinach (Sackett 1975). If wild dandelions are harvested, the leaves are best cooked in one or two changes of water to reduce the bitterness.

Dandelion roots are sometimes eaten raw (Morton 1976), peeled and sliced for salads (Mitich 1989), but are best after two changes of water. They can be consumed

roasted or fried (Mitich 1989). They can be eaten hot, or cold as a salad ingredient. The roots can also be dried, roasted, and ground as a caffeine-free coffee substitute. According to Phillips (1986) "'Dandelion coffee' is really a misnomer. The drink made from the roots is not coffee and does not taste like it, though it is a palatable substitute for either coffee or tea." Some of the carbohydrates in the root are in the form of inulin, which is better than sucrose for diabetics.

Alcoholic beverages are made from dandelion, using flowers for wine and whole plants for beer (Szczawinski and Turner 1978). In Scandinavia, flowers are used to flavor schnapps. The flowers can be eaten outright, although slightly bitter, and turning one's saliva a startling yellow (Mitich 1989). Unopened flower-buds are sometime eaten in pancakes, omelets and fritters, and the flowers are used in the Arabic cake *yublo* (Facciola 1990). Leaves and roots are brewed as tea (tannin is present, as noted in Chemistry). The seeds (minus the plumes) can be eaten (Mitich 1989). Seeds can also be sprouted and eaten (Facciola 1990). Root and shoot extracts are employed commercially in flavoring baked goods, candy, ice cream, and soft drinks (Morton 1981). The reader should keep in mind that however ingested, dandelion is invariably a marked diuretic, promoting urination.

Dandelion is a valuable bee plant because the flowers bloom early in the spring, and at that time may be tile only major source of nourishment for bees. Dandelion is also considered to be an excellent, highly nutritious pasture plant for beef cattle (Bergen et al. 1990), and is said to increase milk flow in dairy cattle (Szczawinski and Turner 1978). Curiously, however, dandelions are often untouched by cattle in pastures (Brunton, personal communication).

A golden yellow dye that colors wool and cotton can be obtained from the flowers, and a purple dye from the roots [see Rinzler (1990) for instructions on how to obtain and use the dyes].

Recipe Sources

Crowhurst (1973) gives recipes for Pickled dandelion buds, Dandelion mead, Dandelion omelette, and Dandelion soup. Smith (1973) has recipes for Dandelion sandwiches, Dandelion tea, Dandelion coffee, Dandelion wine, Luncheon dandelion omelet, Dandelion salad gourmet, and Wilted dandelion salad. Szczawinski and Turner (1978) present recipes for Adam's winter salad, Dandelion coffee, Dandelions in sour cream, and Oldtimer's dandelion wine. Turner and Szczawinski (1978) give recipes for Dandelion punch; Dandelion tea; Café curaçao; Dandy-*Czekolada* [chocolate], Polish style; Dandelion coffee; and Dandy-coffee, Vienna style. Launert (1981) has recipes for Dandelion in sour cream, Dandelion salad, Dandelion salad with tomatoes, and Dandelion wine. Hériteau (1983) has recipes for Dandelion flower omelet, Dandelion and lettuce salad, Old-fashioned dandelion wine, and Dutch dandelion salad. Schneider (1986) gives recipes for Salad of dandelion and fresh goat cheese, Dandelion greens with garlic, Felipe Rojas-Lombardi's dandelions with Penn Dutch dressing, Plain-cooked mild dandelion greens, and Rice with dandelions. Michael (1980) presents ten recipes, including one unpleasantly titled Pissenlit au lard. Phillips (1986) provides a similar recipe entitled Salade de pissenlit au lard, as well as recipes for Dandelion flower wine, Dandelion beer, Wilted dandelions, Dandelion coffee, and Dandelion Nitsuke. Barash (1993) has recipes entitled Dandelion wine, Dandelion "mushrooms," Cornmeal dandies, and Dandy eggs.

Other recipes are: creamed dandelion greens (Organ 1960); Cooked dandelion greens (Corey 1962); Dandelion salad (Corey 1962; Buishand et al. 1986); Stir-fried dandelion greens and pork (Brackett and Lash 1975); Sautéed dandelion greens (Farah 1979); Dandelion with hot bacon dressing (Halpin 1978); Dandelion green noodles (Owen 1978); Dandelion salad with bacon (Garland 1979; Holt 1989); Batter-fried dandelion blossoms (Kavasch 1979); Dandelion greens (Kavena 1980); Stuffed wild mushrooms with lemon, bay and dandelion petals (Leggatt 1987); Warm dandelion salad with mushrooms and poached eggs (Levy 1987).

Importance

Dandelion is grown commercially in France (Szczawinski and Turner 1978) and other European countries. Certain leafy varieties are raised on several farms in New Jersey and sold around New York (le Strange 1977). The center of dandelion cultivation in the U.S. is in the eastern seaboard states during the spring and early summer months, and in Florida and Texas during the winter (Sackett 1975). It has been estimated that about 3600 t were produced in the U.S. in 1959 (Sackett 1975).

In Canada in 1988, wholesalers marketed 111 t, worth $397,000.00 (CAN) in Toronto; and 55 t worth $198,000.00 (CAN) in Montreal (Anon. 1989*c*).

Cultivation Notes

Soil

Dandelion will grow on just about any well-drained soil but performs best on rich well-cultivated loams (Halpin 1978). Sandy or light loamy soils promote earlier spring development (Sackett 1975). A pH tolerance of 4.2-8.3

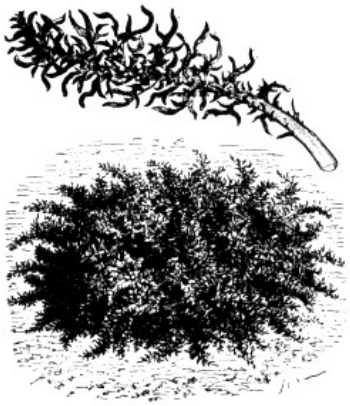


Fig. 388.
Dandelion *(Taraxacum)*, cultivar Moss-leaved,
from Vilmorin-Andrieux et C^{ie} (1883).

has been reported (Duke 1978). Sackett (1975) recommended a pH range of 5.0-6.8. Dandelion responds well to added nitrogen and phosphorus (Halpin 1978).

Climate

Dandelion is a hardy perennial, well-adapted to all of the northern area of North America, except the colder parts of Canada (although native dandelions are found in the High Arctic). In the wild, the plants are normally found in full sun. Irrigation during dry periods is beneficial (Splittstoesser 1990).

Propagation and Cultivation

When cultivated for its edible leaves, dandelion is often grown as an annual. Sackett (1975), however, recommends growing the plant commercially as a biennial, harvested early in the second year before flowering and the development of bitterness in the leaves. The plants can be propagated from root cuttings, but are normally grown from seeds. Seeds are sometimes started in the greenhouse and the young plants transplanted, but dandelion is commonly direct-seeded. Seeds are either sown in spring as early as the soil can be worked for summer and autumn use, or in late summer for harvest the following early spring. Wang et al. (1993) suggest that the seeds be planted at a depth of about 13 mm, with a soil temperature preferably between 20 and 30°C. Seedlings usually emerge in 7-21 days (Wang et al. 1993). Letchamo (personal communication) suggests sowing the seeds from 0 to 10 mm deep at 20-25°C; under full sunshine, the seeds may emerge within 4-5 days. Dandelions should be thinned early as the taproots quickly become difficult to remove (Halpin 1978). The flavor of the leaves can be improved by blanching, accomplished by covering the young developing plants with earth, or coveting them with a light-excluding pot or other material. The cultivar Amé1ioré, à Coeur Plein is almost self-blanching; the cultivar Mayses's Trieb is bred to be forced (Huxley et al. 1992). Kuusi et al. (1984*a*) found that black film, black fiber cloth, and a thick layer of bark humus were all effective in blanching the rosettes. Flowers that develop should be removed, first to keep the plant from directing its energy into fruit production, and second to prevent seeds from being distributed as a weed.

Harvest and Storage

The cultivars sold are said to mature in about 90-95 days. However, leaving the plants this long before harvest may result in tougher, more bitter leaves (Halpin 1978). Spring-planted dandelion can be harvested when the leaves are young and tender. Alternatively, the outer leaves, when 15-20 cm long, can be tied to blanch the inner leaves, 2-3 weeks before harvest. This results in a tender, inner heart, similar to Belgian endive. The plants can be left to overwinter (with a top mulch) and the first tender leaves picked in early spring. Kuusi et al. (1984*a*) obtained a yield in Finland of 5-15 t/ha. Grown for the leaves in the U.S., a good yield is 18 800 kg/ha (Sackett 1975). In the past, dandelion has been grown for the roots for use as a drug, with yields of roots under favorable conditions of 1100-1700 kg/ha (Sievers 1948).

In commercial harvesting, leaves are left attached to a portion of the roots, since this tends to keep the foliage succulent (Sackett 1975). The taproot is cut a little below the surface of the ground. Leaves separated from the base of the root wilt rapidly.

The plants with roots attached can be lifted for forcing at the end of the growing season. After removing dead or damaged outer leaves the roots are placed in a container with damp sand, and then the crown is covered with about 15 cm of additional damp sand. The container is placed in a warm location and within 2-3 weeks the dandelion tops will pierce the top of the sand. These new leaves can be harvested for 2-4 weeks, and subsequently the sand is removed to reveal the rest of the blanched, tender leaves above the crown (Halpin 1978).

Von Welanetz and von Welenetz (1982) provide the following advice to the home consumer regarding storage. The greens can be wrapped in damp paper towels and

Fig. 389.
Dandelion *(Taraxacum)*, cultivar Thick-leaved,
from Vilmorin-Andrieux et C^{ie} (1883).

stored in a plastic bag in the refrigerator for use within 3 days. The leaves can also be frozen; they are first washed, then scalded in boiling water for just 2 minutes, chilled in ice water, drained well, and packed into a freezer container leaving about 1 cm at the top for expansion. Frozen material will last without losing much quality for up to 6 months.

Example Cultivars

Amé1ioré à Coeur Plein, Amé1ioré Géant, Broad Leaved (Thick-Leaved, Cabbage-Leaved), Catalogna Special, Mauser's Trieb, Mayses's Trieb, Vert de Montmagny, Thick-leaved Improved (Broad Leaved, Cabbage Leaved), [most of these are described in Facciola (1990) or Huxley et al. (1992)]. Sackett (1975) lists Thick Leaf, Improved Thick Leaf, and Arlington Thick Leaf. (Note "leaf" in Sackett, "leaved" in Facciola.)

Wild dandelion can be used, but the selected cultivars are known not to be bitter and are therefore recommended (Halpin 1978; Szczawinski and Turner 1978).

Additional Notes

Chemistry

The bitter resin in the roots and shoots contains taraxacin, taraxerin, taraxerol, taraxasterol, inulin, gluten, gum, potash, choline, levulin, and putin (Simon et al. 1984). Taraxacin and taraxasterol are active ingredients of the roots of dandelion (le Strange 1977).The bitter taste of dandelions is due to 11.13-dihydrotaraxine acid-1' O-B-D-glucopyranoside and several other awesomely-named chemicals (Kuusi et al. 1985).The dried plant contains 2.8% tannins (Morton 1981, who provides a fairly lengthy list of other constituents). Because food cultivars of dandelion have been selected to have reduced amounts of the bitter chemicals thought to be responsible for pharmacological properties, food cultivars are likely less effective medicinally than wild forms.

Medicine

Root extracts were once used extensively as a diuretic (to promote urination; see Curiosities), and are still sometimes so employed. Dandelion juice, expressed from the roots, used to be sold by druggists (Grieve 1931). The flowers have been used in folk medicine to treat jaundice and other liver ailments (Duke 1992*a*). By the Doctrine of Signatures, whereby aspects of plants are said to signal their medicinal uses, the yellow of dandelion flowers was interpreted as a sign that jaundice (which causes yellow coloration) and other liver diseases could be treated (Grieve 1931). Juicy plants such as dandelion, suggestive of water retention, were also linked by the Doctrine of Signatures to plants useful as diuretics (Castleman 1991). Dandelion has also served as a tonic (Grieve 1931). A tradition developed in Europe of taking dandelion as a "cleansing cure" in the spring (Weiss 1988). Other ailments treated include fever, insomnia, jaundice, rheumatism, eczema and other skin diseases, constipation, warts, cancers, and tumors (Simon et al. 1984). In China the juice of the fresh plant is applied to snake bites (Keys 1976). The U.S. has imported over 45 t of dandelion in some years for use in patent medicines, at least as recently as 1957 (Mitich 1989; Duke 1992*a*), despite the fact that the dried root appears to lack therapeutic value (Simon et al. 1984), and is abundantly available in the U.S. Tyler (1994) stated that most claims for medicinal usefulness for dandelion are based on animal and clinical investigation conducted in the 1930's, and are insufficient to warrant pharmacological use today.

Because dandelion is such a common weed, it is tempting to test the edibility of nearby weedy plants. One should always be aware of the danger of collecting herbicide-and pesticide-sprayed dandelions on lawns and roadsides.

Contact dermatitis has been reported from handling dandelions (Barash 1993).

Nutrition

Dandelion greens are high in vitamins A and C and niacin (Simon et al. 1984). Content of iron, calcium, phosphorus, potassium, copper, and magnesium are exceptionally high (Mitich 1989). Although high in vitamin C, the level is considerably decreased if the leaves are blanched (Kuusi et al. 1984*b*).Unlike some salad greens, dandelion does not seem to accumulate undesirable levels of nitrates (Kuusi et al. 1984*b*). (As pointed out in the discussion of celery, celery tops with 3-8% nitrates have poisoned dairy cattle.) However, dandelions grown near roads with heavy traffic can pick up lead from engine exhausts (Kuusi et al. 1982).

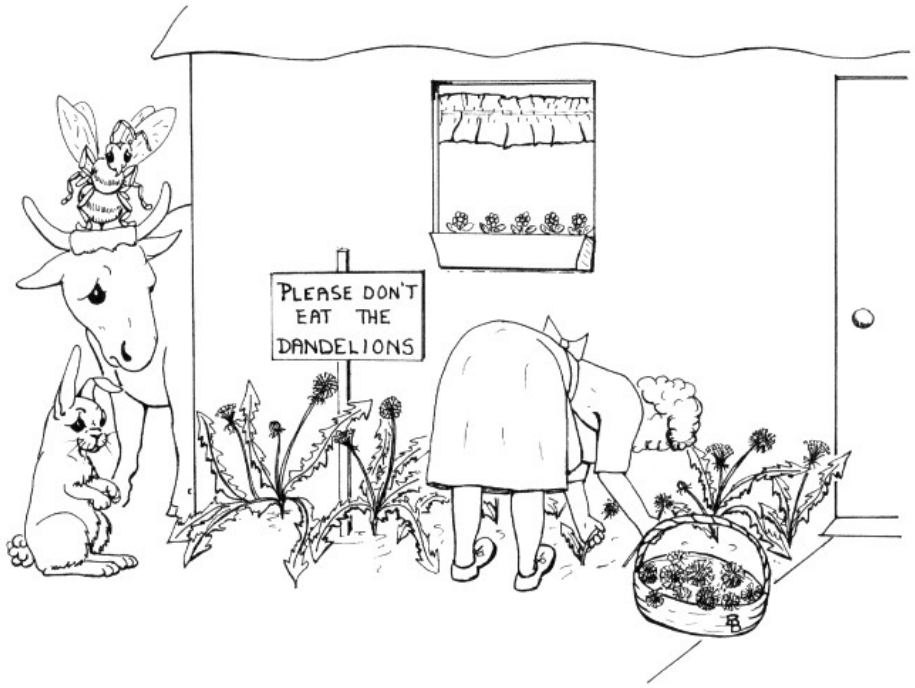


Fig. 390.
"Please don't eat the dandelions." Prepared by B. Brookes.

Curiosities

• Several interpretations have been given for the genus name *Taraxacum*. Clair (1961) claims it is derived from the Greek *taraxis*, a disease of the eye, and *akeomai*, to cure, apparently because in ancient times the milky sap of the dandelion was used to treat some eye disease. Le Strange (1977) says the name is derived from the Greek *taraxis*, disorder, and *akas*, a remedy, literally a remedy for disorder, in reference to early medicinal uses. [For other interpretations, see Grieve (1931), Mitich (1989), and Huxley et al. (1992).]

• The English name dandelion is a corruption of the French *dent de lion*, lion's tooth, generally interpreted as a reference to the coarsely toothed leaves. Indeed, lion-tooth is an obsolete English name for the dandelion (Clair 1961). The reference to a lion tooth is found in nearly all languages of Europe (Grieve 1931); for example, the Italian *dente di leone* and the Spanish *diente de león* (Stobart 1977).

• The name *swine's snout* is an allusion to the shape of the flower head once it has matured and assumed a closed shape; following the release of all of the plumed seeds, the bare appearance of the flower head stimulated the names priest's crown and monk's head, a reference to the common practice in the Middle Ages of shearing the hair of the clergy (Grieve 1931).

• In ancient Greek legend, the Minotaur was a monster shaped half like a man and half like a bull, confined in a labyrinth where he was periodically fed youths and maidens. After killing the Minotaur the Greek hero Theseus ate a dandelion salad (Mitich 1989).

• Dandelion was once in great demand as a medicinal diuretic (to promote urination). In the 18th century it was termed *Herba Urinaria*, and in Holland it is still sometimes called *beddepissers* (Clair 1961). The French *pissenlit*, literally "wet-a-bed," is still another allusion to the reputation of dandelion greens for stimulating the kidneys. Such names as wet-a-bed and piss-a-bed are also old English names for dandelion (Mitich 1989), and the name piss-the-beds is still used in Northumberland (Richards, personal communication).

• Millspaugh (1974) reported that in the early days of the U.S. dandelion leaves were a favorite vegetable of the Digger and Apache Indians "who value them so highly that they scour the country for many days' journeys in search of sufficient to appease their appetites. So great is their love for the plant, that the quantity consumed by a single individual exceeds belief."

• An Algonquin legend relates the story of Shawondesee, the fat lazy south wind (Moldenke and Moldendke 1952). One day he observed a dandelion in the form of a beautiful golden-haired maiden on the meadow near him, but he was too lazy to pursue her. In a few days, he returned, and saw a bent old woman with grizzled white hair. Disappointed, he heaved a tremendous sigh, and observed the old woman's white hair fly away on the breeze. In the spring, the south wind still sighs for the lost beauty who might have been his.

• The Iroquois ascribed sexual symbolism to dandelion roots (Moerman 1982). Roots with a side root reminiscent of the male sexual organ were tossed backwards while saying the name of one's desired love. Alternatively, roots growing intertwined were boiled, and the water used to wash ones face and fingers in the expectation that this would make one sexually irresistible.

• Dandelions were an ingredient of a popular 19th century patent medicine used to treat menstrual discomforts, Lydia E. Pinkham's Vegetable Compound (Castleman 1991). It was claimed by the manufacturer to be "the greatest medical discovery since the dawn of history" (Castleman 1991). (This concoction was made up mostly of fenugreek seeds; see *Trigonella* Curiosities. A reformulated product bearing the same name is still available.)

• Most forms of dandelion are triploid, i.e., they have three rather than the normal two sets of chromosomes, and like most such plants cannot reproduce sexually (Grant 1971). Dandelion is almost exclusively apomictic, that is it produces seeds by non-sexual means (Grant 1971). Flowers are sexual attractants, serving to entice pollinators for sexual purposes. One of the great ironies of nature is that the masses of colorful dandelion flowers (most producing considerable pollen and nectar) that one sees on lawns and parks, are advertising sex for plants that are essentially sterile from a sexual viewpoint.

• Many perennial herbaceous plants, like dandelion, have "contractile roots" which "lock in" to the soil and contract as the rosette grows, keeping the growing point near the soil surface (Mitich 1989). This makes dandelion roots very difficult to eradicate, as any portion not pulled up can reproduce the plant.

• Dandelions used as a companion crop or as a green manure can protect tomato crops from *Fusarium*, a soilborne fungus that is a particular problem in commercial greenhouses. *Fusarium* does not compete well with other soil microorganisms and dandelions appear to increase the number of soil microorganisms. The fungus requires elemental iron to thrive, and dandelion residues contain cichoric acid, which ties up soil iron. Dandelion also contains polyphenols, which are natural fungicides. British Columbia producers have grown dandelions to help protect their red-skinned greenhouse tomatoes. [See Anon. (1990*a*) for additional information.]

• The dandelion has been declared an endangered wildflower in England (Smith 1995).

• The following quotation from the American essayist and poet Ralph Waldo Emerson (1803-82) is especially accurate for the dandelion (Castleman 1991):

> What is a weed?
> A plant whose virtues have not yet been discovered.

Problems and Potential

Most people are prejudiced against the dandelion because it is a bothersome weed of gardens and lawns, and seems an improbable useful plant. Nevertheless edible cultivars are widely available, and there is a small commercial market for dandelion greens. As with the growing market for ethnic vegetables and herbs, it is possible that the use of cultivated dandelion as a commercially marketed potherb will increase.

Selected References

Grieve (1931); Sackett (1975); Halpin (1978); Szczawinski and Turner (1978); Richards (1985); Mitich (1989); Nijs and Bachmann (1995).

Fig. 391.
Wild thyme *(Thymus serpyllum)*, from Köhler (1883-1898).

Thymus

Family: Labiatae (Lamiaceae) (mint family)

Genus Notes

Thymus has about 350 species. These are perennial, aromatic herbs and subshrubs native to Eurasia. There is a wide range of variation among and even within species, and the genus has many unsolved taxonomic problems (Jalas 1970, 1971, 1974, 1980; Flannery 1984). In addition to the four species discussed in detail, the following are used in various parts of the world as condiments or for their essential oil (Mansfeld 1986).

Thymus capitatus (L.) Hoffm. & Link. (= *Coridothymus capitatus* (L.) Reichenb. f.) is known as Spanish oregano, conehead thyme, and Persian hyssop. This wild species is native to parts of the Mediterranean. It is perhaps the third most commercially important "oregano" (see discussion of the term "oregano" in *Origanum*, Genus notes), because of its essential oil, called Spanish oregano oil (Lawrence 1984*b*). About 7.2 t of this essential oil are produced annually worldwide (Lawrence 1992). The oil has a strong inhibitory effect on molds and food-borne bacteria, mainly because of the presence of carvacrol (Paster et al. 1990; Arras and Grella 1992). The oil is used mainly to scent soaps, colognes, after-shave lotions, and other toiletries (Morton 1976). The oil is also used in the food industry, to flavor baked goods, condiments, meats, beverages, ice cream, and candy (Morton 1976). This species was used medicinally against asthma in early Colonial America (Simon et al. 1984).

Thymus mastichina L., known as mastic thyme and Spanish marjoram, is native to Portugal and Spain. It has also been introduced to Argentina where it is grown in gardens. The essential oil, a source of cineol, is called "oil of wild marjoram" and is extracted in Spain. It is used for flavoring meat sauces and soups (Facciola 1990). About 36.5 t of Spanish marjoram essential oil are produced annually worldwide (Lawrence 1992).

Thymus caespititius Brot. (*T. azoricus* Lodd., *T. micans* Soland. ex Lowe) is called Azores thyme and Cretan thyme. It is a mat-forming, woolly subshrub, native to the northwestern Iberian Peninsula, Canary Islands, and the Azores. Its fresh leaves flavor custards and are used like lemon thyme (Morton 1976). Celery (Celery Thyme) is a cultivar of the species with a celery-like aroma (Facciola 1990).

Thymus quinquecostatus L. is known as Japanese thyme. This species is native to northeastern China (Mongolia) and Far Eastern Russia, and is grown in Japan and Korea. In Japan it is used as a condiment for soups and meat dishes.

Thymus zygis L., a native of Portugal and Spain, is known as Spanish thyme, white thyme and sauce thyme. This is an aromatic dwarf shrub with woody stems. The leaves are used as a condiment in southwestern Europe (Facciola 1990). It is also employed in the production of Spanish thyme oil (Simon et al. 1984), and is considered a major source of thyme oil (Jackson and Hay 1994). In 1989, 25 t of Spanish thyme oil were produced, this representing 86% of world production (Lawrence 1992). Verlet (1993) estimated the annual world value of "thyme" essential oil to be $1,125,000.00 (U.S.).

T. pulegioides L., wild thyme of Europe, is the source of about 2000 kg/year of commercial essential oil (Lawrence 1992).

Several *Thymus* species are grown in Canada and northern regions of the U.S. as ornamentals, notably: *T. pseudolanuginosus* Ronn. (woolly thyme); *T. pulegiodes* (some cultivars such as Doone Valley and Lemon have a lemon scent); and *T. thracicus* Velen. (known as lavender thyme, this has a strong lavender scent). *Thymus serpyllum* L. (wild thyme, creeping thyme, or mother-of-thyme) is listed in garden catalogs as available but selections offered usually are either *T. pulegiodes* or *T. praecox* subsp. *articus* (E. Durand) Jalas [Flannery 1984; note in discussion of the Genus Notes for basil that mother-of-thyme is a name also applied to *Acinos thymoides* (L.) Moench]. Species of *Thymus* are difficult to identify and are often confused in the horticulture trade. There is a need for revision of the existing classification of native and cultivated *Thymus* species.

In addition to being appealing, often fragrant ornamentals, *Thymus* species have nectar-rich flowers that are very attractive to honeybees (Huxley et al. 1992). Indeed, thyme blossoms have been famous for centuries for scenting the famous honey available from Mount Hymettus of Greece (Rosengarten 1969), and thyme honey has been called "liquid gold" (Bryant 1977).

Thymus Vulgaris L.

English Names

Garden thyme
Also: black thyme, common thyme, English thyme, German thyme, thyme
["Thyme" is pronounced "time."]

French Names

Family: Labiées, famille de la menthe

Fig. 392.
Garden thyme *(Thymus vulgaris)*, from Köhler (1883-1898).

Thym (m)
Also: barigoule, farigoule, frigoule, mignotise des Génevois, pote, thym commun, thym cultivé, thym des jardins, thym vrai, thym vulgaire

Description, Taxonomy, and History

Garden thyme is a native of the European part of the western Mediterranean, and is often found wild on dry hills of southern Europe. It is an aromatic, perennial subshrub, generally 15-50 cm in height. The small leaves are hairy underneath, with glistening oil glands on both surfaces but particularly on the upper sides. Lavender flowers are borne in loose whorls, clustered on branchlets or on rounded heads. This species has been introduced to many temperate parts of the world, including North America. Two wild subspecies are recognized: subsp. *vulgaris* is native to France, Italy, and Spain and subsp. *aestivus* (Willk.) A. Bolós & O. Bo1ós is native to Spain and nearby Mediterranean Islands. There also are many domesticated selections of thyme including "English thyme" with broad leaves and "French thyme" with narrow leaves.

Garden thyme is one of the most ancient of the useful herbs. It was cultivated in Sumeria in 3000 B.C. (Laws 1981). Its preservative properties were well known to the classical Egyptians who employed the essential oil in embalming preparations. Garden thyme was important as a seasoning to the early Greeks and Romans (Rosengarten 1969). It is uncertain when thyme was first cultivated in northern Europe, some believing that the Romans took it to Britain (Stuart 1979). By the 16th century thyme was generally cultivated as an annual in northern Europe.

Uses

Garden thyme is an extremely important herb, especially in European cooking. It is used to flavor or seem butter, cheeses, chowders, fish, liqueurs, meats, olives, onions, pickles, poultry, sauces, soups, stews, stuffings, vegetable dishes, and vinegars (Duke 1985). The taste is warm, aromatic, sharp, bittersweet and, unlike many herbs, survives long periods of cooking. The herb (foliage, twigs, and flowers) can be used fresh but the aroma is considered more penetrating and desirable when dried. The herb is sold in whole or ground form. The leaves are often added to Italian foods, especially those with tomatoes. Creole cooking of the southern U.S. depends on the use of garden thyme (Farrell 1985). Thyme is also a key element of Cajun seasonings (Hutson 1987). Garden thyme is an important part of *bouquet garni* (an internationally used French name for herbs tied together so that they can be removed at the end of cooking or when the desired flavor is obtained). It complements soups such as clam and fish chowders and vegetables such as carrots, egg plants, onions, peppers, potatoes, tomatoes, and zucchini. It is also often added to fish and some seafood dishes. Garden thyme mingles well with a combination of wine, onion, garlic, and brandy to flavor various meats, including sausages and roasts, wild game, and domestic fowl dishes, especially those cooked slowly for a long time. Thyme is often mixed with marjoram (*Origanum majorana*, discussed in this book), and is often used to flavor olives. In Switzerland, it flavors a special creamy goat's milk cheese. It is also added to the liqueur Bénédictine (Prakash 1990). Garden thyme is used commercially to season croutons, fried chicken, prepared poultry stuffings or dressings, and processed liver spreads (Farrell 1985). Thyme is also popular in herb teas.

The essential oil of garden thyme contains thymol, a white, crystalline phenol with antiseptic and fungicidal properties. The oil is used to preserve meats. Extracts of garden thyme prevent oxidation of some fats, and are especially useful in stabilizing pork fat (Economou et al. 1991) and in preventing deterioration of butter (Farag et al. 1990). Ground thyme has also proven effective in inhibiting some food-borne bacteria, including members of *Salmonella* and *Staphylococcus* (Aktug and Karapinar 1986). Commercially, thymol is the fungicidal ingredient in some antimildew preparations. Foods in which the oil is used include chewing gum, condiments, ice cream, candy, and alcoholic beverages (Morton 1976). The oil is also employed to make mouthwash, gargles, toothpastes, cough syrups, lozenges, herbal essence, colognes, after-shave lotions, detergents, and scented soaps (Rosengarten 1969; Morton 1977).

Recipe Sources

Owen (1978) gives recipes entitled Thyme creamed onions, Thymely summer squash, and Pot roast with thyme. Belsinger and Dille (1984) present 14 thyme recipes, notably: Carrot soup with thyme, Oatmeal bread with thyme and walnuts, Spareribs and potatoes in thyme tomato sauce, Thyme grape jelly, Thyme mushroom pâté, Veal scallops with thyme caper sauce, Lox thyme rolls, Carrot soup with thyme, Butternut purée with thyme, Greek salad with thyme vinaigrette, and thyme mustard. Leggatt (1987) has recipes for Braised fish kebabs with thyme and mint flowers; Roast parsnips with honey and thyme flowers; Braised quails with thyme, lavender and oranges; and Red currant sorbet with thyme flowers. Richardson (1991) has recipes entitled Pot roast with thyme, French onion soup with thyme, Steamed clams with lemon thyme butter, Creole baked cod with thyme, Beef stew with beer and

thyme, Calf liver cooked in wine with thyme, and Rosemary-thyme shortbread. Barash (1993) has recipes for Thyme for guacamole, Thymed flounder, and Mussels with thyme flowers and fennel in saffron cream sauce.

Other recipes are: Thyme jelly (Crowhurst 1973); Grilled fish with thyme (McCormick 1979); Lamb steaks with thyme (Boxer and Back 1980); Fresh fava beans with thyme (Jaffrey 1981); Lamb chops with thyme (Mességué and Peter 1982); Thyme tea (Marcin 1983); Thyme roasted chicken with baby leeks (Hutson 1987); Pheasant pot roast with thyme (Bremness 1988); Pheasant supremes with honey and fresh thyme (Creasy 1988).

Importance

Garden thyme is grown in most European countries, notably France, Spain, Portugal and Greece (Simon et al. 1984). Some "thyme" is actually collected from wild plants in Europe and may represent several species of *Thymus*. Thyme is traded on the international market. In 1979, it was estimated that domestic U.S. production satisfied only 2% of use, while during the 1970's demand was growing at 5-10% per year. In 1988 the U.S. imported 938 t of unprocessed thyme valued at $2,101,900.00 mostly from Spain, and about 18 t of processed thyme valued at $20,500.00 mostly from Denmark (Anon. 1989*a*). Thyme is grown in significant commercial amounts in the western U.S. (Simon et al. 1984).

In 1976 Canada imported about 13 t valued at $10,000.00 (Greenhalgh 1979). There is limited commercial garden thyme production in Canada (Greenhalgh 1979).

About 4 t of thyme oil are produced annually from *T. vulgaris* [by calculation, from information in Lawrence (1992)]. In 1988, the U.S. imported about 14 t of thyme oil valued at $474,800.00, mainly from Spain and France (Anon. 1989*b*; the bulk of this would have been from *T. zygis*).

Four ha of thyme were cultivated in 1995 in Oklahoma for preparation of oleoresin (Motes, personal communication).

Cultivation Notes

Soil

Garden thyme requires a light, well-drained soil such as sand or sandy loam (Kublick 1990), preferably slightly alkaline (Schmidt 1980). In heavy, wet soil, thyme is short-lived and less aromatic (Morton 1977). A pH tolerance range of 4.5-8.0 has been reported (De Baggio 1987).

Climate

Garden thyme is winter-hardy at least to -15°C (Huxley et al. 1992). Marcin (1983) states that it will survive -29°C. It grows at temperatures between 4 and 28°C, optimally at 16°C. Thyme has been said to yield well in a

Fig. 393.
Garden thyme *(Thymus vulgaris)*, from Hallier (1880-1888).

range of temperate and Mediterranean environments (Simon et al. 1984). In North America, this species is winter hardy as far north as the warmer parts of Canada, but in colder regions a protective winter mulch of straw or other material is beneficial (Schmidt 1980).Alternatively, thyme can be potted in the autumn and kept indoors overwinter. Garden thyme requires a sunny location. It is drought tolerant, but some supplementary water is beneficial during dry periods. Thyme grown in a warm, sunny location has a more powerful flavor than plants growing in a damp, northern climate (Garland 1979).

Propagation and Cultivation

Propagation is by seeds, cuttings, layering, or root division. Specific selections of thyme are best obtained as cuttings or live plants to retain desired qualities of flavor and aroma. Thyme seeds are quite small and care must be taken to germinate them (Kublick 1990). Germination usually takes 2-3 weeks according to Schmidt (1980), 8-10 days according to Wang et al. (1993). The seeds are best started indoors in advance of transplanting outdoors, after the danger of frost has diminished. A planting depth of 6 mm or less is recommended (Wang et al. 1993). Commercial garden thyme plantings (in warm climates) are renewed every 2-3 years, because the plants tend to become woody, straggly, and low-yielding (Rosengarten 1969). The home gardener can plant garden thyme 15-20 cm apart to form an attractive solid border. In northern North America, garden thyme is best grown as an annual.

Thyme and lemon thyme (discussed below) can be grown indoors as pot plants, provided that they get at least 5 hours of strong, direct sunlight daily (Crockett and Tanner 1977). A standard commercial potting soil should be supplemented with lime chips or coarse sand to approximate the natural gravelly outdoor environment of the thymes (Crockett and Tanner 1977). The stem tips should be pruned regularly to encourage bushy growth, and the soil should be allowed to dry between waterings.

Harvest and Storage

In commercial production, the herb is harvested while in bloom. In California, mechanical harvesters cut off the flowering tops, including some of the tender stems and leaves. Two such harvests are taken each year (Rosengarten 1969). The herbage is dried in the shade to preserve the grayish-green color, and dries better than most other herbs (Greenhalgh 1979). A good yield is 1.1-2.2 t/ha fresh thyme (Prakash 1990).

The home gardener may cut the upper stems just as flowering begins, hang or lay the stems until dry in a dry shaded location, strip off the leaves, and store them in an airtight jar (Garland 1979).

Example Cultivars

Culinary herb forms are usually not sold as named cultivars. There is a German variation called "Winter-Type" that is adapted to low temperatures in Europe (Letchamo, personal communication). There are also selections known as English thyme and French thyme, as well as the ornamental Argenteus, sometimes called Silver Thyme for its attractive leaves. Several ornamental cultivars are listed in Huxley et al. (1992).

Additional Notes

Chemistry

The dried herb yields about 1% essential oil upon steam distillation. The essential oil is a pale yellowish-red liquid with a sweet, aromatic odor. A dark green or brown oleoresin is also extracted. The major constituent is thymol which comprises up to 50% of the essential oil. Generally 1 kg of the oleoresin is equivalent to 25 kg of freshly ground, dried thyme in flavor and aroma (Prakash 1990).

Several chemical races of garden thyme have been described (Morgan 1989) and these are associated with particular environments. Thymol is usually the major component of the essential oil but other chemicals such as geraniol, linalool, -terpineol, carvacrol, and *trans*-thuyanol-4 may predominate in some populations. The chemistry of the essential oil of garden thyme has been reviewed by Lawrence (1984*b*).

Medicine

Thyme was employed in folk medicine to treat anemia, asthma, bad breath, bronchitis, bruises, cancer, colds, colic, cough, cramps, diabetes, diarrhea, fever, flatulence, gingivitis, gout, headache, indigestion, laryngitis, leprosy, nerves, rheumatism, scarlet fever, snakebite, sore throat, sprains, tumors, warts, whooping cough, and worms (Duke 1985). In medieval Europe, garden thyme was regarded as a cure for nightmares and melancholy, and an aid to controlling menstrual flow, inducing abortion, and promoting urine flow. It was also supposed to strengthen the lungs and aid digestion. In Oman, garden thyme leaves (known locally as *za'ater*) were used for several ailments: powdered dried leaves were mixed with salt and cumin in tea and drunk to alleviate abdominal colic; dried leaves were mixed with ginger and boiled water and ingested for cough and bronchitis; leaves were boiled in water and massaged on breasts to bring milk down, or mixed with salt and warm water to wash the vaginal area after childbirth (Ghazanfar and Al-Sabahi 1993). In China and Japan the plant is used to treat whooping cough (Perry and Metzger 1980).

The antimicrobial properties of thyme oil and its components have long been recognized in medicine (Jackson and Hay 1994). The thymol in the essential oil is known for its antiseptic, disinfectant, and deodorant properties. The ancient Greeks recognized the antiseptic qualities and used thyme to preserve fruits and as a germ killer inside wine vessels (Laws 1981). The extracted oil has been used as an antiseptic ointment, dressing, or rub (Garland 1979). Thymol is employed in pharmaceutical preparations such as gargles, coughdrops, dentifrices, and mouthwashes. It

has also been used as a vermifuge to cure hookworm in horses and dogs (Rosengarten 1969). The use as a vermifuge in man has been discontinued because medicinally effective doses can cause death (Morton 1977).

Thyme oil is poisonous and thymol has caused dermatitis (Duke 1985). Thymol can also cause diarrhea, dizziness, headache, nausea, vomiting, muscular weakness, and can depress heart function, respiration, and body temperature (Morton 1977).

Nutrition

Ground thyme contains about 9% protein, vitamin A, thiamin, riboflavin, and niacin (Duke 1985).

Curiosities

• The world's earliest known written prescription appears to be an ancient Sumerian cuneiform document carved in a stone tablet, possibly prepared thousands of years B.C. (Zverina 1976). It has been translated as: "After grinding together the seeds of saffron and thyme and putting them in beer, the patient shall drink."

• The generic name *Thymus* has been interpreted as derived from the Greek *thumos*, courage or strength (Hereman 1868; Marcin 1983). In classical Greek times, this herb was thought useful to overcome shyness (Marcin 1983). Because of the association with courage, a compliment of the highest order was to tell someone that they "smelled of thyme" (Rosengarten 1969).

• The association with courage lasted into the Middle Ages when it was the custom of ladies to embroider a sprig of garden thyme into the scarves of the knights (Rosengarten 1969).

• Sprigs of garden thyme were placed in soldiers baths to enhance their prowess (Kublick 1990).

• Thyme has come to be associated with sacrifice and fumigation because it was used as incense to perfume and purify temples (Rosengarten 1969). Another interpretation of how the name *Thymus* originated Coy comparison with the one presented above) is that it comes from the Greek *thuo*, to perfume, commemorating the use for incense in the temples (Hereman 1868).

• Ancient Greeks thought that meat eaten with garden thyme would improve eyesight (Farrell 1985).

• Garden thyme has long been suggested to have been the "hay" used in the straw bed of the Christ child (Rosengarten 1969). It is therefore often included in the nativity scene as one of the "manger herbs" (Simmons 1964).

• Maidens once wore garden thyme in their hair to indicate their availability for marriage (Kublick 1990).

• According to English folklore, it was believed that if a girl took a mixture of thyme and rosemary on St. Agnes's Eve (20 January) she would be sent a vision of her future lover (Mercatante 1988).

• A bed of garden thyme was thought to be the home for fairies, and gardeners often left a patch for their use (Kublick 1990). According to legend, the king of the fairies and his followers dance in beds of wild thyme at midnight on Midsummer Night (Lust 1974; this recalls Shakespeare's *A Midsummer Night's Dream*). A recipe dated 1600 "To enable one to see the Fairies" is as follows (after Macleod 1968): "A pint of sallet oyle put into a vial glasse; first wash it with Rose-water and Marygolde water; the flowers to be gathered toward the east. Warm it til the oyle becomes white, then put it into the glasse, and then put thereto the budds of Hollyhocke, the flowers of Marygolde, the flowers or toppes of wild Thyme, the budds of young Hazle; and the Thyme must be gathered near the side of a hill where fairies used to be; and take the grasse of a fairy throne; then all these put into the oyle in the glasse and sette it to dissolve three dayes in the sunne and then keep it for thy use."

• Carl Linnaeus (1701-1778), the great Swedish botanist and father of the modem system of scientific nomenclature, recommended thyme as a cure for hangovers.

• Because it reminded them of a thyme flower, early anatomists named the lymph gland in the chest the thymus (Castleman 1991).

• Thyme has been called the "poor man's herb," because it can be grown in various soils without added fertilizers (Marcin 1983).

• In southern France, wild thyme is traditionally the symbol of extreme republicanism (Bryan and Castle 1974).

• Another tradition in southern France is to feed domestic rabbits thyme before they are killed, so that their flesh will acquire the attractive taste and smell of the herb (Toussaint-Samat 1992).

Fig. 394.
Garden thyme
(Thymus vulgaris),
from Harter (1988).

Problems and Potential

Garden thyme is of minor commercial importance in Canada and the northern U.S. and will likely remain so. Thyme production is widespread in the world, and relatively easily undertaken in regions more suited to garden thyme than northern North America. Production from the wild in Europe makes up a large portion of international trade, and can be increased considerably to meet short term demand (Greenhalgh 1979).

Selected References

Rosengarten (1969); Morton (1977); Garland (1979); Greenhalgh (1979).

Thymus Xcitriodorus (Pers.) Schreb. ex Schweig & Körte

Scientific (Latin) Synonyms

T. pulegioides L. *T. vulgaris* L.

English Names

Lemon thyme

French Names

Thym citronné (m)
Also: thym

[In the genus notes, it was explained that *T. pulegiodes* L. (including the lemon-scented cultivars Doone Valley and Lemon) are encountered in the garden trade; and that *T. serpyllum* L. is a name often misapplied in the garden trade to *T. pulegiodes* or *T. praecox* subsp. *articus*. Morton (1976) refers to "*T. serpyllum* var. *vulgaris*" as "lemon thyme," and states that it is quite distinct from *T. citriodorus*, which she interprets as a hybrid between *T. vulgaris* and *T. pulegioides* (as also done below). Her interpretation that "lemon thyme" is not *T. citriodorus* is inconsistent with the following discussion, and may reflect the (mis)application of the name *T. serpyllum* to lemon-scented forms of *T. pulegiodes*, noted above. As noted

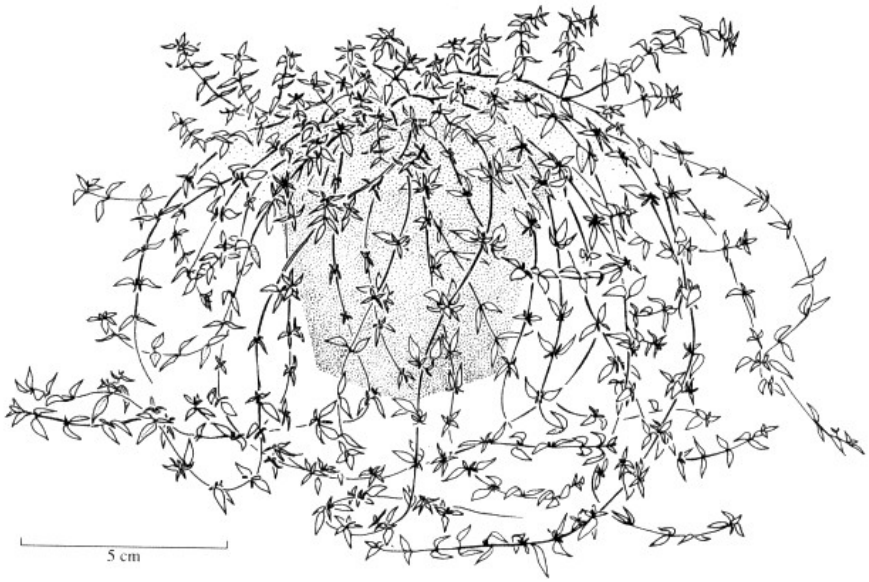


Fig. 395.
Lemon thyme *(Thymus ×citriodorus)*, prepared by S. Rigby. (Based on greenhouse plant from Richters.)

by Mansfeld (1986), biochemical forms of *T. pulegiodes* and other species with a lemon-like scent are often called "lemon thyme," but the name is principally applied to *T. citriodorus*.]

Lemon thyme is the principal thyme of commerce after garden thyme (Simon et al. 1984). It originated as a garden cross between *T. pulegiodes* and *T. vulgaris*. It has rounded green leaves, pale purple or pink-mauve flowers, and develops into a compact, cushion shape. The plants grow 10-35 cm in height. The upper leaves may be a bright lemon yellow color. Lemon thyme performs best in a sunny location in light, well-drained soils along a flower bed or in a rock garden. It is propagated by divisions or cuttings in the spring or autumn (Garland 1979). Rooting side shoots form readily and make propagation easy (Lima 1986). To prevent the plants from becoming very woody, they should be divided every 2 or 3 years (Jacobs 1972).

Lemon thyme is considered less hardy than garden thyme (Garland 1979). Huxley et al. (1992) rate it as capable of growing only as far north as U.S.D.A. zone 7, and Miske (1994) says it is marginally hardy to zone 5. However, it survives in Ottawa, Canada (zone 4). Overfertilizing produces lush, succulent growth that is susceptible to winter killing. Late season harvesting stimulates new growth that will not harden off well before winter. A protective winter mulch is helpful in northern areas. According to Jacobs (1972), the lemony-thyme taste and the smell of the plant are less pungent on heavy soil than on light soil.

Lemon thyme can be added to soups, fish, egg, and chicken dishes. It complements creamy sauces and some sweet dishes (Garland 1979). Jacobs (1972) recommended it particularly with white fish and egg custards. The leaves can be stirred into cottage cheese or sprinkled on buttered boiled potatoes. Lemon thyme also makes a flavorful tea (Kublick 1990). The essential oil contains citral which accounts for the lemon-like flavor (Prakash 1990). The taste is best when the leaves are used fresh. The delicate lemon bouquet is lost through drying or more than the briefest cooking (Lima 1986). Interesting recipes are Onion and lemon thyme tart (Holt 1991) and Lemon thyme cake (Richardson 1991).

North American garden catalogs offer "lemon thyme" cultivars, but it is often difficult to ascertain what species they belong to. Miske (1994) includes in cultivars of *T. citriodorus*: Aureus, with yellow variegated leaves; Argenteus, with silver margined leaves; and Doone Valley, a prostrate form. However, Bailey and Bailey (1976) list Argenteus and Aureus as cultivars of *T. vulgaris*, and Morton puts both under the ambiguous name "*T. serpyllum*."

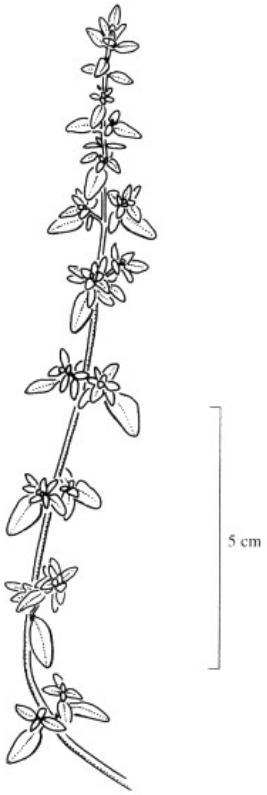


Fig. 396.
Lemon thyme *(Thymus ×citriodorus)* vegetative branch, prepared by S. Rigby. (Based on greenhouse plant from Richters.)

Thymus Herbs-Barons Lois.

English Names

Caraway thyme
Also: seedcake thyme

French Names

Thym corse (m)
[Name suggested by H.S. MacKee and F. Jacquemoud (personal communications).]

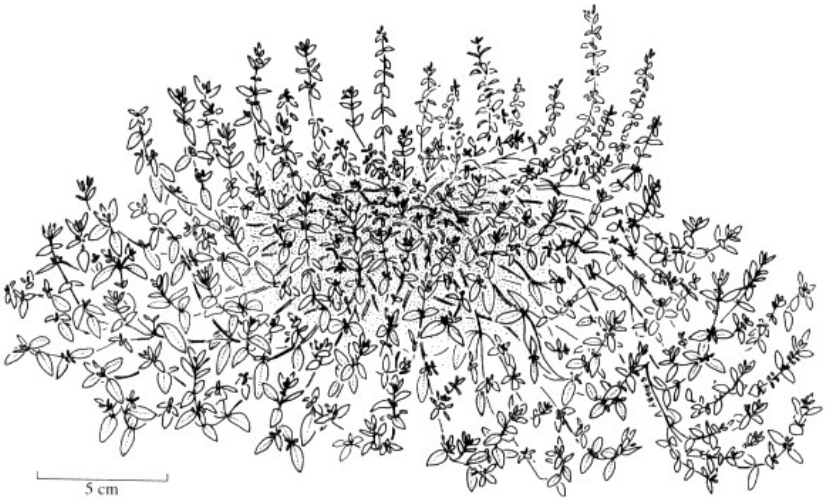


Fig. 397.
Caraway thyme *(Thymus herba-barona)*, prepared by S. Rigby. (Based on greenhouse plant from Richters.)

This species is a dwarf subshrub from Corsica and Sardinia. It is semi-prostrate, with arching branches and small, dark shining leaves. In mid-summer it produces deep rose-pink flowers. Caraway thyme has a distinctive flavor best suited for use with game, meat such as beef, and wines, and for cooking with garlic (Huxley et al. 1992). Jacobs (1972) described the flavor as resembling thyme and cam-way, but resinous. Lemon-scented is a cultivar strongly scented of lemons (Huxley et al. 1992). This species was used in Britain for the traditional dish "baron of beef" (hence *herba-barona* in the scientific name). The leaves were rubbed on the beef before it was roasted (Garland 1979), and are said to have not only flavored the meat but also to have acted as a preservative (Jacobs 1972). The species has been grown as an outdoor perennial culinary herb on Vancouver Island, where it has survived below-freezing temperatures (Jacobs 1972), but it is generally too tender for northern North American winters. It may be grown as an edible potted plant. Caraway thyme is usually propaged by tip-rooting, not by seed. Mature plants do not transplant well. Plantings should be renewed every 3 years, before they become woody. In warm areas, caraway thyme is ideal in sunny, dry rockeries. Leaves are best harvested before the flowers are open, and may be used fresh or dried.

Selected References

Jacobs (1972).

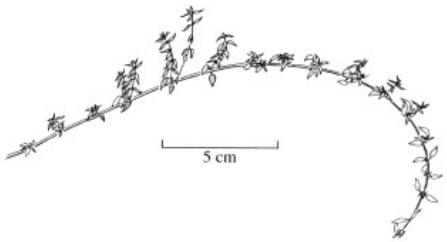


Fig. 398.
Caraway thyme *(Thymus herba-barona)* vegetative branch,
prepared by S. Rigby. (Based on greenhouse plant from Richters.)

T. Praecox Opiz.

English Names

Creeping thyme

French Names

Thym rampant (m)
[Name suggested by H.S. McKee (personal communication).]

This mat-forming herb, generally no higher than 5 cm, is native to Europe. Several subspecies are recognized in Europe (Jalas 1971; Tutin et al. 1972; Jalas 1980). Some cultivated selections belong to subsp. *articus* (E. Durand) Jalas. Some plants are sold as *T. serpyllum* L. (Flannery 1984). One form, available in Canada and the U.S., has a nutmeg scent and can be added to meat dishes or used as a tea (Kublick 1990). Several ornamental cultivars are listed in Huxley et al. (1992).

Trigonella

Family: Leguminosae (Fabaceae) (pea family)

Genus Notes

Trigonella has about 60 species of annual and perennial herbaceous plants native to Eurasia, with one species in Australia. *Trigonella* is very closely related to two genera that are relatively better known economically because they are the sources of major forages, namely *Medicago* (of which the best known species is alfalfa, *M. sativa* L.), and *Melilotus*, which includes several well known species of sweet-clover. Several species of *Trigonella* are also useful as pasture or fodder plants, and are occasionally eaten by humans in the Old World, but not in significant amounts. *Trigonella caerulea* (L.) Ser., sweet trefoil, is a native of Europe that is occasionally cultivated in the New World for ornament. In the Old World it is used to flavor cheese (green cheese as well as other cheeses in Switzerland), and the plant has also been employed to flavor bread, soup,

Fig. 399.
Sweet trefoil *(Trigonella caerulea)*,
from Curtis (1787-present; #2283).

and other dishes, and as an ingredient of Chinese tea. The species discussed below is the only one appreciably cultivated as a condiment.

Trigonella Foenum-Graecum L.

English Names

Fenugreek
Also: billy-goat clover, billy-goat hay, camel grass, common fenugreek, fenugrec, Greek clover, Greek hay, Greek hayseed, hay fenugreek

French Names

Family: Légumineuses, famille du pois
Fenugrec (m)
Also: fenégré, fênugreé, fênugrec, fenu-grec, foin grec (foingrec), graine joyeuse, saine graine, saine-grain(e), senegrain, sénégrain, senegré, senégré, sénégré, sénigré, sinégré, sirdac, trigonelle

Description, Taxonomy, and History

The classification of *T. foenum-graecum* was recently examined by Soskov and Bairamov (1990), who recognized a Mediterranean and an Indian fenugreek. However, the merit of this remains to be validated. Several species are closely related to *T. foenum-graecum*, but which is the most closely-related has not been ascertained (Ladizinsky and Vosa 1986).

Fenugreek is an annual that in most cultivated forms has erect, fairly stiff stems branched at the bases. It usually grows to a height of 30-60 cm. Fenugreek has a long tap root with numerous fine laterals bearing nitrogen-fixing nodules. The petals of the flowers are usually pale yellow, sometimes white, and sometimes with lilac at the base. The pods are very long and narrow (6-17 cm long, 3.5-5 mm broad), curved (rarely straight), slightly pubescent, with reticulate surface markings and a prominent, elongated, narrowing terminal portion. Before ripening the pod is green or reddish, and at maturity it is straw-colored or light brown. Ten-20 seeds are present in the pod, and these are oblong, "olive-green" (greenish-brown) or flesh colored, up to 5 mm long, and with tiny bumps on the surface.

Fenugreek is found in southern Europe and Asia. Its distribution range is difficult to ascertain because it was widely grown in antiquity, and appears to have escaped extensively from cultivation. Its wild distribution has been variously interpreted as including Mesopotamia,

Fig. 400.
Fenugreek *(Trigonella foenum-graecum)*, from Köhler (1883-1898).

Kurdistan, the Punjab, Kashmir, Iran, Asia Minor, Greece, Spain, and Ethiopia. It is not clear whether the plants reported as wild are truly wild forms or are simply feral escapes from cultivation.

Fenugreek is an ancient crop plant, known from an archeological site in Iraq dated at 4000 B.C., as well as from several Early Bronze Age sites of the Near East (Zohary and Hopf 1993). The antiquity of fenugreek is also evidenced by the many words for it in various languages of old derivation: Arabic, Indian (Sanskrit), Latin, and classical Greek. It was grown in ancient Egypt, Greece, and Rome. It is believed that the Greeks obtained fenugreek from India, where an endemic variant of the species is found. Primitive characters of the Indian variant are branching habit with numerous shoots emerging from the base, prompt release of seeds at pod maturity, small seed size, and adaptation to dry conditions.

There is notable development of regional cultivated variants in fenugreek, suggestive of long-continued selection in different parts of the Old World. In addition to the Indian form, fairly divergent variants are found in Abyssinia, Tunisia, Morocco, Egypt, Armenia, Azerbaijan, Turkey, Iran, and western China. If the hypothesis of India representing the center of origin is correct, then it would appear that the additional countries mentioned are secondary areas of variation and evolution.

Uses

The seeds of fenugreek were employed for medicinal and culinary purposes by the Egyptians, Greeks, and Romans, and these uses have persisted down to modern times. Today, fenugreek is a multi-purpose crop, harvested as a spice, a tea, a vegetable, a forage, for the production of dyes, and as a starter material in the production of steroidal hormones such as cortisone. Fenugreek is employed principally for its seeds, used as flavoring. The flavor and odor of fresh seeds are somewhat reminiscent of lovage and celery. Ground seed has a very strong, maple sweetness, spicy, somewhat meatlike (also described as "farinaceous" or "mealy"), but bitter. The aroma is comparable to burnt sugar, but is appetizing and pleasing. The seeds are best known for their use as a constituent of curry powders and spice mixtures, and as a condiment. They are also an ingredient of the Jewish sweet dish Halva, and are often found in mango pickles, chutney, stews and soups. Fenugreek seeds or extracts have been used in syrups, pickles, baked goods, candy, condiments, chewing gums, soft drinks, gelatins, pudding, ice cream, icings, and some prepared meat seasonings (Furia and Bellanca 1975; Farrell 1985). In India and in other eastern countries roasted seeds are used as a coffee substitute, and in mixtures with wheat and millet as bread. In the Western World the ground seeds are employed, with other aromatic substances, to produce

Fig. 401.
Fenugreek *(Trigonella foenum-graecum)*, prepared by M. Jomphe.

artificial maple flavoring. The flavor of fenugreek is also useful for blends that mimic caramel, vanilla, butterscotch, rum, and licorice (Arctander 1960).

In addition to the use of the seeds as a flavoring ingredient for food, the seeds are occasionally used directly as human food, primarily in the Old World. This is an example of a crop known as a "grain legume," a member of the Leguminosae family whose seeds provide human food in the same manner as the familiar cereal grains of the grass (Gramineae) family.

As a vegetable in Asia, seeds are often soaked in water, allowed to produce seedlings about 6 cm long, and the sprouts eaten raw. Young shoots can be chopped and added to salads (Loewenfeld and Back 1974). Sparingly used, "the fresh green leaf can give quite a kick to a salad" (Larkcom 1984). In India, young (rather bitter) leaves are also eaten, and there have been experimental attempts to produce dehydrated leaves for the market (Bajaj et al. 1993). A special variety of fenugreek called *kasoori methi* is used in India to produce highly fragrant, slightly bitter dried leaves, bearing the same name. These are used as a herb throughout India, primarily to enhance the flavor of sauces and gravies (Sahni 1990). *Kasoori methi* is often available in Indian grocery stores.

Fenugreek hay appears to have been used as an admixture in fodder to promote animal health, a form of veterinary practice in very early times which has persisted to the present. Seeds have also been fed to cattle, most notably in India, but Morton (1976) states that the seeds must be deodorized to avoid tainting the milk. Fenugreek is under development as a potential source of high-quality forage in western Canada, and early analyses have shown that the quality matches or exceeds that of alfalfa (Mir et al. 1993). More veterinary information is included in Medicine.

Among the miscellaneous uses of fenugreek are the following. It has been employed as a green manure for orchards, although alternative legumes are usually more suitable. In India, a yellow dye is extracted from the seeds. The seeds have been used as an emollient, and a flavoring agent in pharmacy. The oil is used in cosmetics, hair preparations, and perfumery (Duke 1985). The seed husks are an industrial source of mucilage (Roecklein and Leung 1987). Seeds have insect-repellent properties, and have been mixed with stored grain to protect the latter (Morton 1976).

Recipe Sources

Rosengarten (1969) provides recipes for Hearty vegetable bean soup with fenugreek and Fenugreek beef stew. Blanchard (1975) has recipes for Shrimp in cucumbers (with fenugreek sprouts) and Green rice salad (with fenugreek sprouts). Muenscher (1978) gives recipes for fenugreek seeds entitled Pork pie with corn bread topping, Another meat sauce, Carrot casserole, and Peanut butter apple quickie. Mallos (1979) gives recipes for Fenugreek paste, Fenugreek and coriander paste, Flat bread with fenugreek and coriander paste, and Mixed herb platter.

Other recipes are: Fenugreek seed tea (Loewenfeld and Back 1974; Muenscher 1978; Marcin 1983); Cauliflower and potatoes cooked with fenugreek and fennel seeds (Jaffrey 1981).

Importance

Fenugreek is cultivated in all Mediterranean countries, the Near East and Middle East, northeastern Africa to Ethiopia, Arabia, Turkey, India, China, and Japan. The major areas of cultivation currently are in southern Europe, northern Africa (particularly Morocco, Ethiopia, and Egypt), and India, where the seeds have been harvested for centuries as a flavoring ingredient. Sufficient material is grown in India and Morocco for there to be a small export trade. Cultivation has become infrequent in central to northern Europe.

Fenugreek is of limited commercial significance at present in North America. It has been cultivated to some extent in Argentina. In Canada it was first raised as an experimental essential oil and spice crop at the Agriculture and Agri-Food Canada Research Station at Morden, Manitoba in the middle 1970's. It has since undergone experimental cultivation and breeding to adapt it to Canada (Crop Development Centre 1991; The Furrow 1992). Fenugreek is cultivated and used occasional as fodder in the United States. For seed, it has mainly been grown in California. The food use of fenugreek is culturally entrenched in peoples of the Old World, particularly Indians, and so one encounters it grown occasionally by emigrants to North America.

Cultivation Notes

Soil

Fenugreek requires well drained, medium-textured loams of at least moderate fertility. The pH tolerance range is 5.3-8.2 (Duke and Hurst 1975; Duke 1978). Growth is retarded in wet soils. As a legume, fenugreek can enrich soils by providing nitrogen, and the plant itself needs little if any nitrogen fertilizer.

Climate

A growing season of 4 or 5 months is required. This species is a short-day plant, flowering initiated by shortening days of late summer. Full sun should be provided, although garden plants will tolerate slight shade. Fenugreek grows between 5 and 30°C, optimally about 17°C.

Fig. 402.
Fenugreek *(Trigonella foenum-graecum)*, from Duthie (1893).

Growth is slow and weak at cold temperatures. In areas where temperatures do not go lower than-16°C, sowings under cover in autumn are possible, for a winter crop (Larkcom 1984).

Propagation and Cultivation

Fenugreek is grown from seeds. Fenugreek seeds are advertised in the catalogs of a number of Canadian and American seed supply firms.

Harvest and Storage

After the seeds mature the plants are uprooted and dried, and the seeds threshed and separated. The seeds are additionally dried before storage. Harvests of 675-900 kg/ha seeds have been achieved under favorable conditions (Rosengarten 1969). In England, experimental plantings have produced seeds yields of 3700 kg/ha (Roecklein and Leung 1987). When the plants are grown for hay, yields of about 2 t/ha have generally been realized, although in India 9-10 t/ha of green forage have been produced (Roecklein and Leung 1987) and, in the U.K., forage yields of 12.5 t/ha dry weight have been recorded (Mir et al. 1993). Plants grown for salad purposes (a quite infrequent use) can be sown every 3 weeks for a regular harvest, and the young plants harvested when at a height of about 5 cm.

Example Cultivars

Singh et al. (1994) studied cultivars named Pusa Early Bunch, HM46, and HM57.

Additional Notes

Chemistry

The fixed oil content is about 7%, and is responsible for the odor and flavor of fenugreek. The fatty acids in the fixed oil are chiefly linoleic (60%), oleic (15%) and palmitic (12%) (Lewis 1984). The very bitter taste results from the presence of two alkaloids, trigonelline and choline (Farrell 1985).

Although the seeds are odorous, the volatile oil content is very low, usually less than 0.02% (Farrell 1985), and is mainly made up of anethole (Lewis 1984). While the nonvolatile components of fenugreek seed are relatively well known, little has been published on the volatile portion (Lawrence 1987c). A furanone, 3-hydroxy-4,5-dimethyl-2(5H)-furanone, has been reported to possess the characteristic aroma of fenugreek seed (Girardon et al. 1985, 1986).

Fenugreek seed is a source of the steroid sapogenin diosgenin. Diosgenin, generally isolated from tubers of certain species of *Dioscorea*, is the starting compound for over half of the total steroid production by the pharmaceutical industry (Simon et al. 1984).

Medicine

Fenugreek is one of the oldest cultivated medicinal plants (Simon et al. 1984). The seeds and hay appear to have definite therapeutic value for livestock, as correctly observed by ancient civilizations. Fenugreek fodder has been used to promote animal health for millennia. At times it is added to poor hay to increase the palatability of the latter. Fenugreek is still used as a stimulant and appetizer in livestock food and tonic preparations.

In the past, fenugreek has been used to treat a variety of human ailments. Drugs from the seeds were used for medicinal ointments and plasters, in the treatment of digestive disorders and fevers, and for bronchitis, sore throats, wounds, swollen glands, skin irritation, diabetes, ulcers,

and cancer (Simon et al. 1984). Fenugreek has also been used to promote lactation and as an aphrodisiac (Simon et al. 1984).

Today, drugs from the seeds are used both in human and veterinary medicine. The seeds are a source of diosgenin for use in the synthesis of the female contraceptive pill and synthetic sex hormones. The steroid diosgenin can be converted to progesterone, an anti-estrogen hormone secreted by pregnant women (Rinzler 1990). Fenugreek seeds have been reported to lower blood glucose levels in experimental animals, and indeed the seeds have been used as an oral insulin substitute (Simon et al. 1984). The steroidal sapogenin peptide ester (fenugreekine) has various effects on metabolism (such as promoting urine flow and decreasing tension), and inhibits replication of some viruses (Duke and Ayensu 1985). Fenugreek seeds currently are used in medicine in Asia [Perry and Metzger (1980) and Duke and Ayensu (1985) review various uses].

Fenugreek is often found in health-food stores, but the frequently repeated caution in this book about the dangers of self-medication should be remembered. Coumarins and estrogen in fenugreek can be toxic in overdoses (Duke 1985). Tyler (1993) observed that fenugreek is not a particularly potent medicament, and is quite harmless in normal use.

Nutrition

The seeds of fenugreek contain about 23% protein, 9% oil, and 10% or more carbohydrate. The plant itself is quite nutritious, and is considered a good source of protein, ascorbic acid, niacin, and potassium (Simon et al. 1984). In the Middle East, meatless diets are often supplemented with boiled fenugreek seeds served as a high-protein main dish (Rinzler 1990). Fenugreek seeds contain trigoneline, which when heated or in contact with acids yields the B vitamin niacin (Rinzler 1990). Vitamin C content of the herb is good, but boiling for 5 minutes causes a 50% loss, and drying makes the content negligible (Toghrol and Pourebrahimi 1976). Duke (1977) characterized seed content of calcium, calories, fiber, phosphorus, protein, riboflavin, and thiamin as high, and content of iron as very high; and content of calcium in the leaf as high. Singh et al. (1994) studied a number of "antinutritional factors" in fenugreek seeds, including -galactosides of sucrose (reported to promote flatulence), saponins (toxic to some organisms), phytate (reduces bioavailability of minerals), and phenolic monomers (toxic to some bacteria). The extent, if any, to which these factors in fenugreek are harmful to human nutrition is not clear.

Curiosities

• The genetic name *Trigonella* comes from the Greek *treis*, three, and *gonu*, angle or comer, a reference to the triangular appearance of the flowers of some of the species; the specific epithet *foenum-graecum* is Latin for Greek hay, a reference to the ancient use of the plant in Greece to scent hay (compare derivation of *Foeniculum* in fennel Curiosities).

• In many oriental countries, fenugreek seeds were consumed particularly for the purpose of giving "a captivating buxom plumpness" to the female human form (Rosengarten 1969). Morton (1976) pointed out that women of Libya and Eritrea still eat fenugreek seeds to gain weight. In North Africa and the Middle East, where the seeds are taken "to encourage an alluring roundness of the breast in women generally," the seeds are also eaten to stimulate breast milk (Garland 1979). Castleman (1991) noted that diosgenin in fenugreek seeds is similar to the female sex hormone estrogen, which encourages the body to retain water. Just as "The Pill" causes water retention and bloating in some women, perhaps the fenugreek chemical may have caused some women to develop Rubenesque proportions (Castleman 1991).

• In ancient Egypt, fenugreek was one of the components of *kuphi* ("holy smoke"), an incense used in fumigation and embalming (Rosengarten 1969).

• The Romans laid siege to Jerusalem from A.D. 66 to A.D. 70. The Jewish defenders of Jerusalem added fenugreek to the boiling oil and water that was poured on the Roman troops, on ladders, as they attempted to scale the city walls (Castleman 1991). Mixed with water, ground fenugreek becomes gelatinous and slippery, and would have made it more difficult for the Romans to keep their footing. Castleman (1991) thought this was the only example of the use of a herb in warfare, but see Curiosities for *Capsicum frutescens*.

• In the Middle Ages fenugreek was used as a cure for baldness in men, and in modem Java it has continued to be used in hair tonics (Rosengarten 1969). Small animal studies have revealed potential therapeutic applications of fennel seed in treating baldness, but the utility for human beings has not been verified (Tyler 1993). Male pattern baldness is related to the activity of the hormone testosterone and, as discussed above, fenugreek seeds have hormonal activity.

• The chief ingredient (next to alcohol) of the original formulation of "Lydia Pinkham's Vegetable Compound" is fenugreek seed (dandelion was also present; see

Taraxacum Curiosities). This was an old-time panacea for what was termed "female weakness" (menstrual discomforts) or "female hysteria" (menstrual complaints); one hesitates to think of what female physicians would have construed as male weakness or male hysteria. Lydia's compound is celebrated in verse (Tyler 1993):

> Widow Brown she had no children,
> Though she loved them very dear;
> So she took some Vegetable Compound,
> Now she has them twice a year.

Problems and Potential

Although presently grown primarily on an experimental basis in North America, *T. foenum-graecum* is an appealing new crop that deserves to be considered for purposes of crop diversification in Canada and the U.S. It is presently being developed in western Canada, both as a source of seeds used in the manufacture of steroids, and as forage. Fenugreek is agronomically suited to the prairie environment of Canada and the U.S. (Kiehn and Reimer 1987). It has good potential both as a food plant and as a source of pharmaceuticals.

A fungus disease, Cercospora leaf spot, has been identified as a potentially serious problem for growing fenugreek in western Canada (Zimmer 1984). Cercospora can completely destroy a crop (Kiehn and Reimer 1987).

Selected References

Sinskaya (1950); Lewis (1984); Simon et al. (1984); Farrell (1985).

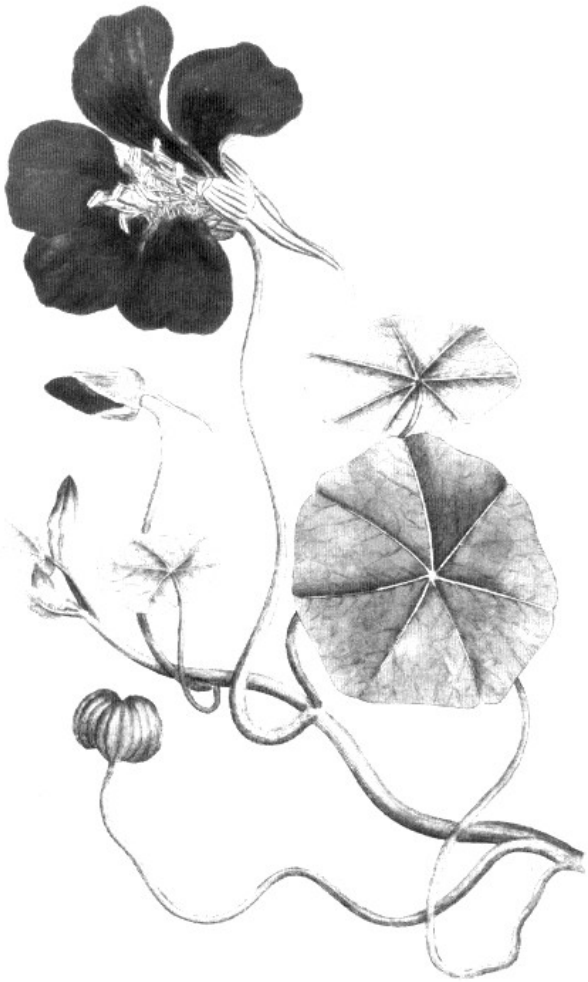


Fig. 403.
Nasturtium *(Tropaeolum majus)*, from Curtis (1787-present; #23).

Tropaeolum

Family: Tropaeolaceae (nasturtium family)

[Often placed in Geraniaceae in older literature.]

Genus Notes

"Nasturtium" as a common name refers to species of the South American genus *Tropaeolum*, not to species designated by the scientific name *Nasturtium*. This curious transfer came about through the similar taste of the leaves, flowers, and fruits of *Nasturtium* and *Tropaeolum*, as the popularity of growing the latter in flower gardens increased (Fernald et al. 1958). *Nasturtium officinale* R. Br. is widely grown as the vegetable watercress, and is discussed in detail in this book.

Tropaeolum has about 90 species of annual or perennial herbs, distributed in cool highlands from Mexico to central Argentina and Chile. *Tropaeolum tuberosum* Ruin. & Pavon is grown in the high Andes for its tuberous root, used as a vegetable. Flower buds, young fruits, and leaves of several species in addition to those described in detail below can be eaten (Uphof 1968).

Warning

Do not use nasturtium plants for culinary purposes unless certain that they have not been sprayed with insecticides, herbicides, or fungicides.

Herbs such as nasturtium that are generally used as ornamentals but are known to be also used occasionally as a condiment have generally not been well studied from a health and dietary viewpoint. It is common sense, therefore, to limit use on any given occasion, as well as on a long term basis.

Tropaeolum Majus L.

English Names

Nasturtium
Also: canary creeper, creeping canary, cress of India, cress of Peru, garden nasturtium, Indian cress, tall nasturtium

French Names

Family: Trop(a)éolacées, famille de la capucine
Capucine grande (f)
Also: capuce de moine, capucine, capucine à larges feuilles, capucine d'Inde, capucine ordinaire, cresse du Pérou, cresson de Chine, cresson des Indes, cresson des jésuites, cresson d'Inde, cresson du Pérou, cresson du Mexique, fleur de sang, fleur sanguine, grande capucine, (grand) cresson d'Inde, (grand) cresson du Pérou, mastouche, sanguine

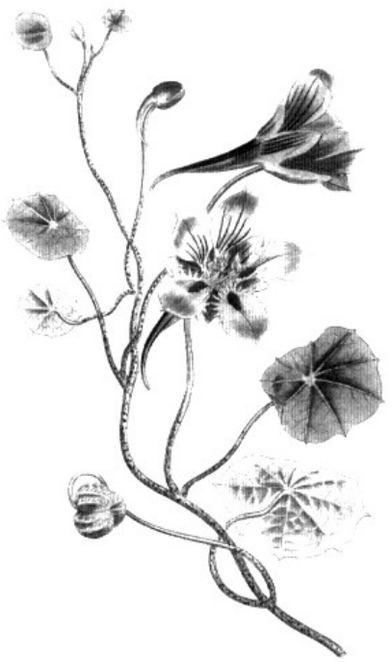


Fig. 404.
Dwarf nasturtium *(Tropaeolum minus)*,
from Curtis (1787-present; #98).

Tropaeolum Minus L.

English Names

Dwarf nasturtium
Also: cress of India, cress of Peru, Indian cress, (lesser) Indian cress, small Indian cress, small nasturtium, Tom Thumb nasturtium, Yellow Lark's heels
[Several of these names are the same as used for *T. majus*.]

French Names

Capucine naine (f)
Also: capucine petite, cresson du Pérou, petite capucine, petit cresson d'Inde

Fig. 405.
Nasturtium *(Tropaeolum majus)*,
from Nicholson (1885-1889).

Description, Taxonomy, and History

Tropaeolum majus is a usually climbing, somewhat succulent annual herb with yellow, orange, red, or creamy white flowers up to 7 cm wide. The spreading stems extend to 3 m, curling around any object they contact. The odor of the plant is mustard-like (Morton 1981). Several of the ornamental forms available have double flowers and colors other than the common ones mentioned above. The species is apparently native to Andean South America, including Ecuador, Peru, and Columbia. However, it is difficult to determine its indigenous range, as it occurs in the feral state in many tropical and subtropical areas. The species

Fig. 406.
Dwarf nasturtium *(Tropaeolum minus)*,
from Vilmorin-Andrieux et C^{ie} (1883).

has been cultivated for over 300 years. It is grown in many countries as an ornamental, and sometimes escapes to the wild.

Tropaeolum minus, native to northwestern South America, is similar, differing in being dwarf, non-climbing, having smaller flowers, the lower petals of which are spotted, and smaller fruits. Garden forms of *T. minus* may have been hybridized with *T. majus* (Bailey 1909). The species has been cultivated in Europe since the 16th century, and was grown in England in the Middle Ages as a root vegetable (Mansfeld 1986).

In past times, both species were favorite garnishes of cold dish salmagundi (a salad plate of chopped meats, anchovies, eggs, and vegetables arranged in rows for contrast and dressed with a salad dressing) (Morton 1976). Continuing this tradition of elegant food, blossoms are sometimes stuffed with herbs, capers, and tuna fish, and served as hors d'oeuvres (Morton 1976). The following comments apply equally to *T. majus* and *T. minus*.

Uses

Nasturtiums are grown mostly as tender garden ornamentals- perennial in hot climates, annual in temperate regions. The common species of nasturtium, *T. majus* and *T. minus*, are also grown for pickling. The leaves, petals, and seeds have a hot, peppery taste. Flower buds and unripened fruit can be placed in vinegar and used like capers. Crushed flowers can be steeped in spiced vinegar, after which the mixture is strained and employed as a sauce. The leaves or shoot tips are sometimes used as a condiment, or in salads and sandwiches like cress, which they resemble in taste. Page (1980) recommends that leaves be eaten fresh as they develop a bitter taste if kept very long. The leaves can also be stuffed like grape leaves in the Greek manner (Halpin 1978; see Recipe Sources). The flowers are also added to salads where they contribute not just flavor but color. Ripe, dried seeds can be ground up and used as seasoning.

Garland (1979) stated "the unripe fruits can be pickled like capers, but should not be eaten in large quantities as they may become purgative." Page (1980), referring to personal medicinal use of nasturtium leaves and flowers, noted that "nasturtium can be harmful if taken in excess and not more than 15 g (1/2 oz) should be eaten at any one time."

A yellow dye can be obtained from the stems of *T. majus* (Morton 1981).

Recipe Sources

Crowhurt (1973) gives recipes for Nasturtium capers, Nasturtium sandwiches, Nasturtium soup, and Stuffed nasturtium. Smith (1973) presents 17 recipes for nasturtium,

including: Clear nasturtium soup, Nasturtium sauce, Pickled nasturtium pods, Nasturtium vinegar, Nasturtium salad dressing, Tossed salad with nasturtiums, Fruit salad nasturtiums exotica, Nasturtium-mushroom salad, Potato salad à la nasturtiums, Crab salad à la nasturtiums, Nasturtium cottage-cheese delight, Asparagus with nasturtium sauce, and Nasturtium sandwiches. Bryan and Castle (1974) provide recipes for Pickled nasturtium seedpods, Nasturtium-mushroom bake, and Nasturtium leaf roll-ups. Scobey and Myers (1975) have recipes for Nasturtium capers and Nasturtium vinegar. Leggatt (1987) presents recipes for Pumpkin, tomato, onion and nasturtium bake; Nasturtium salad with young, fresh salad leaves; and Stir-fried fresh crab with ginger and yellow and red nasturtiums. Barash (1993) has 13 nasturium recipes, including Nasturtium fettucine and Salmon nasturtium pizza.

Other recipes are: Nasturtium sauce (Fox 1933); Pickled nasturtium berries (Leyel 1938); Nasturtium salad (Rose 1979); Mock capers (Loewenfeld and Back 1974); Nasturtium and radish cheese canapés (Owen 1978); Cucumbers and nasturtium leaves salad (Larkcom 1984); Nasturtium tea sandwiches (Jeanneret 1987); Pickled nasturtium seeds (Bremness 1988); Nasturtium shrimp appetizer salad (Creasy 1988); Stuffed nasturtium leaves (Holt 1989); Wild mushroom risotto with nasturtium butter (Holt 1991).

Importance

Nasturtium is grown as an ornamental, and is one of many bedding plants sold in the garden trade. Its use as a culinary herb is of no commercial importance.

Cultivation Notes

Soil

Nasturtium is known to grow well in poor soils, but an ordinary garden loam, preferably somewhat sandy, is ideal (Halpin 1978). Very rich soil or excessive nitrogen encourages lush foliage but fewer blossoms (Halpin 1978). The soil should be fairly moist but well-drained.

Climate

Young plants are sensitive to frost, and should not be transplanted to the outdoors until late spring. The plants grow best in warm, sunny locations, but will tolerate some shade.

Propagation and Cultivation

Nasturtium grows readily from seeds, which in northern North America are preferably started indoors in pots or boxes for transplanting after danger of frost. The seeds germinate in a week, or even more quickly if soaked in lukewarm water overnight before planting (Crockett and Tanner 1977).

Tip cuttings can be taken and rooted in late autumn, before a killing frost, and used to establish windowsill plants that can provide edible foliage and blossoms during the winter (Halpin 1978). Indoor plants require at least 4 hours of direct sunlight daily, and temperatures ranging from 4 to 8°C at night to no more than 20°C during the day (Crockett and Tanner 1977). The soil should be kept barely moist, and the plants fed with a liquid fertilizer.

Nasturtiums attract aphids. Crockett and Tanner (1977) recommend that if nasturtium is to be harvested for culinary purposes, chemical sprays should be avoided, and the plants s. imply washed with a garden hose in the hope of dislodging insect pests.

Harvest and Storage

Flowers should be used when fully open but still fresh, while the leaves can also be dried after chopping, or dried whole and subsequently crumbled (Loewenfeld and Back 1974). Leaves are most tender before the plants flower. The seeds pods can be used when small or full grown, but should still be green.

Example Cultivars

Many ornamental cultivars are available, but rarely recommended particularly for culinary purposes. Belsinger (1991) notes that Alaska and Empress of India have often been recommended in seed catalogs as edible cultivars;

Fig. 407.
Nasturtium *(Tropaeolum majus)*,
from Lamarck and Poiret (1791-1823).

and she recommends the cultivars Whirlybird and Dwarf Jewel for their edible flowers. Because of hybridization, cultivars of nasturtium are often blends of at least two species. Huxley et al. (1992) list several cultivars alleged to belong to "*T. majus*." Sutton's Sunset, and Sutton's Salmon Pink are cultivars of dwarf nasturtium.

Additional Notes

Chemistry

Nasturtium contains mustard oils, which contribute to the peppery flavor. The glucosinolate glucotropaeolin has been recorded in the seeds (Stuart 1979), and especially in the young leaves (Morton 1981). This has antibiotic and fungistatic activity (Morton 1981).

Tropaeolum majus seed oil has the highest proportion (75-80%) of erucic acid of any known seed oil (Carlson and Kleiman 1993). The seeds have a low oil content, but at least in principle represent a potential new source of commercial seed oil (Carlson and Kleiman 1993).

Medicine

Nasturtium was used in classical herbal medicine (Fleury de la Roche 1924). An infusion in water of fresh leaves was considered to stimulate appetite and urination, and to counteract scurvy and scrofula (swollen lymph glands of the neck). The plant was also used to treat infections of the genito-urinary and respiratory systems (Stuart 1979). Morton (1981) records the following medicinal uses: stem decoction for coughs and bronchitis in Guatemala; plant juice for ringworm in Mexico; pulverized fruits as a purgative in Argentina; and seed oil as a rubefacient (skin reddening agent) in Cuba.

Handling nasturtium plants sometimes causes skin irritation (Morton 1981).

Nutrition

Nasturtium leaves are rich in vitamin C, hence their use as an antiscorbutic (see mention of scurvy, above). A nutritional analysis of the seeds revealed that they are very high in iron and phosphorus (Goel and Kumar 1989).

Curiosities

• The genus name *Tropaeolum* was coined by Linnaeus from the Latin *tropaeum*, meaning trophy, which meant victory in battle. In classical times this was often signified by setting up a tree-trunk on the battlefield and hanging captured helmets and shields upon it. The analogy with nasturtium is explained by the fact that gardeners used to grow the plants up poles, and Linnaeus thought the rounded leaves were like shields, and the flowers like spear-pierced, bloodstained helmets (Huxley et al. 1992).

• In England, garden cress (*Lepidium sativum* L.) was commonly used in salads, when leaves of nasturtium started to be used for the same purpose. To distinguish the two, nasturtium was called Indian cress.

• In the Victorian language of flowers, nasturtium signifies patriotism (Barash 1993).

• Thomas Jefferson (1743-1826), the third president of the United States, grew many herbs at Monticello, his well known estate in Virginia. His favorite herb was nasturtium (Barash 1993).

• Dwight D. Eisenhower (1890-1969), the 34th president of the United States, included nasturtium in his highly prized recipe for vegetable soup (Smith 1973).

• Nasturium flowers have a "spur" (a hollow, tube-like extension). The cultivar Whirlybird lacks this spur, making it easer to clean, as there is no place for insects to hide (Barash 1993).

Problems and Potential

The species discussed in detail here have no prospects of being developed commercially for their edibility. Their economic importance lies in their continued use in the garden trade as bedding plants, a usage which has declined in recent years. The extraordinarily high proportion of erucic acid in the seed oil is of potential economic importance, albeit at present seemingly unlikely to be exploited commercially.

Selected References

Carlson and Kleiman (1993).

Viola

Family: Violaceae (violet family)

Genus Notes

Viola is a genus of world-wide distribution, centred in the temperate regions, but occurring in mountainous areas in the tropics. It has 400-500 species of perennial, rarely annual, stemless or stemmed herbs, and occasionally subshrubs and vines. Many of the species produce open and showy (chasmogamous) flowers in the early spring (these are often sterile), and closed (cleistogamous) flowers that lack petals and produce seeds by self-pollination and fertilization in the bud throughout the summer. About 80 species occur in North America (Brizicky 1961). Numerous species of *Viola* are grown as ornamentals, particularly in rock gardens and as edging or border plants, especially in moist, rich soils and partial shade. Pansies, violas (rafted pansies), and violettas (miniature violas) are names commonly used to designate the three major groups of horticultural violets (Fuller 1990, 1994). Horticultural forms are usually hybrids, derived from breeding and rigorous selection of species belonging to *Viola* section *Melanium*. The most familiar are the garden pansies, *V. wittrockiana* Gams, which are presumed to have arisen from hybridization between *V. lutea* Huds., *V. tricolor* L., and possibly *V. altaica* Ker-Gawl. (Mabberly 1987; Fuller 1990). The flowers and leaves of *V. wittrockiana* have a stronger flavor than other violets, and are eaten in salads or used as a garnish; the flowers are also used to make tea. *Viola tricolor*, known as European wild pansy, miniature pansy, field pansy, and Johnny-jump-up, is naturalized in North America, where it is known as the wild or field pansy. This pansy is well known for its flowers that often combine different colors, such as yellow, purple, red, and white. A medicinal preparation called traviolin has been obtained from the leafy stems of *V. tricolor* in Russia (Brizicky 1961). A few other species of violets have been used on a very limited basis as food (Uphof 1968; Facciola 1990) and Szczawinski and Turner (1980) state that the leaves of all the violet species of Canada are edible.

The use of violets as food is ancient, although very limited, extending back to early Greek and Roman times, when violets were used to flavor butter, oil, vinegar, and wine (Szczawinski and Turner 1980). Violet-flavored sherbet has been a favorite concoction of Asia Minor and other parts of the Middle East since very early times (Coombs 1981), some considering this the national drink of Syria and Turkey (Wetherbee 1986). The violet was one of the first flowers grown commercially, with nurseries established in Greece about 400 B.C. (Coombs 1981). In the 15th century,

Fig. 408.
European wild pansy *(Viola tricolor)*,
from Köhler (1883-1898).

violets were often used in sauces and soups, and to make fritters, and some members of the Royalty in Great Britain during the Victorian era were fond of violet preparations (Szczawinski and Turner 1980). The leaves of wild violets were used as a substitute for okra in the south during the American Civil War (Fernald et al. 1958).

Sweet scented "Parma violets" are sometimes thought to have been derived from *V. odorata*, although there is evidence to suggest that they originated from other fragrant *Viola* species (Huxley et al. 1992). These are hardy only in warm areas. Parma violets are cultivated in southern Europe as a source of essential oil for perfumery.

Violets were used in ancient times. The classical Greeks and Romans used violets in their wine, conserves, and cosmetics (Loewenfeld and Back 1974). Violets were not merely harvested from the wild, but are known to have been cultivated at least back to 300 B.C. (le Strange 1977). They were once commonly grown in gardens as a drug plant, primarily in Europe but also in India. Classical herbal uses are presented in the section on medicine.

Viola Odorata L.

Scientific (Latin) Synonyms

V. officinalis Cr.

English Names

Sweet violet
Also: blue violet, common violet, English violet, florist's violet, garden violet, March violet, purple violet, scented English violet, sweet-scented violet, violet, wild violet

French Names

Family: Violacées, famille de la violette
Violette odorante (f)
Also: février, fleur de carême, fleur de mars, jacée de printemps, jacée du printemps, violette de mars, violette (bleue), violette de carême, violette des hales, violier commun, violier de mars
[Several of the above names reflect the early spring-flowering of the plants.]

Warnings

(1) While leaves and flowers of sweet violet are edible, rhizomes, roots, and seeds can be harmful (see Medicine). (2) Do not use the plants for culinary purposes unless certain that they have not been sprayed with insecticides, herbicides or fungicides.

Description, Taxonomy, and History

Viola odorata is a low-growing (to 15 cm tall) perennial, stemless herb arising from a creeping rhizome, and spreading by long, rooting stolons (runners or creeping rhizomes). The flowers are dark violet (varying to paler shades), rose or white, and fragrant (in some plants they have an exceptionally delightful odor). The leaves are heart shaped. Unlike most species of *Viola*, the seeds of *V. odorata* are not forcibly ejected from the fruit at maturity. The species grows wild in Europe, Africa, and Asia, and occurs as an occasional garden-escape to roadsides and waste places across Canada and in much of the U.S. This is the best known *Viola*, since it has long been used as a source of perfume, and is common in the florist trade

Fig. 409.
Sweet violet *(Viola odorata)*, from Hallier (1880-1888).

and in gardens. There are many selections that have been made for these purposes. Cultivars differ in stature, and the flowers range considerably in size and color, with some forms having double flowers. Ornamentals generally have much larger flowers than wild plants of the species. *Viola odorata* is a member of *Viola* section *Viola*, and so is not closely related to the garden pansies (of section *Melanium*) discussed above.

Uses

Viola odorata is one of the few violets with petals sufficiently strong that they hold their shape when candied (Rinzler 1990). Candied violet flowers are used to decorate cakes, puddings, and ice cream, and fresh flowers are sometimes put in salads (Loewenfeld and Back 1974). The flowers may also be processed into syrup, jellies and marmalade, and can be added to gelatins, ices, vinegar, honey, wines, and salad dressings. According to Grieve (1931), the flowers can have a slight laxative effect (violet syrup and root extract can be quite laxative).

Young leaves can be eaten in salads and soups, or dipped in batter and fried (Facciola 1990). For decorative effect, violet leaves and the fresh flowers can be used as an edible garnish on meat dishes, particularly veal (Stobart 1977). Both leaves and flowers may be used to brew tea.

Violet syrup or extract is sometimes used to flavor ice creams, candy, baked goods, and liqueurs (Furia and Bellanca 1975). One sweet, violet-colored liqueur has the attractive name of *parfait amour* (Stobart 1977).

Practical means of extracting perfume from violets were not found until the 19th century (Coombs 1981). Violet has been said to be of equal importance in perfumery to rose and jasmine (Cu et al. 1992). About 100 kg of flowers are needed to produce just 31 g of essential oil, a ratio of 100 000: 31 (Uphof 1968). Violet flowers are no longer commonly used as a source, but the volatile natural products of the leaves continue to be extracted for perfumery. Sweet violets are grown for perfumery especially in northern Italy, southern France and on the southern coast of the Crimea (Mansfeld 1986).

The principal use of sweet violet is in horticulture. The plants are widely grown in gardens and in the florist trade.

Sweet violet can be used as a ground cover. In the mountains of Java it has been used to anchor the soil.

Recipe Sources

Crowhurt (1973) presents recipes for Violet omelette, Violet salad, Violet soup, Violet whip, and Pansy wine. Smith (1973) gives 28 recipes with violet. Bryan and Castle (1974) have recipes for Violet salad and Pansy honey custard. Coon (1977) provides 30 violet recipes, and states that "the uses of violets in food preparation are practically limitless." Smith (1977) has recipes for Violet mushroom salad, Violet jam, Candied violets, Violet studded snowball (with ice cream and sherbet), Poached salmon and violets, Cold soups h la violet, Violet "spinach," and Violet tea. Szczawinski and Turner (1980) provide recipes for Violet greens, Violet and watercress salad with sour cream, and Fried violet leaves. Leggatt (1987) has recipes for Wholemeal red and yellow pepper quiche with pansies [Substitute viola for pansy (*Viola wittrockiana* Gains.).], Hot cauliflower bake with cheese and violas, Scented green salad with violets, Prawns (shrimp) in hot cheese sauce with violets and chives, Primavera salad with violets and exotic fruits, and Crème pâtissière with crystallized violets. Barash (1993) has recipes for Violet salad, Violet lavender sorbet, Chocolate violet cake, and Oranges with violet syrup.

Other recipes are: Violet flower syrup (Loewenfeld and Back 1974); Candied violets (Hériteau 1975); Flower jelly (Rose 1979); Violet herb salad (Bremness 1988); Frangipane tart with crystallized violets (Holt 1989); Violet mint sauce (Schofield 1989); Crêpes with viola cream filling and violet syrup (Belsinger 1991).

Importance

Sweet violet is commercially important mostly as a florist's flower and as a garden ornamental. It is also a source of extracts used in perfumery. Usage as a culinary herb is limited.

Cultivation Notes

Soil

Sweet violets thrive in rich or well-enriched soils. Heavy, sandy loams that are well drained but capable of retaining and supplying moisture at all times are best. Sweet violet thrives in moderately rich, moist, well-drained soil, preferably supplemented with compost, manure, or leaf mold (Crockett and Tanner 1977).

Climate

Sweet violets can be maintained outdoors in southern Canada and much of the U.S., but benefit from a winter coveting of leaves in colder regions. Sweet violets are often grown in greenhouses or in frame culture with or without artificial heat for the florist industry. Outdoor plants thrive in partial shade, reflecting the natural woodland habitat of the species.

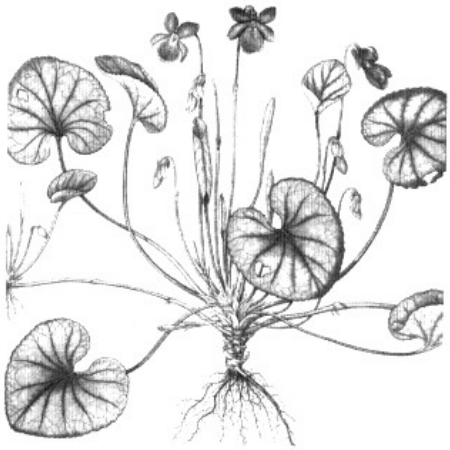


Fig. 410.
Sweet violet *(Viola odorata)*, from Bulliard (1784).

Propagation and Cultivation

This species is usually increased by offsets removed in late winter or early spring. These are best rooted in sand. Vigorous old plants can be divided in the spring, but this should not be done with plants that appear weak or unhealthy. Cuttings can also be made from well-developed runners (stolons) and rooted in sand. Plants can be reproduced from seed, but this is not usual. Regular weeding is essential.

Harvest and Storage

Flowers for culinary purposes can be gathered and used fresh in the spring when they appear. Coon (1977) recommends picking the blossoms in shade, thoroughly washing them in cool water, draining, drying the petals on a cloth-covered screen with no petal touching another, covering with a second layer of cloth, and allowing a period of drying in the shade away from sunlight or direct heat to help retain color and fragance. When crumbly to touch, the dried petals are placed in air-tight containers and stored in a warm, dark, dry place.

Example Cultivars

There are numerous cultivars in the horticultural trade. Coombs (1981) presents an extremely extensive list. Varieties suited for use as a culinary herb have not been identified.

Additional Notes

Chemistry

Sweet violet contains saponins, a glycoside, violarutin; methyl salicylate and salicylic acid glycosides; mucilage; an alkaloid, odoratine; and anthocyanin pigments (Stuart 1979). On hydrolysis, the root glucoside gaultherin yields methylsalicylic acid (Morton 1981). The chemical composition of violet has been extensively studied for the perfumery industry. Over a hundred compounds have been recorded. Cu et al. (1992) provide an excellent review of the literature.

Medicine

In classical herbal medicine, sweet violets were used to treat many diseases and conditions. Flowers, leaves, seeds, and "roots" (rhizomes) were all employed in medicine. An infusion of flowers was used as an emollient, calmative, and for the treatment of pulmonary infections and fevers. This was also employed as a gargle for sore throat. Violets were also used to treat insomnia and, very commonly, as a laxative. A syrup of the herb and flowers was recommended as an effective cure for venereal disease (Bryan and Castle 1974). Many of the folk uses in Europe were transferred to the New World, especially from Spain, and are still commonly encountered in Central America and southwards (Morton 1981). Sweet violet is rarely used in modem medicine, although it is employed by herbalists [those interested can consult Grieve (1931) and Loewenfeld and Back (1974)].

Seeds and rhizomes can be poisonous in large doses, causing severe gastroenteritis, nervousness, and respiratory and circulatory depression (Lewis and Elvin-Lewis 1977). The rhizomes, roots, and seeds are strong laxatives, and can induce nausea and vomiting (Rinzler 1990).

Nutrition

According to Bryan and Castle (1974) both the leaves and flowers are high in vitamins A, C, and iron. Szczawinski and Turner (1980) state that the leaves of violet species are exceptionally high in vitamins A and C.

Curiosities

• The genus name *Viola* traces to the Greek word for violet, *ion* [*vion* in an earlier form, according to Steam (1992a)]. *Io* was a nymph in Greek mythology who was turned into a cow. To console her and sweeten her diet, the god Zeus turned her tears into violets (Schofield 1989).

Fig. 411.
Sweet violet *(Viola odorata)*, from Sturm (1900-1907).

• The name pansy originates from the French pensée for thought or thinking of you, believed to be based on the resemblance of the flower to a face in deep contemplation (Barash 1993).

• Like the sweet violet, many other species of *Viola* produce both open (chasmogamous) and closed (cleistogamous) flowers in individual plants. This phenomenon occurs in at least 56 families (Mayers and Lord 1983). In most such species open flowers are large and showy, attracting insects for cross-pollination, whereas the closed flowers are much smaller and produce seeds by self-pollination and fertilization as a hedge against the possibility that insects won't be available for pollination, and seeds won't be produced at all (Schofield 1989).

• Much so-called "violet" scent actually comes from orris "root" [rhizomes of *Iris germanica* L. var. *florentina* (L.) Dykes, and *I. pallida* Lam.] (Anon. 1982b).

• Violets have long been used in love potions. The classical Greeks chose violet as their flower of fertility (Loewenfeld and Back 1974).

• The sweet violet was held in such esteem in ancient Greece that it became the symbol of the city of Athens (le Strange 1977).

• The esteem in which the violet was held is also reflected by a Moslem proverb attributed to Mohammed: "The excellence of the violet is as the excellence of Islam above all other religions." In the Koran, Mohammed says 'The superiority of the extract of violets above all other extracts is as my superiority over the rest of men" (Coon 1977).

• In the Middle ages violets were placed in pillows to give them a sweet scent (Loewenfeld and Back 1974).

• In southern Germany during the Middle Ages, the discovery of the first violet to emerge triggered rejoicing. It was tied to a stake as a symbol of the coming of spring, and a festival was held in its honor (Fox 1933).

• Violets have been associated with death, especially with the death of the young, as reflected in works' of great writers such as Shakespeare and Milton (Grieve 1931).

• Robin Hood and Sir Richard dined on stewed violets gathered in the woods (Coon 1977).

• Before litmus (which is obtained from lichens) was widely employed to indicate pH, syrup of violets was used (it turns red with acids, green with alkalies) (Coombs 1981).

• The story of Napoleon and Josephine, and the sweet violet that united them, has been recorded by Grieve (1931) and Wetherbee (1986). Napoleon's favorite flower was the violet, perhaps because the flowers reminded him of his childhood in the woods of Corsica. He met Josephine at a ball, where she wore a coronet of violets and carded a bouquet of violets, which she threw to him from her carriage while departing. In memory of this, she wore a wedding gown embroidered with violets, and he gave her violets on each anniversary of their wedding. When he was sentenced to live out his days at Elba, he told his followers that he would return in the spring, with violets. In fact, in 1815 he returned to the royal palace in Paris, showered by fragrant, purple violets. Accordingly, he was called by his followers "Caporal Violette" and "Papa-Père la Violette," and the violet was adopted as the emblem of the Imperial Napoleonic party. After Josephine's death, Napoleon picked some violets near her grave, keeping them along with a lock of Josephine's hair in a locket near his breast until he died. His life-long grief, however, did not prevent his remarriage.

• When the French monarchy was restored, the wearing of violets was banned, and French governments off and on until 1874 forbade any reproduction showing a violet, the symbol of the Bonapartists (Lehner and Lehner 1960). Nevertheless, the violet flourished in the early days of the French Republic (Coombs 1981). France was flooded with postcards picturing innocent-looking violets with Napoleon's portrait cleverly hidden among the flowers (Lehner and Lehner 1960).

• In the 19th century, the training of sweet violets to grow as "trees," reminiscent of tree roses, became popular (Coombs 1981). This was done by encouraging a leader through cutting back branches for at least 2 years. The result was a self-standing stem, sometimes approaching a metre in height, topped by a crown of flowering branches.

• The violet is the symbol of New Brunswick, Poland, and North Portugal (Coon 1977).

• Symbolism of violet flowers includes (Coombs 1981): sweet = modesty, blue = faithfulness, white = purity of. sentiment, small white = candor and innocence.

Problems and Potential

Sweet violet has established stable markets in horticulture, the florist trade, and perfumery. Fungal diseases in the early part of this century threatened the horticultural industry, but research has brought these diseases under control. Usage as a culinary herb is presently very restricted and will likely remain so.

Selected References

Coon (1977); Szczawinski and Turner (1980); Coombs (1981); Farrar (1989).

Fig. 412.
Ginger *(Zingiber officinale)*, from Köhler (1883-1898).

Zingiber

Family: Zingiberaceae (ginger family)

Genus Notes

There are about 100 species of *Zingiber*. These are perennial herbs, native to the shaded forest lowlands of tropical Asia. In addition to the species discussed below, several are used as ornamentals in tropical areas and are occasionally grown in northern areas in greenhouses. A few others are used locally in Asia as spices, mostly gathered from the wild (Uphof 1968; Facciola 1990).

Mioga ginger [*Zingiber mioga* (Thunb.) Rose.] is a native of China and perhaps Japan, that is grown in more temperate climates than ginger, discussed below (Cost 1984). The rhizomes are used as a source of Japanese ginger, which has a bergamot-like flavor (Uphof 1968). In Japan, the non-fibrous bases of spring shoots are pickled, dyed red, and used for garnish. Young flowers and fruits are also consumed. In California, some mioga ginger has been grown for the Japanese ethnic community, the sprigs eaten fresh as part of a Buddhist tradition (Cost 1984).

Ginger, discussed below, should not be confused with wild ginger (*Asarum canadense* L.), a native of North America growing from Manitoba to New Brunswick, south to Kansas and North Carolina (Erichson-Brown 1979).The rhizome of wild ginger has the flavor and taste of ginger and has been used by native Americans for flavor and as a medicinal plant.

There are a number of exotic ornamental species in the ginger family that have ginger in their names, including red ginger [*Alpinia purpurata* (Vieill.) K.Schum.], shell ginger [*A. zerumbet* (Pers.) B.L. Burtt & R.M. Sm.], torch ginger [*Nicolaia elatior* (Jack) Horan.], white ginger (*Hedychium coronarium* J. König), and yellow ginger (*H. flavum* Roxb.). All of the preceding are illustrated in Morton (1971).

Zingiber Officinale Roscoe

English Names

Ginger
Also: Canton ginger, common ginger, East Indian ginger, Jamaica ginger (Jamaican ginger), red ginger, stem ginger, true ginger
[Ginger grass is *Cymbopogon martinii* var. *sofia*, discussed in the Genus notes for *Cymbopogon*.]

French Names

Family: Zingiberacées, famille du gingembre
Gingembre (m)
Also: anome, anome des Indes, gingembre officinal, herbe au gingembre

Description, Taxonomy, and History

Ginger is a herbaceous perennial, producing reed-like stalks 30-150 cm high from a thick, creeping, jointed rhizome. Flowering stalks and non-flowering, leafy stems emerge separately from the rhizome (flowering stalks are often not produced in some climates). Small flowers are produced in a cluster. The plant is known only in cultivation, and wild forms have not been identified (Purseglove et al. 1981). However, a dwarf ginger with unusually small rhizomes was collected by the National Research Centre for Spices, India, from Western Ghats of Kerala, and Kokkat (personal communication) considers it to be the first collection of purely wild ginger. Ginger is one of the oldest and most widely consumed spices and has been extensively disseminated since ancient times. The area of origin is uncertain, likely from tropical Asia or Indonesia (Farrell 1985; Huxley et al. 1992). Maximum variability of cultivated ginger occurs in the northeastern region of India (Ravindran et al. 1994). Cultivars vary in rhizome pungency and color, with white, pale yellow, yellow and red predominating.

Ginger was one of the first spices to reach Europe from Asia and was originally thought to be an Arabian product because it was transported by Arabian traders (Rosengarten 1969; Stobart 1977). Legend holds that around 2400 B.C. a baker on the Isle of Rhodes, near Greece, prepared the first gingerbread (Fanrrell 1985). This recipe found its way to Egypt where its flavor was so revered that it was served on ceremonial occasions (Farrell 1985).The ancient Romans distributed ginger products throughout their empire. Ginger was mentioned by the Chinese philosopher Confucius (551-479 B.C.) (Rosengarten 1969). Marco Polo (ca. 1254-1324) was the first European to record ginger growing in China. In 14th century England, it was the second most common spice after pepper (Harrington 1978).A ship manifest from the 16th century shows that ginger was already being imported to Europe from San Domingo in the West Indies (Farrell 1985). The early Spaniards had introduced ginger before that time, perhaps earlier than 1547 (Farrell 1985).

The familiar commercial product comes from the fleshy, underground rhizome (botanically a stem), called "root" in the commercial trade, and this convention will be followed here. So-called "stem ginger" is taken from the new growth of rhizomes, highly regarded for tenderness

due to lack of fibers (Stobart 1977). Ginger from different countries is often very characteristic, because of a combination of cultivar used, cultivation techniques, climate, and preparation technique. Thus different forms of commercial ginger are obtained from Jamaica, Sierra Leone, Nigeria, India (Cochin ginger), and Japan (Farrell 1985). Clones from different countries produce differently colored gingers ranging from light, buff in Jamaica to a darker hue in Nigeria (Farrell 1985).

Uses

Ginger is an extraordinary spice. It rounds out the flavor of some foods, accents others, and contributes a unique freshness. Ginger's pungency increases with the application of heat (Farrell 1985). The range of foods with which ginger can be used, as noted below, is exceptional.

Commercial products include fresh rhizomes, dried ground ginger, and candied ginger. The fresh root is an important component of Asian and Oriental cooking. The taste of fresh material is considered milder than that of the dried product. In New Delhi, India, shops sell 20-year-old pickled ginger called "gillori," made of large wafer-thin slices rolled into little triangles around a stuffing of spices and pinned with a clove (Stobart 1977).After scraping the skin away, fresh ginger may be preserved in strong spirit or sherry. Ginger is also canned, crystallized in sugar, or preserved in syrup, a practice originating in ancient China (Stobart 1977). Stem ginger is the form preferred for the manufacture of preserved or crystallized ginger because it is less fibrous than older parts of the rhizome. The pink-colored young rhizomes are milder than the mature rhizome as they contain less gingerol, which makes ginger "hot" (Harrington 1978). In Japan, the young rhizomes are marinated briefly in rice vinegar and sugar and are known as red-pickled ginger or "beni-shoga." The rhizomes may be washed and dried with the skin left on; the resulting product is relatively dark and is known as "green" or "black" ginger (although the outer flesh is actually brown). This is sometimes parboiled, skinned, and bleached white. Peeled ginger is called white ginger. A fine powdering of lime may be added and this preparation is highly regarded (Purseglove et al. 1981). In cooking, dried ginger is "bruised" by hitting with a rolling pin or hammer, to open the fibers and allow the flavor to escape.

In the West, dried powdered ginger has traditionally been the most commonly marketed form, although fresh ginger root is now widely available in supermarkets. The powdered product is of lower quality and it may have been adulterated. The volatile essential oil that provides the special flavor is often lost on drying (Stobart 1977).

Fresh ginger is peeled and either thinly sliced or ground to a pulp for inclusion in curries, meat, poultry, and fish dishes. Shrimp, scampis, or mussels are delicious stirred in a pan with a mixture of ginger, soy sauce, and brown sugar. Ginger is commonly added to Chinese stir fries and vegetable dishes and is also popular in Japanese cooking. "Pink ginger," commonly served in Japanese restaurants as a garnish, can be made by removing the skin of very young ginger roots, slicing the ginger very thin, dipping it in lemon juice, and seasoning with salt; the lemon juice turns the ginger pink (Rinzler 1990). Ginger is a component of many types of baked goods including gingerbread, cakes, gingersnaps and other cookies, pumpkin pie, and puddings. It is also added to creams, sweet sauces, ginger beer, ginger wine, cordials, soft drinks, and punches. As a table condiment it is sprinkled on fruits, particularly melons, peaches, and pears. Ginger is delicious on ice cream or made into a syrup for use in barbecue sauce, baked apples, fruit compote, and ice cream (Farrell 1985). It can also be added to soups, macaroni and cheese, mincemeat, pickles, sweet rolls, and fried chicken. The taste of winter squash, pumpkin, sweet potatoes, and carrots is particularly enhanced by ginger. Young, spicy ginger shoots are also eaten as a potherb or putted and used in sauces and dips (Facciola 1990). Ginger becomes milder with cooking, but turns bitter if burned Rinzler (1990).

Commercially, ginger or one of its extracts is combined with products similar to many of those mentioned above. Ginger is often added to prepared meats such as sausage, knockwurst, bologna, salami, and pressed ham (Farrell 1985). The essential oil is occasionally used in flavoring drinks, cookies, and desserts (Van Beck 1991). The oil is also used in cosmetics such as mens' toilet lotions, pharmaceuticals, and in perfumes (Rosengarten 1969; Van Beck 1991). The oleoresin is used to flavor soft drinks such as ginger ale, ginger beer and gingerade.

Ginger is an attractive ornamental when in leaf, both in the house and garden. It is a good example of edible landscaping.

Recipe Sources

Rosengarten (1969) provides recipes for Ginger orange rice, Ginger pickled beets, and Hawaiian gingered pork. Hooker (1971) gives recipes for Gingered ham and oranges, Fresh coconut-ginger bread, and Ginger syrup. Claiborne and Lee (1972) have recipes for Pigs' feet with ginger and Steamed whole crabs with ginger sauce. Garland (1979) has recipes for Steamed spinach and ginger and Irish ginger (which is mostly whisky). McCormick (1979) gives recipes for Ginger cream dressing and Lamb in gingered

cranberry sauce. Dahlen and Phillipps (1983) present recipes entitled Pickled ginger and Beef & stem ginger. Cost (1984) presents 75 ginger recipes. Jeanneret (1987) provides recipes for Coconut and ginger muffins, Ginger shortbread, and Ginger squares. Norman (1990) has recipes for Salmon with ginger and lime; Crab with avocado and ginger; Shiitake mushrooms with ginger, fagara and garlic; Gingerbread; and Caribbean ginger beer. Shulman (1991) has recipes for Boston brown bread with ginger, Gingered carrots, Ginger-flavored buckwheat pasta, Gingered mushrooms, Grapefruit and figs with ginger and lime, Ginger tea, and Iced ginger-lime tea.

Additional recipes are: Ginger ice cream (Day and Stuckey 1964); Ginger beer (Wolfe 1972); Stir-fried duck with spring ginger (Chang et al. 1979); Coffee with ginger (Mallos 1979); Pickled ginger (Shepard 1979); Ginger jelly (Stuart 1979); Duck soup with purslane and ginger (Boxer and Back 1980); Whole fried fish with ginger sauce (Brennan 1981); Fried chicken with ginger (Sing 1981); Ginger garlic dressing (Rogers 1983); Pear ginger sorbet (Tolley and Mead 1985); Gingered Thai vinegar (Hutson 1987); Oriental squash in ginger sauce (Richardson 1990); Baked sweet potatoes with chive and ginger butter (Holt 1991); Steamed fish with young ginger (Solomon 1992).

Importance

Ginger, "the 10th most important spice of commerce" (Awang 1992), is a major spice traded on the international market. Countries like India produced for the international market as much as 70 000 t of rhizomes annually in the 1980's (Sethi and Anand 1982), although 15 000-25 000 t was more common (Purseglove et al. 1981). More recently, India produces about 1 485 000 t annually (for both domestic and foreign consumption) from an estimated 53 300 ha (Ravindran et al. 1994). Much of this production is for the domestic market. The major producing areas are the West Indies (especially Jamaica), India, West Africa (especially Sierra Leone), Malaysia, Sri Lanka, Fiji, Hawaii, Japan, and Queensland (Australia) (Duke and duCellier 1993). Other areas of cultivation include China, Egypt, Nigeria, Mexico, and Central and tropical South America (especially Brazil) (Purseglove et al. 1981; Farrell 1985). Ginger from Jamaica is consider by some to be of the highest quality (Farrell 1985). Over the period 1986-93, Indonesia was the world's biggest exporter (Dull 1995), and The United Kingdom and the Arab countries are the major importers (Duke and duCellier 1993). Ginger is not cultivated as a crop either in Canada or mainland U.S. Hawaii's recent statistics: 1991:5443 t worth $7,560,000.00 from 101 ha; 1992:5262 t worth $6,380,000.00 from 117 ha; 1993:4491 t worth $5,247,000.00 from 146 ha; 1994: 2722 t worth $5,220,000.00 from 61 ha (Dull 1994*a,c*, 1995).

Most of the ground and sweet ginger imports in recent years to the U.S. have came from Taiwan and Thailand. In 1988, the U.S. imported 4575.8 t of fresh ginger valued at $3,768,530.00, about 100 t of ground, dried ginger valued at $191,370.00, 378 t of sweet ginger valued at $650,090.00, and 247 t of candied ginger valued at $646,710.00 (Anon. 1989*a*). Most of the fresh ginger came from Brazil and south Pacific Islands (particularly Fiji). Imports in succeeding years were: 1989 - 4500 t worth $5,150,000.00; 1990 - 5800 t worth $6,570,000.00, and 1991 - 7450 t worth $8,000,000.00 (Duke and duCellier 1993).

No Canadian statistics seem available on importation of ginger products into Canada. Canada was the principal market in 1993 for U.S. ginger exports, accounting for 85% of the 1182 t exported from the U.S. (Dull 1994*a*).

Fig. 413.
Ginger *(Zingiber officinale)*, from Engler and Prantl (1889).

Li (1992*a*) notes that ginger may be grown as a crop in British Columbia greenhouses, although locally grown plants have no economic significance.

Verlet (1993) estimated the annual world value of ginger essential oil to be $2,750,000.00 (U.S.).

Cultivation Notes

Soil

In the tropics, ginger is grown commercially in well-drained, rich, well-tilled, medium-textured soils (Rosengarten 1969).A pH range of 5.5-7.0 is best (Hackett and Carolane 1982), with a tolerance range of 4.3-7.5 (Duke and duCellier 1993). In temperate regions, ginger is grown by home gardeners in pots containing a rich soil of equal parts compost, potting soil, and peat moss (Lima 1986). Poorly drained soils cause rhizomes to rot (Duke and duCellier 1993).

Climate

Ginger is mainly grown in the tropics, and is not a suitable crop for North America. Growth of ginger occurs between 17 and 35°C, optimally about 23°C. It requires warmth and grows best with high humidity and abundant water. The plant has been rated as capable of surviving outdoors as far north as U.S.D.A. climatic zone 6 (Creasy 1982), but it requires winter protection. The rhizomes are sensitive to water-logging (Purseglove et al. 1981). During active growth, pot-grown ginger should be given plenty of water and grown in partial shade. The plants lose their leaves and die back at the end of summer and should not be watered while they are dormant in the winter (Huxley et al. 1992). Light watering should be started when new shoots appear, and increased watering provided as the leaves grow.

Propagation and Cultivation

Although a perennial, ginger is often grown commercially as an annual. The plant is propagated by the splitting of the fleshy rhizomes [the portions are known as "seed pieces" or "setts" (Purseglove et al. 1981)]. In commercial production, small pieces of rhizome 2-5 cm long are planted just below the soil surface on ridges, 30-50 cm apart. Ginger plants are heavy feeders and are usually grown in a rotation of crops (Rosengarten 1969).

For the home gardener, the rhizomes are placed horizontally 1-2 cm deep Under the soil surface in large pots. Either the rhizomes are planted directly, or cut into smaller pieces, each with at least one "eye." This is best done in the spring as the rhizomes are dormant during the winter. The soil should be kept moist until new shoots emerge, which may take more than a month. The plants should receive occasional fertilizer during the growing period. The pots can be placed outside in light shade when there is no danger of frost. Ginger leaves are easily damaged by wind. However, the plants will survive for many years indoors, even in an eastern- or western-facing window, providing harvests for use in the kitchen (Lima 1986).

The easiest way to obtain a ginger plant is to purchase a healthy fresh rhizome in a grocery store and plant it following the above directions. Some Canadian and U.S. garden catalogs also offer living rhizomes.

Harvest and Storage

In commercial operations, the rhizome is harvested 7 months to a year after planting. The rhizomes are lifted at 7 months after planting, while still immature, for producing preserved ginger. If left to continue developing after 7 months, the rhizomes become more pungent, but also more fibrous, and while they may be better suited to the production of dried ginger, they are unsuitable for preserved ginger. The rhizomes are lifted (usually by hand), washed, and then they may be peeled and dried depending on the desired product (Rosengarten 1969; Purseglove et al. 1981). Yields vary greatly, good harvests varying from 1570 to 2250 kg/ha (Purseglove et al. 1981). (Much higher yields are often reported, based on fresh weight rather than dried product.) Lewis (1984) stated that commercial yields of green ginger are normally between 10 and 25 t/ha. A yield of 40 t/ha, worth over $50,000.00/ha, has been obtained in Hawaii (Duke and duCellier 1993).

The home gardener should allow the plants to grow for about 6 months before harvesting portions of rhizome. A piece can be harvested by digging into the soil with a sharp knife or small spade. The entire rhizome can be lifted annually. Some of the rhizome can be cut off for use in the kitchen and the rest can be replanted (Lima 1986). Small pieces can be cut off as desired. Harvested fresh rhizomes should be washed immediately, and if not promptly consumed, may be air-dried in the shade for 1 or 2 days to allow the cut surfaces to partially heal, and stored.

Ginger can be stored fresh in a refrigerator for about a week if wrapped in plastic to protect it against excess humidity (Harrington 1978). For longer storage, place the piece of rhizome in a small jar of sherry, and refrigerate. It will apparently keep almost indefinitely this way (Harrington 1978). The rhizome can be frozen. However, it should be grated for use in recipes while still frozen because thawed ginger root becomes too mushy to grate. The rhizomes can be stored for a year by steeping them in a solution of salt, acetic acid, and potassium

metabisulphite, and then kept in clean jars (Sethi and Anand 1982). This does not require refrigeration. Pieces can be removed from the rhizomes as needed.

Example Cultivars

Chinese yellow is described by Facciola (1990). Purseglove et al. (1981) and Lewis (1984) list a number of popular commercial cultivars. Since ginger is propagated vegetatively, cultivars are clones.

Additional Notes

Chemistry

The essential oil of ginger is obtained by steam distillation and makes up about 1-3% of the fresh rhizome (Rosengarten 1969). The pungency comes from the chemicals zingerone, shogaol, and gingerol; the flavor is mainly due to cineol, borncol, geraniol, linalool, zingiberene, and farnasene (Purseglove et al. 1981; Farrell 1985). An oleoresin is obtained by percolating ground ginger with acetone or other solvents and then evaporating off the solvent. The extract is dark brown to black and semi-solid. Of the oleoresin, 1 kg is equivalent to 25 kg of freshly ground ginger in aroma and flavor (Farrell 1985). Additional information on the chemistry of ginger is provided by Awang (1992).

Medicine

Ginger has a long history of use as a medicinal plant. It was employed in the Middle Ages to treat the Black Death, and indeed may have been of some help because it can promote sweating (Stobart 1977). It has also been used to reduce flatulence and colic, as an aromatic stimulant of the stomach, and for reducing colds and coughs (Garland 1979; Farrell 1985). There are similar uses in veterinary medicine - to treat indigestion in horses and cattle, colic of horses, and to prevent griping from purgatives (Ravindran et al. 1994). Ginger is considered quite useful in preventing the effects of sea sickness and motion sickness (Garland 1979; Tyler 1993). Indeed, Chinese sailors chewed ginger to prevent sea sickness well before medical science had demonstrated the effectiveness of this treatment (Castleman 1991). Ginger has been experimentally shown to delay rancidity in salted pork patties (Rinzler 1990), and in pre-refrigeration times was almost certainly invaluable as a preservative, like many other herbs. Ginger has been used in China for almost 2500 years, and the claim has been made that it is an ingredient in almost half of all oriental herbal medicines (Awang 1992). It continues to be used in China for various medicinal purpose, such as for the treatment of bleeding, chest congestion, cholera, colds, diarrhea, nausea, stomach ache, baldness, cancer, rheumatism, snakebite, and toothache (Duke and Ayensu 1985). In India, ginger is one of the essential ingredients of most of the ayurvedic (traditional Hindu medicine) preparations. In Vietnam it is used to treat intestinal diseases (Nguyeñ-Xuân-Duñg and Dà-Tât-Loi 1991). Perry and Metzger (1980) review the rather extensive uses in other Asian countries. Ginger has a broad range of interesting medical properties deserving of additional study (Awang 1992).

Ginger is generally regarded as safe, minor heartburn the most serious side effect recognized (Awang 1992). Some people simply find ginger irritating to the stomach (Rinzler 1990). Tyler (1993) notes that some studies have suggested that very large overdoses carry the potential for depressing the central nervous system and causing irregular heartbeat.

Nutrition

Ginger rhizome is a good source of vitamin C (Harrington 1978). Ancient Chinese navigators took pots of ginger with them to prevent scurvy on long voyages. The roots contain 8.5-12.9% protein, 3.2-7.7% fat, and 60.0-80.6% carbohydrate; the principal carbohydrate of the root is starch, with small quantities of glucose, fructose, sucrose, and traces of raffinose (Duke and Ayensu 1985). Duke (1977) characterized content of fiber, iron, and potassium as high. Additional information on nutrient content is given in Duke and Ayensu (1985).

Fig. 414.
Ginger *(Zingiber officinale)*,
from Hatter (1988).

Curiosities

• The genus name *Zingiber* comes from the Sanskrit word *singabera*, meaning "horn-shaped," in reference to the shape of the rhizomes (Rosengarten 1969; Rinzler 1990).

• An old Indian proverb states "Every good quality is contained in ginger" (Castleman 1991).

• Ginger was once regarded as an aphrodisiac (Rodway 1979). Its aphrodisiac qualities were alluded to in the "Thousand and one nights" (Purseglove et al. 1981). It was purported to be so potent that after simply rubbing one's hand with ginger, just touching a woman was sufficient to win her heart (Harrington 1978). The common use of ginger in men's toilet water may stem from the traditional belief that ginger is an aphrodisiac (Harrington 1978).

• Most heat-producing herbs and spices have reputations as aphrodisiacs (Pailler 1993). Not only ginger but also black pepper, chile peppers, horseradish, and the mustards are notable for producing heat in the body following ingestion, or even (in the case of the mustards and horseradish) producing heat when simply combined with water (Pailler 1993).

• After big meals, the classical Greeks ate ginger wrapped in bread as a digestive aid. Gradually the herb was put in the bread itself, and thus gingerbread was created (Castleman 1991).

• In the thirteenth century, a pound of ginger was worth a sheep (Shulman 1991).

• During the Middle Ages, ginger was considered so important that the street where traders sold spices in Basel, Switzerland was called Imbergasse, meaning "ginger alley" (Rosengarten 1969).

• During the 19th century English taverns kept ground ginger that thirsty customers could sprinkle on top of their beer or ale and then stir into their drinks with a red hot poker (Rosengarten 1969).

• The name ginger was commonly applied to redheaded females in Elizabethan England, because of their supposed hot temperaments (Cost 1984).

• The thick, somewhat flattened rhizomes of ginger are called "hands" in the trade because they commonly divide into finger-like projections (Rosengarten 1969).

• Ginger added to the Japanese delicacies sushi and sashimi (raw or slightly cooked fish) may be useful in suppressing the dangerous larvae of the nematode *Anisakis* (Awang 1992). (For another hypothesis about the value of herbs in sushi, see perilla Curiosities.) The Chinese believe that ginger is an antidote to shellfish poisoning, and therefore often season fish and seafood with it (Castleman 1991).

• Contact with fresh ginger root stimulates circulation, and the fresh root can be applied to the cheeks as a natural "rouge" (Pailler 1993).

Problems and Potential

This tropical plant has no commercial potential in the cool temperate climate of Canada and the northern U.S., where it will remain a curiosity that can be grown as a culinary house plant.

Selected References

Rosengarten (1969); Purseglove et al. (1981); Govindarajan (1982); Hackett and Carolane (1982); Cost (1984); Lewis (1984); Farrell (1985); Lima (1986); Awang (1992); Duke and duCellier (1993).

Appendix I—
Conversions Between Metric (SI), British Imperial and Canadian, and American Units of Measurement

(Figures that are not given to five significant digits are exact.)[1]

Metric Prefixes

nano	=	one billionth	=	0.000000001	deca	=	ten	=	10
micro	=	one millionth	=	0.000001	hecto	=	one hundred	=	100
milli	=	one thousandth	=	0.001	kilo	=	one thousand	=	1 000
centi	=	one hundreth	=	0.01	mega	=	one million	=	1 000 000
deci	=	one tenth	=	0.1	giga	=	one billion	=	1 000 000 000

Length

1 millimetre (mm) = 0.039370 inch; (1 inch = 25.4 mm)

1 centimetre (cm) = 0.39370 inch; (1 inch = 2.54 cm)

1 metre (m) = 39.370 inches = 3.2808 feet = 1.0936 yards; (1 foot = 0.30480 m, 1 yard = 0.91440 m)

1 kilometre (km) = 0.62137 miles; (1 mile = 1.6093 km)

Area

I square centimetre (cm^2) = 0.15500 square inch; (1 square inch = 6.4516 cm^2); (1 square foot = 929.03 cm^2)

1 square metre (m^2 = 10.764 square feet = 1.1960 square yards; (1 square yard = 0.83613 m^2)

1 hectare (ha) = 10 000 m^2 = 2.4711 acres = 107 639 square feet; (1 acre = 43 560 square feet = 0.40469 ha)

I square kilometre (kin^2) = 247.11 acres = 0.38610 square miles; (1 mile square = 640 acres = 2.5900 km^2)

Weight (or mass)

(N.B. in this book the metric ton or tonne is abbreviated t; this is also often abbreviated MT)

1 gram (g) = 0.035274 ounce; (1 ounce = 28.350 g)

1 kilogram (kg) = 2.2046 pounds; (1 pound = 0.45359 kg)

1 tonne (t) = 1000 kg; (1 short ton (Canadian, U.S.) = 2000 lb = 0.90718 t);

(1 long ton (British Imperial) = 2240 lb = 1.0160 t)

Weight/area

1 kg/m^2 = 0.20482 pounds/square foot; (1 lb/square foot = 4.8824 kg/m^2)

1 kg/ha = 0.89218 pounds/acre; (1 lb/acre = 1.1209 kg/ha)

1 tonne/ha (t/ha) = 0.44609 short tons/acre; (1 short ton/acre = 2000 lb/acre = 2241.7 kg/ha = 2.2417 t/ha)

Volume, Dry

(Note: in this book litre is abbreviated L; it is also commonly abbreviated 1)

1 cubic centimetre (cc) = 1 millilitre (mL) = 0.061024 cubic inches; (1 cubic inch = 16.387 cm^3)

1 litre (L) = 1 cubic decimetre (dm^3) = 61.024 cubic inches = 0.035315 cubic foot; (1 cubic foot = 28.317 L)

1 litre = 0.027497 Canadian, British Imperial bushel = 0.028378 U.S. bushel;

(1 Imperial bushel = 36.368 L, 1 U.S. bushel = 35.239 L)

1 cubic metre (m^3) = 1.3080 cubic yards; (1 cubic yard = 0.76455 m^3)

[1]Some of the above relationships are from CSA Standard CAN/CSA-Z234.1-89, Canadian Metric Practice Guide, but this often does not provide five significant digits. B.G. Whitford provided or verified all of the above relationships (see Acknowledgements).

Volume, Wet (Liquid)

Canadian, British Imperial

1 litre (L) = 35.195 fluid ounces = 1.7598 pints = 0.87990 quarts = 0.21997 gallons;

(1 fluid ounce = 28.413 mL, 1 pint = 0.56826 L, I quart = 1.1365 L, 1 gallon = 4.5461 L)

American

1 L = 33.814 fluid ounces = 2.1134 pints = 1.0567 quarts = 0.26417 gallons;

(1 fluid ounce = 29.574 mL, 1 pint = 0.47318 L, 1 quart = 0.94635 L, 1 gallon = 3.7854 L)

Temperature Conversion

[temperature °C = (temperature °F- 32).÷ 1.8; temperature °F = (temperature °C × 1.8) + 32]

°C	°F	°C	°F	°C	°F	°C	°F
50	122	25	77	0	32	-25	-13
49	120.2	24	75.2	-1	30.2	-26	-14.8
48	118.4	23	73.4	-2	28.4	-27	-16.6
47	116.6	22	71.6	-3	26.6	-28	-18.4
46	114.8	21	69.8	-4	24.8	-29	-20.2
45	113	20	68	-5	23	-30	-22
44	111.2	19	66.2	-6	21.2	-31	-23.8
43	109.4	18	64.4	-7	19.4	-32	-25.6
42	107.6	17	62.6	-8	17.6	-33	-27.4
41	105.8	16	60.8	-9	15.8	-34	-29.2
40	104	15	59	-10	14	-35	-31
39	102.2	14	57.2	-11	12.2	-36	-32.8
38	100.4	13	55.4	-12	10.4	-37	-34.6
37	98.6	12	53.6	-13	8.6	-38	-36.4
36	96.8	11	51.8	-14	6.8	-39	-38.2
35	95	10	50	-15	5	-40	-40
34	93.2	9	48.2	-16	3.2	-41	-41.8
33	91.4	8	46.4	-17	1.4	-42	-43.6
32	89.6	7	44.6	-18	0.4	-43	-45.4
31	87.8	6	42.8	-19	-2.2	-44	-47.2
30	86	5	41	-20	-4	-45	-49
29	84.2	4	39.2	-21	-5.8	-46	-50.8
28	82.4	3	37.4	-22	-7.6	-47	-52.6
27	80.6	2	35.6	-23	-9.4	-48	-54.4
26	78.8	1	33.8	-24	-11.2	-49	-56.2

Appendix 2—
Tips to Produce the Perfect Herbal Tea[1]

Choice

• Over a hundred species of herbs described in this book have been used for tea, and dozens of these are excellent. There is also considerable variation in taste among varieties of many species. A few herbs traditionally employed to make tea are now known to be toxic and should never be used. Some should be avoided by those with certain allergies, diseases, or when pregnant. Some should not be given to the very young. Many should only be consumed in moderation. Consult the information provided in this book.

• Don't consume either wild or cultivated plants unless certain of their identity, as some plants are poisonous, and teas made from them have resulted in death.

Remember the adage

There are old mushroom hunters.

And there are bold mushroom hunters.

But there are no old, bold mushroom hunters.

Growth

• Plants should be healthy, and generally should be grown in a well-drained soil.

• Don't overfertilize. Less fertilizer tends to produce slower, steadier growth and better flavor. Consider avoiding inorganic fertilizers entirely, and limiting organic fertilization (well-rotted manures, composts).

• Keep pets away: dogs tend to add theft own flavor to plantings, and cats are attracted to catnip and some other herbs.

• Be absolutely sure that the plants have not been exposed to pesticides, herbicides, or fungicides.

Harvest

• Pick vigorously growing material and avoid old, senescent or damaged leaves. However, for some herbs older material is more flavorful. Check the information provided in this book.

• Inspect for insects - they probably dislike the prospect of ending up in your tea as much as you do.

• Harvest before the plants flower, unless the flowering parts are to be used for tea.

• Harvesting about 10 a.m., after the sun has dried off the morning dew, often produces the best material.

• Be gentle: bruising the leaves will release fragrance and flavor prematurely.

Drying

• Check information for particular herbs, as the results sometimes depend on technique. A few herbs just don't dry well, but can be preserved frozen. Some herbs produce much better tea when used fresh. Many herbs can be dried in a food dehydrator or with limited heat in a microwave oven. All can be dehydrated by tying in bunches and hanging in a dark, airy, dry area. They can also be placed on paper towels, covered with cheesecloth, and dried from the gentle heat produced on top of a refrigerator.

Storage

• When leaves are crispy dry, separate them from the stems.

• Keep leaves as whole as possible to preserve flavor.

• Place leaves in a tightly sealed container. Glass jars with air-tight lids are ideal. Sealable plastic bags are a good alternative.

• Store in the dark in a cool place. Do not store in cupboard over kitchen stove, where heat will accelerate evaporation of the essential oils.

• Put a date on the container, and use within a reasonable period.

Brewing

• Crush the leaves at the last minute, just before placing in the tea ball, tea bag or pot.

• For each 6 to 8 ounce cup of tea (170-225 ml), use 1 teaspoon (5 ml) of dried leaves or 1 tablespoon (15 ml) of fresh leaves. Consider blending, especially with lemon-flavored herbs. Adjust amounts to taste with experience.

• Heat clean water (filtered if necessary) until it boils, and pour it over the tea ball, bag, or leaves in the tea pot.

• Let the tea steep 6-10 minutes.

•Pour into cups, add sweetener, lemon, etc. to taste.

• Enjoy!

[1] Much of this information from Poncevage (1995).

Bibliography

Abegaz, B., Yohannes, P.G., and Dieter, R.K. 1983. Constituents of the essential oil of Ethiopian *Cymbopogon citratus* Stapf. J. Nat. Prod. **46**: 424-426.

Abou Dahab, A.M., Fahmy, G.E., Sarhan, A.Z., and Harridy, I.M. 1983. Effect of fertilizers on chemical constituents of *Calamintha officinalis* Jord. var. *nepetoides*. Ann. Agric. Sci., Fac. Agric., Ain-Shams Univ., Cairo, Egypt **28**: 867-884.

Adams, C.D. 1972. Flowering plants of Jamaica. Robert MacLehose and Company Ltd., The University Press, Glasgow, UK. 848 pp.

Adams, D. 1996. New and unusual herbs for the garden. The Herbarist **62**: 51-52.

Adams, J. 1987. Landscaping with herbs. Timber Press, Portland, OR, USA. 223 pp.

Adams, R.R 1987. Investigation of *Juniperus* species of the United States for new sources of cedarwood oil. Econ. Bot. **41**: 48-54.

Adams, R.P. 1993. *Juniperus. In* Flora of North America north of Mexico, vol. 2. *Edited by* Flora of North America Editorial Committee. Oxford University Press, New York, NY. pp. 412-320.

Adler, P.R., Simon, J.E., and Wilcox, G.E. 1989. Nitrogen form alters sweet basil growth and essential oil content and composition. Hortscience **24**: 789-790.

Ahmad, M.U., Husain, S.K., Ahmad, I., and Osman, S.M. 1979. *Hibiscus sabdariffa* seed oil: a re-investigation. J. Sci. Food Agric. **30**: 424-428.

Akashy, H., and Yokoyama, Y. 1975. Dried leaf extracts of *Stevia*. Toxicological tests. Shokuin Kogyo 18:34-43.

Akeroyd, J.R. 1989. *Rheum* Linnaeus. *In* The European garden flora 3(Pt. 1). *Edited by* S.M. Walter and 10 others. Cambridge Univ. Press, Cambridge, U.K. p. 124.

Akgül, A., De Pooter, H.L., and De Buyck, L.F. 1991. The essential oils of *Calamintha nepeta* subsp. *glandulosa* and *Ziziphora clinopodioides* from Turkey. J. Ess. Oil. Res. **3**: 7-10.

Aktug, S.E., and Karapinar, M. 1986. Sensitivity of some common food-poisoning bacteria to thyme, mint and bay leaves. Int. J. Food Microbiol. **3**: 349-354.

Albert-Puleo, M. 1980. Fennel and anise as estrogenic agents. J. Ethnopharmacol. **2**: 337-344.

Algar, A.E. 1985. The complete book of Turkish cookery. Kegan Paul International, London, U.K. 335 pp.

Alkire, B.H., and Simon, J.E. 1993. Water management for Midwestern peppermint (*Mentha* × *piperita* L.) growing in highly organic soils, Indiana, USA. Acta Hortic. (The Hague) **344**: 544-556.

Allison, R.M. 1966. Soluble oxalates, ascorbic [acid] and other constituents of rhubarb varieties. J. Sci. Food Agric. **17**: 554-557.

Alpine, A. 1978. Untamed mustard. Harrowsmith **13**: 108, 110, 111.

Ames, B.N., Magaw, R., and Gold, L.S. 1987. Ranking possible carcinogenic hazards. Science **236**:271-280.

Anderson, E.F. 1993. Plants and people of the golden triangle. Ethnobotany of the hill tribes of Northern Thailand. Dioscorides Press, Portland, OR, USA. 279 pp.

Anderson, R.C., Fralish, J.S., Armstrong, J.E., and Benjamin, P.K. 1993. The ecology and biology of *Panax quinquefolium* L. (Araliaceae) in Illinois. Amer. Midl. Nat. **129**: 357-372.

Andrews, A.C. 1951. The opium poppy as a food and spice in the classical period. Agric. Hist. **25**: 152-155.

Andrews, J. 1984. Peppers. The domesticated Capsicums. University of Texas Press, Austin, TX, USA. 170 pp.

Andrews, J. 1986. Peppers. The world's favorite All-American spice. Pac. Discovery **39**(1): 20-33.

Andrews, J. 1988. Around the world with the chili pepper: post-Columbian distribution of domesticated Capsicums. J. Gastronomy **4**(3): 21-35.

Andrews, J. 1990. A newly recognized variety of chili-pepper (*Capsicum*: Solanaceae) developed in the United States. Phytologia **69**: 413-415.

Andrews, J. 1993*a*. Red hot peppers. Macmillan Publishing Co., New York, NY, USA. 242 pp.

Andrews, J. 1993*b*. Diffusion of Mesoamerican food complex to Southeastern Europe. Geogr. Rev. **83**: 194-204.

Andrews, J. 1995. Peppers. The domesticated Capsicums. 4th ed. University of Texas Press, Austin, TX, USA. 170 pp.

Andrews, T. 1987. The literature of herbs. *In* Proceedings of the second national herb growing and marketing conference. *Edited by* J.E. Simon and L. Grant. Purdue Research Foundation, West Lafayette, IN, USA. pp. 210-218.

Andrews, T., Corya, W.L., and Stickel, D.A., Jr. 1982. A bibliography on herbs, herbal medicine, "natural" foods, and unconventional medical treatment. Libraries Unlimited, Inc., Littleton, CO, USA. 339 pp.

Angier, B. 1978. Field guide to medicinal wild plants. Stackpole Books, Harrisburg, PA, USA. 320 pp.

Anon. 1948. La culture du houblon. Minist. Agricul. Que. Bull. 101:16 pp.

Anon. 1949. Rhubarb. Minist. Agric. Fish. London Bull. **113**: 35 pp.

Anon. 1952. Lemon grass paper. Chemurg. Dig. **11**(10): 16.

Anon. 1956. Watercress cultivation. Minist. Agric. Fish. London Bull. 136: 28 pp.

Anon. 1977. Mustard production. Continental Grain Company, Winnipeg, MB, Canada. 8 pp.

Anon. 1979. Garlic. International standardization of fruit and vegetables. Revised. OECD, Paris, France. 45 pp.

Anon. 1981. Genetic resources of Cruciferous crops. IBPGR Secretariat, Rome, Italy. 48 pp.

Anon. 1982*a*. Herb or erb? Plants Gard. (Brooklyn) **38**(2): 15.

Anon. 1982*b*. An illustrated dictionary of herbs. Plants Gard. (Brooklyn) **38**(2): 34-64.

Anon. 1982*c*. The garlic lover's cookbook. Revised. Celestial Arts, Berkeley, CA, USA. 166 pp.

Anon. 1983. A dictionary of Oriental herbs and vegetables. Plants Gard. (Brooklyn) **39**(2): 65-75.

Anon. 1986. Weed seeds order, 1986. Can. Gaz. **120**: 1-4.

Anon. 1988. Vegetable crops production guide. Atl. Prov. Agric. Serv. Comm. Publ. 1400: 117 pp.

Anon. 1989*a*. U.S. spice trade. U.S. Dep. Agric. For. Agric. Serv. FTEA 1-89:39 pp.

Anon. 1989*b*. U.S. essential oil trade. U.S. Dep. Agric. For. Agric. Serv. FTEA 2-89: 21 pp.

Anon. 1989*c*. Development opportunities in the horticultural sector for selected vegetables products. Agric. Can. Comm. Coord. Dir., Ottawa, ON, Canada. 60 pp.

Anon. 1990*a*. Iron-fisted dandelions stand guard over crops. Agri-Features Agric. Can. Comm. Br. No. **2120**: 11-12.

Anon. 1990b. Alberta fresh. Annual meeting Alberta Fresh Vegetable Marketing Board, Calgary, AB, Canada. Irregularly paginated (ca. 26 pp.)

Anon. 1991. Garlic in Wall Street Journal. HerbalGram **24**: 8.

Anon. 1992*a*. High value, low volume. Furrow **97**(4): 16-17.

Anon. 1992*b*. A new look at an ancient herbal remedy. Curr. Cont. **23**(36): 6.

Anon. 1992*c*. Annual unload report: fresh fruits and vegetables. Agriculture Canada Dev. Branch, Ottawa, ON, Canada. 139 pp.

Anon. 1992*d*. Rediscovering wormwood: qinghaosu for malaria. Lancet **339**: 649-651.

Anon. 1992*e*. 1991/92 Annual Report. Can. Seed Grower's Assoc. Annu. Rep. **88**: 60.

Anon. 1993*a*. In Brief: harmful herb. New Sci. **137**: 12.

Anon. 1993*b*. Annual unload report: Part I. Domestic fruits and vegetables. 1992. Agile. Can. Agri-Food Dev. Br. 81 pp.

Anon. 1994. Herbs top growth category in supermarkets and drug stores. HerbalGram **31**: 9.

Ansari, A.A., and Nand, G. 1987. Little known economic plants of Pauri Garhwal. Indian J. For. **10**: 316-317.

Arctander, S. 1960. Perfume and flavor materials of natural origin. S. Arctander, Elizabeth, NJ, USA. 736 pp.

Aritomi, M. 1982. Chemical studies on the constituents of edible plants (part 1). Phenolic compounds in leaves of *Perilla frutescens* Biltton var. *acuta* Kudo f. *viridis* Makino. J. Home Econ. Jpn. **33**: 353-359.

Aritomi, M., Kumori, T., and Kawasaki, T. 1985. Cyanogenic glycosides in leaves of *Perilla frutescens* var. *acuta*. Phyto-chemistry (Oxf.) **24**: 2438-2439.

Armada, J., and Barra, A. 1992. On *Aloysia* Palau (Verbenaceae). Taxon **41**: 8-90.

Arneja, D.V., Sharma, D.N., Chand, D., and Singal, S.P. 1987. Some reproductive traits of white leghorn male birds as affected by *Ocimum sanctum* (tulsi) feeding. Indian J. Poult. Sci. **22**: 279-282.

Arora, J.S. 1989. Marigold. *In* Commercial flowers. *Edited by* T.K. Bose and L.P. Yadav. Naya Prokash, Calcuta, India. pp. 713-731.

Arora, R.K. 1985. Genetic resources of less known cultivated food plants. National Bureau of Plant Genetic Resources, New Delhi, India. 126 pp.

Arras, G., and Grella, G.E. 1992. Wild thyme, *Thymus capitatus*, essential oil seasonal change and antimycotic activity. J. Hortic. Sci. **67**: 197-202.

Ashley, A., and Ashley, P. 1992. The Canadian plant sourcebook (1992/93 edition). Privately published, Ottawa, ON, Canada. 293 pp.

Asif, M., Afaq, S.H., Tariq, M., and Masoodi, A.R. 1979. Chromatographic analysis of *Myrtus communis* fixed oil. Fette Seifen Anstrichm. **81**(12): 473-474.

Asthana, O.P., and Gupta, R.S. 1984. Effects of NP levels on physiological parameters at three growth stages in sacred basil (*Ocimum sanctum* Linn.). Indian Perf. 28: 49-53.

Astley, D. 1990. Conservation of genetic resources. *In* Onions and Allied Crops. Vol 1. Botany, physiology, and genetics. *Edited by* H.D. Rabinowitch and J.L. Brewster. CRC Press, Inc., Boca Raton, FL, USA. pp. 177-198.

Atal, C.K., and Bradu, B.L. 1976. Search for aroma chemicals of industrial value from genus *Cymbopogon*. Part III -*Cymbopogon pendulus* (Nees ex Steud.) Wats. (Jammu lemongrass) - a new superior source of citral. Indian J. Pharm. **38**(2): 61-63.

Augusti, K.T. 1990. Therapeutic and medicinal values of onions and garlic. *In* Onions and allied crops. Vol. III. Biochemistry, food science, and minor crops. *Edited by* J.L. Brewster and H.D. Rabinowitch. CRC Press, Inc., Boca Raton, FL, USA. pp. 93-108.

Awang, D.V.C. 1987. Comfrey. Can. Pharmaceut. J. **120**: 100-104.

Awang, D.V.C. 1989. Feverfew. Can. Pharmaceut. J. **122**: 266-268, 270.

Awang, D.V.C. 1990. Borage. Can. Pharmaceut. J. **123**: 121, -126.

Awang, D.V.C. 1991. Comfrey update. HerbalGram **25**: 20-2.

Awang, D.V.C. 1992. Ginger. Can. Pharmaceut. J. **125**: 309-311.

Awang, D.V.C., Dawson, B.A., Fillion, J., Girad, M., and Kindack, D. 1993. Echimidine content of commercial comfrey (*Symphytum* spp. - Boraginaceae). J. Herbs Spices Med. Plants **2**(1): 21-34.

Ayers, G.S., and Widrlechner, M.P. 1994*a*. The genus *Agastache* as bee forage: a historical perspective. Amer. Bee J. **134**: 341-348.

Ayers, G.S., and Widrlechner, M.P. 1994*b*. The genus *Agastache* as bee forage: an analysis of reader returns. Amer. Bee J. **134**: 477-483.

Ayers, G.S., Kiehn, F., and Davidson, C. 1994. Potential bee forage at the Agriculture Canada Morden Research Station. Part I: Two experimental essential oil crops that might also have the potential for supplying exceptional bee forage. Amer. Bee J. **134**(1): 31-33.

Bacon, J. 1988. Exotic vegetables A-Z. Salem House Publishers, Topsfield, MA, USA. 128 pp.

Bae, H.-W. 1975. Abstracts of Korean ginseng studies (1687-1975). The Research Institute, Office of Monopoly, Seoul, Republic of Korea. 254 pp.

Bae, H.-W. (*Editor*). 1978. Korean ginseng. 2nd edition. Korea Ginseng Research Institute, Ini-Dong, Chongro-ku, Seoul, Republic of Korea. 317 pp.

Baer, A.B. 1943. *Angelica archangelica*. The Herbarist 9: 13-17.

Bailey, L.H. 1900. Cyclopedia of American Horticulture, 4 vol. Virtue & Company, Toronto, ON, Canada.

Bailey, L.H. 1909. Cyclopedia of American horticulture. 4 vol. Macmillan, New York, NY, USA.

Bailey, L.H. 1922. The cultivated Brassicas. Gentes Herb. **1**(2): 53-108.

Bailey, L.H. 1930. The cultivated Brassicas. Second paper. Gentes Herb. **2**(5): 211-267.

Bailey, L.H. 1940. Certain noteworthy Brassicas. Gentes Herb. **4**(9): 318-330.

Bailey, L.H., and Bailey, E.Z. 1976. Hortus third. Revised by staff of L.H. Bailey Hortorium. MacMillan Publishing Co., New York, NY, USA. 1,290 pp.

Bailey, W.G., Whitehead C., Proctor, J.T.A., and Kyle, J.T. (editors). 1995. The challenges of the 21st century - Proceedings of the International ginseng conference - Vancouver 1994. Simon Fraser University, Burnaby, B.C. 645 pp.

Bailey, W.G, Skretkowicz, A.L., Sawchuk, A.M., Proctor, J.T.A., Clark, L., and Lefebvre, C.M. 1994. International ginseng conference - Vancouver 1994. Program, abstract and trade show booklet. 78 pp.

Baillargeon, G. 1986. Eine taxonomische Revision der Gattung *Sinapis* (Cruciferae: Brassiceae). Frein Universität Berlin, Berlin, Germany. 268 pp.

Bajaj, M., Aggarwal, P., Minhas, K.S., and Sidhu, J.S. 1993. Effect of blanching treatments on the quality characteristics of dehydrated fenugreek leaves. J. Food Sci. Technol. 30: 196-198.

Bakova, N.I., Dmitriev, L.B, Mashahov, V.I., Dimitrieva, V.L., and Grandberg, I.I. 1988. Characteristics of the essential oils of various *Elsholtzia ciliata* Thunb. biotypes. Izv. Timiryazev. Skh. Akad. 10(2): 162-169. [In Russian]

Balandrin, M.F., Kinghorn, A.D., and Farnsworth, N.R. 1993. Plant-derived natural products in drug discovery and development - an overview. *In* Human medicinal agents from plants. *Edited by* A.D. Kinghorn and M.F. Balandrin. American Chemical Society, San Francisco & Washington, DC, USA. pp. 2-12.

Ball, P.W. 1972*a*. Taxonomic and nomenclatural notes on European Labiatae (*Acinos* Miller, *Calamintha* Miller, *Lamium* L., *Satureja* L.). Bot. J. Linn. Soc. 65: 342-352.

Ball, P.W. 1972*b*. *Stachys* L. *In* Flora Europaea, vol. 3. *Edited by* T.G. Tutin, V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, S.M. Walters and D.A. Webb. Cambridge University Press, Cambridge, UK. pp. 151-157.

Baltisberger, M. 1989. Études biosystématiques du genere *Betonica*. Nombres chromosomiques. Biocosme Mésogéen, Nice 6: 1-19.

Baranov, A.I. 1966. Recent advances in our knowledge of the morphology, cultivation and uses of ginseng (*Panax ginseng* C.A. Meyer). Eton. Bot. **20**: 403-406.

Baranov, A.I. 1979. On a technical English name for *Eleutherococcus*. Taxon **28**: 586-587.

Barash, C.W. 1993. Edible flowers - from garden to palate. Fulcrum Publishing, Golden, CO, USA. 250 pp.

Barclay, G. 1993. The coriander mystery. *In* Herbs '93. Proceedings eighth national herb growing and marketing conference. *Edited by* A. Kestner and J.E. Simon. International Herb Growers & Marketers Association, Mundelein, IL, USA. pp. 40-46.

Barker, A.V. 1989. Liming of soils for production of herbs. Herb Spice Med. Plant Dig. 7(4): 1-4.

Baser, K.H.C., and Özek, T. 1993. Composition of the essential oil of *Calamintha grandiflora*. Planta Med. 59: 390.

Baser, K.H.C., Kürkçüoglu, M., and Özek, T. 1992. Composition of the Turkish cumin seed oil. J. Ess. Oil Res. 4: 133-138.

Basker, D. 1993. Saffron, the costliest spice: drying and quality, supply and price. Acta Hortic. (The Hague) **344**: 86-97.

Baskin, J.M., and Baskin, C.C. 1988. The ecological life cycle of *Cryptotaenia canadensis* (L.) DC. (Umbelliferae), a woodland herb with monocarpic ramets. Amer. Midl. Nat. **119**: 165-173.

Baslas, R.K., and Kumar, P. 1981. Phytochemical studies of the plants of *Coleus* genera. Herba Hung. **29**: 213-221.

Bassuk, N. 1986. Year-round production of greenhouse-grown French tarragon. Hortscience **21**: 258-259.

Batmanglij, N. 1986. Food of life. Mage Publishers, Inc., Washington, DC, USA. 247 pp.

BCMAFF. 1993. Annual Horticultural statistics 1992 (Nov. 19, 1993, 93-08). Province of British Columbia, Ministry of Agriculture, Fisheries and Food, Statistical Services Unit. p. 22.

Beabaire, N.A., and Simon, J.E. 1987. Production potential of *Borago officinalis* L. Acta Hortic. (The Hague) **208**: 101-113.

Beal, W.J. 1915. Michigan weeds. (2nd ed.). Mich. Agric. Coil. Exp. Stn. Bull. **267**: 181 pp.

Beekstrom-Sternberg, S.M., and Duke, J.A. 1994. Potential for synergistic action of phytochemicals in spices. *In* Spices, herbs and edible fungi. *Edited by* G. Charalambous. Elsevier, London, UK. pp. 201-223.

Beech, D.F. 1977. Growth and oil production of lemongrass (*Cymbopogon citratus*) in the Ord Irrigation Area, Western Australia. Aust. J. Exp. Agric. Anim. Husb. **17**: 301-307.

Beerentrup, H.M. Zu, and Robbelen; G. 1987. Calendula and coriandrum - new potential oil crops for industrial uses. Fett. Wiss. Technol. **89**: 227-230.

Beerling, D.J., Bailey, J.P., and Conolly, A.P. 1994. *Fallopia japonica* (Houtt.) Ronse Decraene (*Reynoutria japonica* Houtt.; *Polygonum cuspidatum* Sieb and Zucc.) J. Ecol. **82**: 959-979.

Belisle, D. 1991. An overview of the herb and spice industry. *In* Special "Cropportunities" (conference). University of Saskatchewan, Saskatoon, SK, Canada. pp. 75-78.

Belsinger, S. 1991. Flowers in the kitchen. Interweave Press, Loveland, CO, USA. 128 pp.

Belsinger, S., and Dille, C. 1984. Cooking with herbs. Van Nostrand Reinhold Company, New York, NY, USA. 261 pp.

Bergen, P, Moyer, J.R, and Kozub, G.C. 1990. Dandelion (*Taraxacum officinale*) use by cattle grazing on irrigated pasture. Weed Technol. **4**: 258-263.

Bergeron, C., Charbonneau, J., Desroches, B., and Gosselin, A. 1995. Influence of supplemental lighting and irrigation on mineral composition, growth, and premarrubin content of horehound, *Marrubium vulgare* L. J. Herbs Spices Med. Plants **3**(1): 3-15.

Bernath, J. 1992. Untitled report. Herb Spice Med. Plant Dig. **10**(1): 5.

Berti, M.T., and Schneiter, A.A. 1993. Preliminary agronomic evaluation of new crops for North Dakota. *In* New crops -exploration, research, and commercialization. *Edited by* J. Janick and J.E. Simon. J. Wiley and Sons, New York, NY, USA. pp. 106-109.

Bettencourt, E., and Konopka, J. 1990. Directory of germplasm collections. 4. Vegetables. IBPGR Secretariat, Rome, Italy. 250 pp.

Bezzi, A., Franz, C., and Landi, R. 1992. Constitution and characterization of *Salvia officinalis* L. clones. Acta Hortic. (The Hague) **306**: 53-65.

Bhattacharjee, R. 1980. Taxonomic studies in *Stachys*: a new infrageneric classification of *Stachys* L. Notes R. Bot. Gard. Edinb. **38**: 65-96.

Bhattacharjee, R. 1982. *Stachys. In* Flora of Turkey, vol. 7. *Edited by* P.H. Davis. University Press, Edinburgh, U.K. pp. 199-262.

Bianchini, F., and Corbetta, F. 1977. Health plants of the world. Atlas of medicinal plants. Newsweek Books, New York. 242 pp.

Bicchi, C., Frattini, C., Pellegrino, G., Rubiolo, R., Raverdino, V., and Tsoupras, G. 1992. Determination of sulphurated compounds in *Tagetes patula* cv. Nana essential oil by gas chromatography with mass spectrometric, Fourier transform infrared and atomic emission spectrometric detection. J. Chromatogr. 609: 305-313.

Bisht, J.C., Pant, A.K., Mathela, C.S, Kubold, U, and Vostrowsky, O. 1985. Constituents of essential oil of *Elsholtzia strobilifera*. Plant Med. **51**: 412-414.

Bisset, N.G (*Editor*). 1994. Herbal drugs and phyto-pharmaceuticals. A handbook for practice on a scientific basis. CRC Press, Boca Raton, FL, USA. 566 pp.

Bittman, S. 1992. The salad lover's garden. Doubleday, New York, NY, USA. 202 pp.

Blackburn, J.L. (*Chair*). 1993. Second report of the expert advisory committee on herbs and botanical preparations. Health Canada. Irregularly paginated (ca. 80 pp.).

Blackwell, W.H. 1990. Poisonous and medicinal plants. Prentice Hall, Englewood Cliffs, N J, USA. 329 pp.

Blake, S.T. 1971. A revision of *Plectranthus* (Labiatae) in Australia. Queensland Herb., Dep. Primary Ind., Brisbane, Australia. Contrib. Queensl. Herbarium No. 9: 420 pp.

Blanchard, M. 1975. The sprouter's cookbook. Garden Way Publishing, Charlotte, VT, U.S.A. 144 pp.

Blank, I., and Schieberle, P. 1993. Analysis of the seasoning-like flavour substances of a commercial lovage extract (*Levisticum officinale* Koch.). Flavour Fragrance J. **8**(4): 191-195.

Block, E. 1985. The chemistry of garlic and onions. Sci. Amer. **252**(3): 114-119.

Blum, B.M. 1973. Relation of sap and sugar yields to physical characteristics of sugar maple trees. For. Sci. **19**: 175-179.

Blumenthal, M. 1992*a*. Gin and tonic: herbal origins. HerbalGram **26**: 7.

Blumenthal, M. 1992*b*. AHPA petitions FDA for approval of *Stevia* leaf sweetener. HerbalGram **26**: 22, 55.

Bock, S.A. 1993. Anaphylaxis to coriander: a sleuthing story. J. Allergy Clin. Immunol. **91**: 1232-1233.

Boelens, M.H., and Jimenez, R. 1992. The chemical composition of Spanish myrtle oils. Part II. J. Ess. Oil. Res. **4**: 349-353.

Bois, D. 1927. Les plantes alimentaires chez tousles peuples et à travers les âges. Histoire, utilisation, culture. Vol. 1. Phanérogames légumières. Paul Lechavalier, Paris, France.

Bois, D. 1934. Les plantes alimentaires chez tous les peuples et à travers les âges. Histoire, utilisation, culture. Vol. 3. Plantes à épices, à aromates, à condiments. Paul Lechavalier, Paris, France.

Boivin, G. 1992. Lexique des légumes. Publications du Québec, Quebec City, QC, Canada. 59 pp.

Bonar, A. 1985. The Macmillan Treasury of herbs. Macmillan Publishing Co., New York, NY, USA. 144 pp.

Bond, R. E. 1989. Rau ram. The Herbarist **55**: 34-37.

Bonnardeaux, J. 1992. The effect of different harvesting methods on the yield and quality of basil oil in the Ord River irrigation area. J. Ess. Oil Res. **4**: 65-69.

Bor, N.L. 1965. A note on *Cymbopogon winterianus* Jowitt. Öest. Bot. Z. **112**: 185.

Borrego-Escalante, F., Bustamante-Garcia, L., Oyervides-Garcia, A., and Navarro-Guerrero, E. 1992. Germination and propagation of the oregano plant (*Lippia berlandieri*). *In* Proceedings First International Conference on new industrial crops and products. *Edited by* H.H. Naqvi, A. Estilai, and I.P. Ting. Association for the Advancement of Industrial Crops, Riverside; CA, USA. pp. 211-213.

Bos, R., Hendriks, H., and Os, F.H.L. Van. 1983. The composition of the essential oil in the leaves of *Coleus aromaticus* Bentham and their importance as a component of the species antiaphthosae Ph. Ned. Ed. V. Pharm. Weekbl. Sci. Ed. **5**: 129-130.

Bosland, P.W. 1992. Chiles: a diverse crop. HortTechnology **2**(1): 7-10.

Bosland, P.W. 1993. *Capsicum*: a comprehensive bibliography. 2nd ed. The Chile Institute, Las Cruces, NM, USA. 255 pp.

Bosland, P.W. 1994. Chiles: history, cultivation, and uses. *In* Spices, herbs and edible fungi. *Edited by* G. Charalambous. Elsevier, London, U.K. pp. 347-366.

Bouwmeester, H.J., and Smid, H.G. 1995. Seed yield in caraway (*Carum carvi*). 1. Role of pollination. J. Agric. Sci. (Cambridge) **124**: 235-244.

Bouwmeester, H.J., Smid, H.G., and Loman, E. 1995. Seed yield in caraway (*Carum carvi*). 2. Role of assimilate availability. J. Agric. Sci. (Cambridge) **124**: 244-251.

Bouwmeester, H.J., Davies, J.A.R., Smid, H.G., and Welten, R.S.A. 1995. Physiological limitations to carvone yield in caraway (*Carum carvi* L.). Ind. Crops Prod. **4**: 39-51.

Boxer, A., and Back, P. 1980. The herb book. Octopus Books Ltd., London, U.K. 224 pp.

Boyle, T.H., Craker, L.E., and Simon, J.E. 1991. Growing medium and fertilization regime influence growth and essential oil content of rosemary. Hortscience **26**: 33.

Brackett, B., and Lash, M. 1975. The wild gourmet. D.R. Godine, Boston, MA, USA. 160 pp.

Bragg, D.C., and Stokke, D. 1994. Field identification of birdseye in sugar maple (*Acer saccharum* Marsh.) U.S. Dep. Agric. For. Serv., N. Cent. For. Exp. Stn., Res. Pap. NC **317**: 16 pp.

Brako, L., Rossman, A.Y., and Farr, D.F. 1995. Scientific and common names of 7,000 vascular plants in the United States. The American Phytopathological Society, St. Paul, MN, USA. 295 pp.

Brandle, J.E, and Rosa, N. 1992. Heritability for yield, leaf: stem ratio and stevioside content estimated from a landrace cultivar of *Stevia rebaudiana*. Can. J. Plant Sci. **72**: 1263-1266.

Braudel, F. 1972. The Mediterranean and the Mediterranean world in the age of Philip II. 2 vol. Collins, Glasgow, U.K.

Breemhaar, H.G., and Bouman, A. 1995. Mechanical harvesting and cleaning of *Calendula officinalis* and *Dimorphotheca pluvialis*. Ind. Crops Prod. **3**: 281-284.

Bremness, L. 1988. The complete book of herbs. Viking Studio Books, New York, NY, USA. 288 pp.

Brennan, G., Cronin, I., and Glenn, C. 1985. The new American vegetable cookbook. Simon & Schuster Inc., New York, NY, USA. 319 pp.

Brennan, J. 1981. The original Thai cookbook. Richard Marek Publishers, New York, NY, USA. 318 pp.

Brenner, D.M. 1993. Perilla: botany, uses and genetic resources. *In* New crops - exploration, research, and commercialization. *Edited by* J. Janick, and J.E. Simon. J. Wiley and Sons, New York, NY, USA. pp. 322-328.

Brewster, J.L. 1994. Onions and other vegetable alliums. Crop production science in horticulture series, no. 3. CAB International, Wallingford, Oxon, U.K. 256 pp.

Brewster, J.L., and Rabinowitch, H.D. 1990*a*. Garlic agronomy. *In* Onions and allied crops. Vol. III. Biochemistry, food science, and minor crops. *Edited by* J.L. Brewster and H.D. Rabinowitch. CRC Press, Inc., Boca Raton, FL, USA. pp. 147-157.

Brewster, J.L., and Rabinowitch, H.D. (*Editors*). 1990*b*. Onions and allied crops. Vol. III. Biochemistry, food science, and minor crops. CRC Press, Inc., Boca Raton, FL, USA. 265 pp.

Brieskorn, C.H., and Riedel, W. 1977. Flavonoide aus *Coleus amboinicus*. Planta Med. **31**: 308-310.

Briggs, C.J. 1989. Pennyroyal: a traditional medicinal herb with toxic potential. Can. Pharm. J. **122**: 369, 371-372.

Brigham, D. 1958. Scented geraniums. Plants Gard. (Brooklyn) **14**(2): 156-159.

Brill, S. undated. Shoots and greens of early spring in Eastern North America. "Wildman" Steve Brill, Publisher, Jamaica, NY, USA. 55 pp.

Britton, N.L., and Brown, A. 1896-1898. An illustrated flora of the Northern United States, Canada and the British possessions from Newfoundland to the parallel of the southern boundary of Virginia and from the Atlantic westward to the 102d meridian. 3 vol. Charles Scribner's Sons, New York, NY, USA.

Brizicky, G.K. 1961. The genera of the Violaceae in the Southeastern United States. J. Arnold Arbor. *42*: 321-333.

Brobst, J.E. 1988. Chives for everyone. The Herbarist **54**: 48-52.

Brody, J. 1987. Jane Brody's nutrition book (revised). Bantam Books, New York, NY, USA. 552 pp.

Bronaugh, W. 1992. The biggest sugar maple. Amer. For. 98(11/12): 43.

Brouk, B. 1975. Plants consumed by man. Academic Press, New York, NY, USA. 479 pp.

Brown, D. 1995. Encyclopedia of herbs and their uses. The Readers Digest Association (Canada) Ltd., Westmount, Qc, Canada. 424 pp.

Brown, H.A. 1935. Righte dittany. The Herbarist **1**: 23-27.

Browse, P.M. 1986. Rosemaries. Pac. Hortic. **47**(3): 40-46.

Brunton, D.F. 1989. The marsh dandelion (*Taraxacum* section *Palustria*; Asteraceae) in Canada and the adjacent United States. Rhodora **91**: 213-219.

Bryan, J.E., and Castle, C. 1974. The edible ornamental garden. 101 Productions, San Francisco, CA, USA. 192 pp.

Bryant, T.G. 1977. Thyme honey - liquid gold. N.Z.J. Agric. **135**(2): 19, 21.

Bubel, N. 1972. Comfrey and how it grew on us. Org. Gard. **19**(5): 58-61.

Buchanan, R.A., Cull, I.M., Otey, F.H., and Russell, C.R. 1978. Hydrocarbon- and rubber-producing crops. Evaluation of 100 U.S. species. Econ. Bot. **32**: 146-153.

Buchbauer, G., and Jirovetz, L. 1994. Use of fragrances and essential oils as medicaments. Flavour and Fragrance J. 9(5): 217-222.

Buchbauer, G., Jirovetz, L., Jager, W., Plank, C., and Dietrich, H. 1993. Fragrance compounds and essential oils with sedative effects upon inhalation. J. Pharm. Sci. 82: 660-664.

Buckle, J. 1996. Aromatherapy - a clinical trial. Acta Hortic. (The Hague) No. 332: 253-264.

Buckley A.R. 1980. Trees and shrubs of the Dominion Arboretum. Agric. Can. Res. Br. Publ. **1697**: 237 pp.

Buishand, T., Houwing, H.P., and Jansen, K. 1986. The complete book of vegetables. Gallery Books, W.H. Smith Publishers, New York, NY, USA. 180 pp.

Bulliard, P. 1784. Histoire des plantes vénéneuses et suspectes de la France. Bulliard, Paris, France. 177 pp., 85 pl.

Bumpus, H. 1975. Some myrtles, false and true. The Herbarist **41**: 30-34.

Bunney, S. 1992. The illustrated encyclopedia of herbs - their medicinal and culinary uses. Chancellor Press, London, U.K. 320 pp.

Burkill, I.H. 1935. A dictionary of the economic products of the Malay Peninsula. Crown Agents for the Colonies, London, Great Britain. 2,402 pp. (2 vol.).

Burros, M., and Jay, S. 1996. "Dietary supplement" with a buzz. Can. Bot. Assoc. Bull. **29**: 30 [reprinted from NY Tunes, April 10 1996].

But, P.P.H, and But, T.P.C. 1984. Hong Kong - *the* buyers of American ginseng. *In* Proceedings Sixth North American ginseng conference. *Edited by* J.T.A. Proctor. University of Guelph, Guelph, ON, Canada. pp. 99-111.

Buzzanell, P.J, Dull, R., and Gray, E 1995. The spice market in the United States - recent developments and prospects. Foreign Agric. Serv, U.S. Dep. Agric., Agric. Info. Bull. **709**: 48 pp.

Bye, R, Linares, E., Ramamoorthy, T.P, García, F., Collera, O., Palomino, G., and Corona, V. 1987. *Agastache mexicana* subsp. *xolocotziana* (Lamiaceae), a new taxon from the Mexican medicinal plants. Phytologia **62**: 157-163.

Byrnes, M.S. 1995. *Ruta graveolens*, an ethnobotanical inquiry into the historical relationship between man and plant. The Herbarist **61**: 121-131.

Cáceres,A., Cano, O., Samayoa, B, and Aguilar, L. 1990. Plants used in Guatemala for the treatment of gastrointestinal disorders. 1: Screening of 84 plants against enterobacteria. J. Ethnopharmacol. **30**: 55-73.

Cáceres, A, Figueroa, L., Taracena, A.M., and Samayoa, B. 1993. Plants used in Guatemala for the treatment of respiratory diseases. 2: Evaluation of activity of 16 plants against Gram-positive bacteria. J. Ethnopharmacol. **39**: 77-82.

Camp, W.H., Boswell, V.R, and Magness, F.R. 1957. The word in your garden. National Geographic Society, Washington, DC, USA. 231 pp.

Campbell, M. 1991. Asian herbs and specialty vegetables. *In* Herbs '91. Proceedings sixth annual conference, International Herb Growers & Marketers Association. *Edited by* J.E. Simon and A. Kestner. International Herb Growers & Marketers Association, Mundelein, IL, USA. pp. 48-51.

Campbell, M.S. 1968. *Myrtus. In* Flora Europaea. Volume 2. *Edited by* T.G. Tutin, V. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, and S.M. Walters. Cambridge University Press, New York, NY, USA. pp. 303-304.

Carle, R., and Isaac, O. 1985. Chamomile in pharmaceutical practice: phytochemical aspects. *In* Proceedings: Le camomille - chamomile in industrial and pharmaceutical use. *Edited by* R. Della Loggia et al. Soc. Ital. Fitochimica, Trieste, Italy. pp. 37-58.

Carlini, E.A., Contar, J.D., Silva-Filho, A.R., Da Silverira-Filho, N.G., Frochtengarten, M.L., and Bueno, O.F. 1986. Pharmacology of lemongrass (*Cymbopogon citratus* Stapf.) I. Effects of teas prepared from the leaves on laboratory animals. L Ethnopharmacol. **17**: 37-64.

Carlson, K.D., and Kleiman, R. 1993. Chemical survey and erucic acid content of commercial varieties of nasturtium, *Tropaeolum majus* L. J. Amer. Oil Chem. Soc. **70**: 1145-1148.

Carmichael, M.C. 1988. Some of my best friends are herbs. The Herbarist **54**: 76-81.

Carnat, A.P., Chossegros, A., and Lamaison, J.L. 1991. The essential oil of *Satureja grandiflora* (L.) Scheele from France. J. Ess. Oil Res. **3**: 361-362.

Carnat, A.P., Lamaison, J.L., and Petitjean-Freytet, C. 1992 ["1991"]. Agrimony: Comparative study of *Agrimonia eupatoria* and *Agrimonia procera* Wallr. Plant. Méd. Phytothér. **25**(4): 202-211. [In French]

Carr, R.K., and Hunter, G.E. 1973. Flavonoid studies of *Pycnanthemum*: Labiatae. J. Tenn. Acad. Sci. **48**(1): 2-5.

Carrier, L. 1986. Decline in Québec's forests. Assessment of the situation. Direction de la Recherche et du Développement, Ministère de l'Énergie et des Ressources, QC, Canada. 30 pp.

Castleman, M. 1991. The healing herbs. Rodale Press, Emmaus, PA, USA. 436 pp.

Cathey, H.M. 1990. USDA plant hardiness zone map. U.S. Dep. Agric., Agric. Res. Serv. Misc. Publ. **1475**. [map.]

Chadwick, A. 1985. The production of watercress in Great Britain. Herbs Spices Med. Plants **3**(2): 3-4.

Chadwick, A. 1995. Recent herbal literature. Herb Spice Med. Plant Dig. **13**(1): 6.

Chadwick, A.F., and Craker, L.E. 1987. Stalking the elusive reference. *In* Proceedings of the first national herb growing and marketing conference. *Edited by* J.E. Simon and L. Grant, Purdue University, West Lafayette, IN, USA. pp. 276-285.

Chadwick, A.F., and Craker, L.E. 1988. The scientific literature on herbs. Sci. Technol. Libr. 9(1): 71-103.

Chadwick, A.F., and Craker, L.E. 1989. Stalking the elusive reference - knowing your prey. *Edited by* J.E. Simon, A. Kestner, and M.A. Buehrle. *In* Herbs '89: Proceedings of the fourth national herb growing and marketing conference, July 22-25, 1989, San Jose, CA, USA. pp. 341-351.

Chambers, H.L. 1992. *Mentha* - genetic resources and the collection at USDA - ARS NCGR-Corvallis. Lamiales Newsl. **1992**(1): 3-4.

Chambers, H.L. 1993. Chromosome survey and analysis of artificial hybrids in *Pycnanthemum*. Castanea **58**: 197-208.

Chambers, H.L., and Hamer, J. 1992. More about picky pycnanthemums. Tipularia 7(1): 19-23.

Chambers, H.L., and Hummer, K.E. 1994. Mints in the U.S.D.A. germplasm repository. Herb Spice Med. Plant Dig. **12**(3): 1-5.

Chandler, R.F. 1985*a*. Traditional remedies still valued in modem pharmacy. Can. Pharm. J. **118**: 419.

Chandler, R.F. 1985*b*. Licorice, more than just a flavour. Can. Pharm. J. **118**: 421-424.

Chandler, R.E 1986. An inconspicuous but insidious drug. Can. Pharm. J. **119**: 562-566.

Chandler, R.F. 1987. Wormwood. Can. Pharm. J. **120**: 602-604.

Chandler, R.F. 1988. Ginseng - an aphrodisiac? Can. Pharm. J. **121**: 36-38.

Chang, W.W., Chang, I.B., Kutscher, H.W., and Kutscher, A.H. 1979. An encyclopedia of Chinese food and cooking. Crown Publishers Inc., New York, NY, USA. 534 pp. [9th printing]

Chantiles, V.L. 1984. The New York ethnic food market guide & cookbook. Dodd, Mead & Co., New York, NY, USA. 370 pp.

Charles, D.J., and Simon, J.E. 1993. Changes in essential oil content and composition with leaf development in *Ocimum gratissimum* L. Acta Hortic. (The Hague) **344**: 421-427.

Charles, D.J., Simon, J.E., and Widrlechner, M.P. 1991. Characterization of essential oil of *Agastache* species. J. Agric. Food Chem. **39**: 1946-1949.

Charron, D., and Gagnon, D. 1991. The demography of northern populations of *Panax quinquefolium* (American ginseng). J. Ecol. **79**: 431-445.

Chavagnat, A. 1978. Lavender seed dormancy and germination. Acta Hortic. (The Hague) No. 83: 147-151.

Cheatham, S., and Johnston, M.C. 1995. The useful wild plants of Texas, the Southeastern and Southwestern United States, the Southern Plains, and Northern Mexico. Vol. 1. Useful Wild Plants Inc., Austin, Tx, USA.

Chin, A.H.G., and Nushirwan, Z. 1990. Properties of vegetable oils from some unexplored sources in Malaysia. Malays. Agric. Res. Dev. Inst. Res. J. **18**(2): 261-265.

Chittick, H.N. 1981. The *Periplus* and the spice trade. Azania **16**: 185-190.

Chubey, B.B., and Dorrell, D.G. 1976*a*. Changes in the chemical composition of dill oil during hydrodistillation. Can. J. Plant Sci. **56**: 619-622.

Chubey, B.B., and Dorrell, D.G. 1976*b*. Quality and yield of dill oil produced in Manitoba. Can. J. Plant Sci. **56**: 215-216.

Claiborne, C., and Lee, V. 1972. The Chinese cookbook. J.B. Lippincott Co., New York, NY, USA. 451 pp.

Clair, C. 1961. Of herbs & spices. Abelard-Schuman, London, U.K. 276 pp.

Clapham, A.R., Tutin, T.G., and Moore, D.M. 1987. Flora of the British Isles. Revised. Cambridge University Press, New York, NY, USA. 688 pp.

Clark, G.H., and Fletcher, J. 1906. Farm weeds of Canada. Department of Agriculture, Ottawa, ON, Canada. 103 pp.

Clark, J., Jr. 1939. Artemisias. The Herbarist **5**: 36-43.

Clavio, L.Z. 1990. Writing for herb periodicals: the editor's point of view. *In* Herbs '90. Proceedings fifth annual conference, International Herb Growers & Marketers Association. *Edited by* J.E. Simon, A. Kestner, and M.R. Buehrle. International Herb Growers & Marketers Association, Silver Springs, PA, USA. pp. 202-206.

Clifton, C. 1984. Edible flowers. McGraw-Hill, New York, NY, USA. 94 pp.

Codd, L.E. 1971. Generic limits in *Plectranthus, Coleus* and allied genera. Mitt. Bot. Staatssamml. München **10**: 245-252.

Codd, L.E. 1975. *Plectranthus* (Labiatae) and allied genera in Southern Africa. Bothalia **11**: 371-442.

Codd, L. E. 1985. Lamiaceae. *In* Flora of Southern Africa. Vol. 28. Part 4. *Edited by* O.A. Leistner. Botanical Research Institute, South Africa. pp. 1-247.

Cole, T.J. 1979. A checklist of ornamental trees for Canada. Agric. Can. Publ. **1343**: 26 pp.

Coleman, J.C., Blouin, M., and Gracey, C.A. 1991. An inquiry into the competitiveness of the Canadian fresh and processed · fruit and vegetable industry. Supply and Services Canada, Ottawa, ON, Canada. 277 pp.

Collicutt, L.M. 1989. 'Marshall's Delight' monarda. Hortscience **24**: 525.

Compadre, C.M., Hussain, R.A., Leon, I., and Enríquez, R.G. 1987. Volatile constituents of *Montanoa tomentosa* and *Lippia graveolens*. Planta Med. **53**: 495-496.

Compadre, C.M., Pezzuto, J.M., Kinghorn, A.D., and Kamath, S.K. 1985. Hernandulcin: an intensely sweet compound discovered by review of ancient literature. Science **227**: 417-419.

Cook, J. 1990. *Allium* underground. Org. Gard. **37**(8): 28-33.

Coombs, R.E. 1981. Violets. The history and cultivation of scented violets. Croom Helm, London, U.K. 142 pp.

Coon, N. 1977. The complete book of violets. Thomas Yoseloff, London, U.K. 147 pp.

Cooper, B. 1993. The delightful *Hibiscus sabdariffa*. Tea Coffee Trade J. **165**(1): 100-102.

Corey, H. 1962. The art of Syrian cookery. Doubleday & Company, Garden City, NY, USA. 186 pp.

Corliss, J. 1992. Researchers mind the mint. Agric. Res. (Wash. DC) **40**(1): 15-17.

Cost, B. 1984. Ginger east to west, a cook's tour with recipes, techniques & lore. Aris books, Berkeley, CA, USA. 189 pp.

Cotton, C.M., Evans, L.V., and Gramshaw, J.W. 1991. The accumulation of volatile oils in whole plants and cell cultures of tarragon (*Artemisa dracunculus*). J. Exp. Bot. **42**: 365-375.

Courter, J.W., and Rhodes, A.M. 1969. Historical notes on horse-radish. Econ. Bot. **23**: 156-164.

Cox, D., and Craker, L.E. 1993. The use of herbs as bedding plants. Herb Spice Med. Plant Dig. 11(2): 1-5.

Cox, J. 1991. The magic of marigolds. Org. Gard. **38**(5): 68-72.

Cox, P.A, and Balick, M.J. 1994. The ethnobotanical approach to drug discovery. Sci. Amer. **270**(6): 82-87.

Craker, L. E. 1987. Agronomic practices for dill production. Purdue Univ. Agric. Exp. Stn. Bull. **530**: 58-61.

Craker, L.E. 1989. Herbs, spices, and medicinal plants gain in scientific and commercial importance. Diversity **5**(2-3): 47.

Craker, L.E. 1990. Herbs and volatile oils. Herb Spice Med. Plant Dig. **8**(4): 1-5.

Craker, L.E. 1993. The directory of specialists in herbs, spices, and medicinal plants. Publication of The Herb, Spice, and Medicinal Plant Digest, Amherst, MA, USA. 99 pp. [2nd edition 1994, 101 pp.]

Craker, L.E., Chadwick, A.F., and Simon, J.E. 1986. An introduction to the scientific literature on herbs, spices, and medicinal plants. Herbs Spices Med. Plants (Recent Adv. Bot. Hortic. Pharmacol.) **1**: 1-9.

Crammet, B., and Ikan, R. 1986. Sweet glycosides from the stevia plant. Chem. Br. **22**: 915-916, 918.

Crane, J.C. 1949. Roselle - a potentially important plant fiber. Econ. Bot. **3**: 89-103.

Creasy, R. 1982. The complete book of edible landscaping. Sierra Club Books, San Francisco, CA, USA. 379 pp.

Creasy, R. 1988. Cooking from the garden. Sierra Club Books, San Francisco, CA, USA. 547 pp.

Creasy, R. 1990. Edible flowers. Org. Gard. **37**(2): 47-49.

Creekmore, H. 1966. Daffodils are dangerous. The poisonous plants in your garden. Walker and Company, New York, NY, USA. 258 pp.

Crockett, J.U. 1978. Roses. Time-Life Books, Alexandria, VA, USA. 160 pp.

Crockett, J.U., and Tanner, O. 1977. Herbs. Time-Life Books, Alexandria, VA, USA. 160 pp.

Crone, G.R. 1937. The voyages of Cadamosto and other documents on western Africa. Hakluyt Society, London, U.K. 159 pp.

Cronin, E 1982. Elixir or not, ginseng is a lucrative cash crop. Can. Geogr. **102**(6): 60-63.

Crop Development Centre. 1991. Special cropportunities (Proceedings Agricultural Canada Workshop on Alternative Crops, Aug. 6-7, 1991). Crop Development Centre, Univ. Saskatchewan, SK. 157 pp.

Crosby, G.A. 1976. New sweeteners. Crit. Rev. Food. Sci. Nutr. **7**: 297-323.

Crosby, G.A., and Wingar, R.E., Jr. 1979. A survey of less common sweeteners. *In* Developments in sweeeteners, Vol. 1. *Edited by* C.A.M. Hough, K.J. Parker, and A.J. Vlitos. Applied Science Publishers Ltd., London, U.K. pp. 135-164.

Crowder, S. 1992. Sociable garlic. Ottawa Citizen. Wed. Nov. 4, p. E2.

Crowhurst, A. 1973. The flower cookbook. Lancer Books, New York, NY, USA. 198 pp.

Cu, J.Q, Perineau, F., and Gaset, A. 1992. Volatile components of violet leaves. Phytochemistry **31**: 571-573.

Culvenor, C.C.J. 1956. The alkaloids of *Echium plantagineum* L. 1. Echiumine and echimidine. Aust. J. Chem. **9**: 512-520.

Curran, D.F. 1983. The complete ginseng grower's manual. D.F. Curran Productions, Missoula, MT, USA. 146 pp.

Curran, D.F., and Curran, P.A. 1985. The ginseng disease and pest reference guide. D.F. Curran Productions, Missoula, MT, USA. 118 pp.

Currie, J. 1994. Making sense of the zone system. Can. Gard. **5**(1): 30-33, fold-out map.

Curtis, W. (*Editor*). 1787 - present. The Botanical Magazine. London, U.K.

Dahlen, J., and Phillipps, K. 1983. A popular guide to Chinese vegetables. Crown Publishers Inc., New York, NY, USA. 113 pp.

Dansereau, P, and Desmarais, Y. 1947. Introgression in sugar maples - II. Amer. Midl. Nat. **37**: 146-161.

D'Arcy, W.G., and Eshbaugh, H. 1973. The name for the common bird pepper. Phytologia **25**: 350.

Darrah, H.H. 1972. The basils in folklore and biological science. The Herbarist **38**: 3-10.

Darrah, H.H. 1974. Investigation of the cultivars of the basils (*Ocimum*). Econ. Bot. **28**: 63-67.

Darrah, H.H. 1978. The clove scented basil: *Ocimum gratissimum* L. The Herbmist **44**: 31-37.

Darrah, H.H. 1980. The cultivated basils. T.E. Thomas/Buckeye Printing Company, Independence, MO, USA. 40 pp.

Davis, E.A., and Morris, D.J. 1991. Medicinal uses of licorice through the millennia: the good and plenty of it. Mol. Cell. Endocr. **78**: 1-6.

Davis, P.H. 1980. Materials for a flora of Turkey XXXVII: Labiatae, Plumbaginaceae, Plantaginaceae. Notes R. Bot. Gard. Edinb. **38**: 23-64.

Day, A., and Stuckey, L. 1964. The spice cookbook. David White Co., New York, NY, USA. 623 pp.

Dean, J. 1987. Mustard production in Manitoba. Man. Agile. Publ. **140-1**: 3 pp.

Deans, S.G., and Ritchie., G. 1987. Antibacterial properties of plant essential oils. Internat. J. Food Microbiol. **5**: 165-180.

Deans, S.G., and Svoboda, K.P. 1989. Antibacterial activity of summer savory (*Satureja hortensis* L.) essential oil and its constituents. J. Hortic. Sci. **64**: 205-210.

Deans, S.G., and Svoboda, K.P. 1990. Biotechnology and bioactivity of culinary and medicinal plants. AgBiotech News Info. **2**: 211-216.

Deans, S.G, and Waterman, P.G. 1993. Biological activity of volatile oils. *In* Volatile oil crops: their biology, biochemistry and production. *Edited by* R.K.M. Hay and P.G. Waterman. Longman Scientific & Technical, Burnt Mill, Harlow, Essex, U.K. pp. 97-111.

De Baggio, T. 1987. DeBaggio's notes for herb growers. Herb Spice Med. Plant Dig. **5**(4): 7-8.

De Baggio, T. 1988. Sweet cicely: seed germination tricks. Herb Spice Med. Plant Dig. **6**(1): 6.

DeLyser, D.Y., and Kasper, W.J. 1994. Hopped beer: the case for cultivation. Econ. Bot. **48**: 166-170.

Demarne, F.-E., and van der Walt, J.J.A. 1989. Origin of the rose-scented *Pelargonium* cultivar grown on Réunion Island. South Afr. J. Bot. **55**: 184-191.

Demarne, F.E., and van der Walt, J.J.A. 1990. *Pelargonium tomentosum*: a potential source of peppermint-scented essential oil. South Afr. J. Plant Soil **7**: 3639-3642.

Dempsey, J.M. 1975. Fiber crops. University of Florida Press, Gainesville, FL, USA. 457 pp.

De Muth, S. 1992. Resource guide to growing and using herbs. Special reference briefs SRB 93-01. Alternative Farming System Information Center, U.S. National Agricultural Library. 15 pp.

Dent, T.C. 1992. Some preliminary implications from a limited statistical analysis concerning the distribution of sugar maple in Central America. *In* Biogeography of Meso-America, Proceedings of a symposium, Oct. 1984. *Edited by* S.P. and A.L Darwin. Tulane Stud. Zool. Bot. Suppl. Publ. No. **1**: 73-77.

Deschênes, J.-M. 1970. The history of the genus *Acer*, a review. Naturaliste Can. **97**: 51-59.

DeWitt, D. 1991. Chile peppers: a selected bibliography of the Capsicums. The Chile Institute, Las Cruces, NM, USA. 74 pp.

DeWitt, D., and Bosland, P.W. 1993. The pepper garden. Ten Speed Press, Berkeley, CA, USA. 240 pp.

DeWitt, D., and Gerlach, J. 1989. If you can't stand the heat... don't bring these chiles into your kitchen. Harrowsmith **4**(24): 44-49.

DeWitt, D., and Gerlach, N. 1984. The fiery cuisines. St. Martin's Press, New York, NY, USA. 229 pp.

De Wolf, G.P., Jr. 1955. Notes on cultivated Labiates. 5. *Lavandula*. Baileya **3**: 47-57.

Diawara, M.M., Trumble, J.T., Quiros, C.F., and Hansen, R. 1995. Implications of distribution of linear furanocoumarins within celery. J. Agric. Food Chem. **43**: 723-727.

Diaz, A.M., and Abeger, A. 1987. *Myrtus communis*, chemical composition and biological activity of the extracted juice. A review. Fitoterapia **58**: 167-174. [In Spanish.]

Diaz del Castillo, B. 1966. The true history of the conquest of Mexico. University Microfilms, Ann Arbor, MI, USA. 514 pp. [Reprint of 1800 Keating translation of 1568 original.]

Dickstein, E.S., and Kunkel, F.W. 1980. Foxglove tea poisoning, Amer. J. Med. **69**: 167-169.

Dietz, J. 1991. Gearing up to grow garlic. Furrow **96**(3): 8.

Dippel, L. 1893. Handbuch der Laubholzkunde. Verlag von Paul Parey, Berlin, Germany. 752 pp.

Dirr, M.A. 1986. *Rosa rugosa*. Amer. Nurseryman **163**: 190.

Divine, D. 1973. The opening of the world. G.P. Putnam's Sons, New York, NY, USA. 272 pp.

Dominguez, X.A., Sanchez, V.H., Suarez, M., Baldas, J.H., and Rosario-Gonzalez, M. del. 1989. Chemical constituents of *Lippia graveolens*. Plant Med. **55**: 208-209.

Dore, W.G. 1967. A mingling of maples. Trail & Landscape (Ottawa Field-Naturalist Club) 1: 64-67.

Doshi, A., and Thakore, B.B.L.K. 1995. Sources of resistance in opium poppy against downy mildew disease incited by *Peronospora arborescens* (Berk de Bary). Plant Genet. Resourc. Newsl. **104**: 31.

Douglas, G.B. 1991. Establishment and early regrowth of sheep's burnet (*Sanguisorba minor* ssp. *muricata* (Spach) Briq.) examined multivariately. Ph.D. thesis, Massey University, Palmerston North, New Zealand. 357 pp.

Douglas, G.B., and Foote, A.G. 1993. Growth of sheep's burnet and two dryland legumes under periodic mob-stocking with sheep. N.Z. J. Agric. Res. **36**: 393-397.

Douglas, G.B., Gordon, I.L., Chu, A.C.P., and Robertson, A.G. 1993. Effect of genotype and seed size on early vegetative growth of sheep's burnet. N.Z. J. Agric. Res. 36: 109-116.

Douglas, G.B., Robertson, A.G., Chu, A.C.P., and Gordon, I.L. 1990. Establishment and growth of sheep's burnet in the lower North Island of New Zealand. N.Z.J. Agric. Res. **33**: 385-394.

Dove, J.S. 1990. Formulating a business plan. *In* Herbs '90. Proceedings fifth annual conference, International Herb Growers & Marketers Association. *Edited by* J.E. Simon, A. Kestner, and M.R. Buehrle. International Herb Growers & Marketers Association, Silver Springs, PA, USA. pp. 123-126.

Dove, J.S. 1994. Business plan outline. *In* Herbs '94. Proceedings ninth national herb growing and marketing conference. *Edited by* A. Kestner, J.E. Simon, and A.O. Tucker. International Herb Growers & Marketers Association, Mundelein, IL, USA. pp. 125-130.

Dowling, D. 1995. New used blooming for old reliable herbs. The Ottawa Citizen, May 4, p. E7.

Downey, R.K., and Röbbelen, G. 1989. *Brassica* species. *In* Oil crops of the world. *Edited by* G. Robbelen, R.K. Downey, and A. Ashri. McGraw-Hill, Toronto, ON, Canada. pp. 339-362.

du Coffre, M. 1992. Le nouveau jardin aromatique. Libre Expression, Montreal, QC, Canada. 223 pp.

Dudai, N., Poljakoff-Mayber, A., Lerner, H.R., Putievsky, E., Ravid, U., and Katzir, I. 1993. Inhibition of germination and growth by volatiles of *Micromeria fruticosa*. Acta Hortic. (The Hague) **344**: 123-130.

Duke, J.A. 1973. Utilization of *Papaver*. Econ. Bot. **27**: 390-400.

Duke, J.A. 1977. Vegetarian vitachart. Q. J. Crude Drug Res. **15**: 45-66.

Duke, J.A. 1978. The quest for tolerant germplasm. *In* Crop tolerance to suboptimal land conditions [proceedings of a symposium]. *Edited by* G.A. Jung. Amer. Soc. Agric. Spec. Publ. **32**: 1-61.

Duke, J.A. 1979. Ecosystematic data on economic plants. Q. J. Crude Drug Res. **17**: 91-110.

Duke, J.A. 1981. Growing ginseng. U.S. Dep. Agric. Farm. Bull. **2201**: 8 pp.

Duke, J.A. 1982. Herbs as a small farms enterprise and the value of aromatic plants as economic intercrops. U.S. Dep. Agric. Misc. Publ. **1422**: 76-83.

Duke, J.A. 1985. CRC handbook of medicinal herbs. CRC Press, Boca Raton, FL, USA. 677 pp.

Duke, J.A. 1986. Handbook of Northeastern Indian medicinal plants. Quarterman Publications, Lincoln, MA, USA. 212 pp.

Duke, J.A. 1989. Ginseng: a concise handbook. Reference Publication, Inc., Algonac, MI, USA. 273 pp.

Duke, J.A. 1992*a*. Handbook of edible weeds. CRC Press, Boca Raton, FL, USA. 246 pp.

Duke, J.A. 1992*b*. Handbook of phytochemical constituents of GRAS herbs and other economic plants. CRC Press, Boca Raton, FL, USA. 654 pp.

Duke, J.A. 1993. Medicinal plants and the pharmaceutical industry. *In* New Crops. *Edited by* J. Janick and J.E. Simon. John Wiley and Sons, Inc., New York, NY, USA. pp. 664-669.

Duke, J.A., and Ayensu, E.S. 1985. Medicinal plants of China. 2 vol. Reference Publications, Inc., Algonac, MI, USA.

Duke, J.A., and duCellier, J.L. 1993. CRC handbook of alternative cash crops. CRC Press, Boca Raton, FL, USA. 536 pp.

Duke, J.A., and Hurst, S.J. 1975. Ecological amplitudes of herbs, spices, and medicinal plants. Lloydia **38**: 404-410.

Duke, J.A., and Reed, C.F. 1978. Caraway - an economic plant. Q. J. Crude Drug. Res. **16**(3): 116-118.

Duke, J.A., Gunn, C.R., Leppik, E.E., Reed, C.F., Solt, M.L., and Terrell, E.E. 1973. Annotated bibliography of opium and Oriental poppies and related species. U.S. Dep. Agric. Agric. Res. Serv. 349 pp.

Dull, R.E.T. 1994*a*. Tropical products: world markets and trade. U.S. Dep. Agric. Foreign Agric. Serv. Circ. Ser. FTROP 1-94 (April): 93 pp.

Dull, R.E.T. 1994*b*. Tropical products: world markets and trade. U.S. Dep. Agric. Foreign Agric. Serv. Circ. Ser. FTROP 2-94 (June): 66 pp.

Dull, R.E.T. 1994*c*. Market report. HerbalGram **31**: 60-63.

Dull, R.E.T. 1995. Tropical products: word markets and trade. U.S. Dep. Agric. Foreign Agric. Serv. Circ. Ser. FTROP 1-95 (April): 112 pp.

Durden, G. 1992. North American cooking with ginseng. Cookbook Publishers, Inc., Olathe, KS, USA. 66 pp.

Duthie, J.F. 1893. Field and garden crops of the north-western provinces and Oudh, with illustrations. Part 3. Department of Land Records and Agriculture, N.W. Provinces and Oudh, India. 65 pp.

Economou, K.D., Oreopoulou,V., and Thomopoulos, C.D. 1991. Antioxidant activity of some plant extracts of the family Labiatae. J. Am. Oil Chem. Soc. **68**: 109-113.

Edmonds, J.M. 1991. The distribution of *Hibiscus* L. section *Furcaria* in tropical East Africa. International Board for Plant Genetic Resources, Rome, Italy. 60 pp.

Eisner, T. 1964. Catnip: its raison d'être. Science **146**: 1318-1320.

El-Adawy, T.A., and Khalil, A.H. 1994. Characteristics of roselle seeds as a new source of protein and lipid. J. Agric. Food. Chem. **42**: 1896-1900.

Elbert, V.F., and Elbert, G.A. 1974. Fun with growing herbs indoors. Crown Publishers Inc., New York, NY, USA. 192 pp.

Elfellah, M.S., Akhter, M.H., and Khan, M.T. 1984. Anti-hyperglycaemic effect of an extract of *Myrtus communis* in streptozotocin-induced diabetes in mice. J. Ethnopharmacol. **11**: 275-281.

El-Hamidi, A., Ahmed, S.S., and Shaarawy, F. 1983. *Lippia citriodora* grown in Egypt. A new crop under development. Acta Hortic. (The Hague) **132**: 31-33.

Elisha, E.E., Moussa, S.O., and Abed, S.K. 1988. The effects of the leaf extracts of *Myrtus communis* on the central nervous system. II: The myorelaxant and hypothermic actions. J. Biol. Sci. Res. **19**(Suppl.): 777-792.

Ellner, S., and Shmida, A. 1981. Why are adaptations for long-range seed dispersal rare in desert plants? Oecologia (Berl) **51**: 133-144.

El-Sayed, A.M., Al-Yahya, M.A., and Hassan, M.M.A. 1989. Chemical composition and antimicrobial activity of the essential oil of *Chenopodium botrys* growing in Saudi Arabia. Int. J. Crude Drug Res. **27**: 185-188.

Elson, C.E., Underbakke, G.L., Hanson, P., Shrago, E., Wainberg, R. H., and Qureshi, A.A. 1989. Impact of lemongrass oil, an essential oil, on serum cholesterol. Lipids **24**: 677-679.

Emboden, W.A., Jr. 1974. Bizarre plants. MacMillan Publishing Co., New York, NY, USA. 214 pp.

Embong, M.B., Hadziyev, D., and Molnar, S. 1977*a*. Essential oils from spices grown in Alberta. Caraway oil (*Carum carvi*). Can. J. Plant Sci. **57**: 543-549.

Embong, M.B., Hadziyev, D., and Molnar. S. 1977*b*. Essential oils from spices grown in Alberta. Dill seed oil, *Anethum graveolens* L. (Umbelliferae). Can. Inst. Food Sci. Technol. J. **10**: 208-214.

Embong, M.B., Hadziyev, D., and Molnar, S. 1977*c*. Essential oils from herb and spices grown in Alberta. Sage oil, *Salvia officinalis*, L. (Labiatae). Can. Inst. Food Sci. Technol. J. **10**: 201-207.

Embong, M.B., Hadziyev, D., and Molnar, S. 1977*d*. Essential oils from spices grown in Alberta. Anise oil (*Pimpinella anisum*). Can. J. Plant Sci. 57: 681-688.

Embong, M.B., Steele, L., and Hadziyev, D. 1977. Essential oils from herbs and spices grown in Alberta. Peppermint oil, *Mentha piperita* var. Mitcham, L. Can. Inst. Sci. Technol. J. **10**: 247-256.

Engler, A., and Prantl, K. 1887. Die natürlichen Pflanzen-familien. Division 2, vol. 2. Verlag von Wilhelm Engelmann, Germany.

Engler, A., and Prantl, K. 1889. Die natürlichen Pflanzenfamilien. Division 2, vol. 6. Verlag yon Wilhelm Engelmann, Germany.

Engler, A., and Prantl, K. 1897. Die natürlichen Pflanzenfamilien. Division 4, vol. 3. Verlag von Wilhelm Engelmann, Germany.

Engler, A., and Prantl, K. 1898. Die natürlichen Pflanzenfamilien. Division 3, vol. 7 & 8. Verlag yon Wilhelm Engelmann, Germany.

English, J. 1985. The cultivation of ginseng. Herb Spice Med. Plant Dig. **3**(2): 1-2, 5-7.

Epling, C. 1935. Notes on *Monarda*: the subgenus *Cheilyctis*. Madroño 3: 20-31.

Erichsen-Brown, C. 1975. Herbs in Ontario. How to grow and use fifty herbs. Breezy Creeks Press, Aurora, ON, Canada. 37 pp.

Erichsen-Brown, C. 1979. Use of plants for the past 500 years. Breezy Creeks Press, Aurora, ON, Canada. 510 pp.

Eriksen, A.B., and Nordal, I. 1989. Ecotypic differentiation in relation to soil nitrogen in northern Scandinavian *Cochlearia officinalis*. Holarctic Ecol. **12**: 31-38.

Ernst, D. 1989. *Pimpinella anisum* L. (anise): cell culture, somatic embryogenesis, and the production of anise oil. Biotechnol. Agric. For. **7**: 381-397.

Esau, K. 1960. Anatomy of seed plants. John Wiley & Sons, New York, NY, USA. 376 pp.

Eshbaugh, W.H. 1984. Foreword. *In* Peppers. The domesticated Capsicums. *By* J. Andrews. University of Texas Press, Austin, TX, USA. p. ix.

Eshbaugh, W.H. 1993. Peppers: history and exploitation of a serendipitous new crop discovery. *In* New crops. *Edited by* J. Janick and J.E. Simon. John Wiley and Sons, New York, NY, USA. pp. 132-139.

Etoh,T., Kojima, T., and Matsuzoe, N. 1992. Fertile garlic clones collected in Caucasia. *In* The genus *Allium* - taxonomic problems and genetic resources. *Edited by* P. Hanelt, K. Hammer and H. Knüpffer. Institut für Pflanzengenetik und Kulturpflanzenforschung, Gatersleben, Germany. pp. 49-54.

Etoh, T., Noma, Y., Nishitarumizu, Y., and Wakamoto, T. 1988. Seed productivity and germinability of various garlic clones collected in Soviet Central Asia. Mem. Fac. Agric. Kagoshima Univ. **24**: 129-139.

Evans, B.L. 1985. Ginseng: root of Chinese-Canadian relations. Can. Hist. Rev. **66**: 1-26.

Facciola, S. 1990. Cornucopia. A source book of edible plants. Kampong Publications, Vista, CA, USA. 667 pp.

Falkengren-Grerup, U., and Tyler, G. 1992. Chemical conditions limiting survival and growth of *Galium odoratum* (L.) Scop. in acid forest soil. Acta Oecol. **13**: 169-180.

FAO. 1994. FAO yearbook: production. Food and Agriculture Organization of the United Nations, Rome. Vol. 47. FAO Stat. Ser. No. **117**: 254 pp.

Farag, R.S., Ali, M.N., and Taha, S.H. 1990. Use of essential oils as natural preservatives for butter. J. Am. Oil Chem. Soc. **68**: 188-191.

Farah, M. 1979. Lebanese cooking. 4th edition. Lebanese Cuisine, Portland, OR, USA. 159 pp.

Farnsworth, N.R. 1993. Relative safety of herbal medicines. HerbalGram **29**: 36A-36H.

Farnsworth, N.R., Kinghorn, A.D., Soejarto, D.D., and Waller, D.P. 1985. Siberian ginseng (*Eleutherococcus senticosus*): current status as an adaptogen. *In* Economic and medicinal plant research, vol. 1. *Edited by* H. Wagner, H. Hikino, and N.R. Farnsworth. Academic Press, London. pp. 155-215.

Farrar, R. 1989. Pansies, violas and sweet violets. Hurst Village Publishing, Hurst, Berkshire, U.K. 80 pp.

Farrell, K.T. 1985. Spices, condiments, and seasonings. AVI Publishing Co., Westport, CT, USA. 415 pp.

Feiger, J.B. 1975. Homegrown horse-radish. Org. Gard. **22**(5): 108-109.

Fennell, B. 1993. Delightful herbal liqueurs. The Herbarist **59**: 118-120.

Fenwick, G.R., and Hanley, A.B. 1985. The genus *Allium* - Part 3. CRC Crit. Rev. Food Sci. Nutr. **23**: 1-73.

Fenwick, G.R., and Hanley, A.B. 1990. Processing of alliums; use in food manufacture. *In* Onions and allied crops. Vol. III. Biochemistry, food science, and minor crops. *Edited by* J.L. Brewster and H.D. Rabinowitch. CRC Press, Inc., Boca Raton, FL, USA. pp. 73-91.

Ference, D. [D. Ference and Associates Ltd.] 1988. Assessment of the market potential for ginseng cultivated in B.C. 133 pp. [Prepared for Associated Ginseng Growers of British Columbia.]

Ference, D. [D. Ference and Associates Ltd.] 1989. Economic opportunities for Canada in essential oils and medicinal crops. Agriculture Canada Policy Branch Working Paper 10/ 89. 287 pp.

Ferguson, J.M., Weeks, W.W., and Fike, W.T. 1988. Catnip production in North Carolina. Herb Spice Med. Plant Dig. **6**(4): 1-4.

Fernald, M.L. 1970. Gray's manual of botany. 8th ed. D. Van Nostrand, New York, NY. 1632 pp.

Fernald, M.L., Kinsey, A.C., and Rollins, R.C. 1958. Edible wild plants of eastern North America. Revised. Harper & Row Pub., New York, NY, USA. 452 pp.

Ferron, M., and Cayouette, R. 1975. Noms des mauvaises herbes du Québec. (3ème. éd.). Agriculture Québec. 113 pp.

Findley, M. 1971. Watercress - storehouse of vitamins and minerals. Org. Gard. **19**(4): 45.

Fischer, N., Nitz, S., and Drawert, E 1987. Original flavour compounds and the essential oil composition of marjoram (*Majorana hortensis* Moench). Flavour Fragrance J. 2: 55-61.

Fisher, B. 1984. Cucumber-flavored herbs. Org. Gard. **31**(5): 40, 42.

Fisher, P. (*Editor*). 1994. Ginseng Report (Ginseng Growers Association of Canada, Simcoe, Ont.) Vol. 2 (July) (unpaginated).

Fitch, W.H. 1924. Illustrations of the British Flora. Fifth revised edition. L. Reeve & Co., London, U.K. 338 pp.

Fitz-Gerald, M.E. 1942. Lemon verbena. The Herbarist **8**: 36-37.

Flannery, H. B. 1984. *Thymus serpyllum*. Misapplied name, misunderstood plant. The Herbarist **50**: 26-35.

Fleisher, A., and Fleisher, Z. 1988*a*. Identification of biblical hyssop and origin of the traditional use of oregano-group herbs in the Mediterranean region. Econ. Bot. **42**: 232-241.

Fleisher, A., and Fleisher, Z. 1988*b*. The essential oil content of annual *Carum carvi* L. grown in Israel. Dev. Food Sci. **18**: 33-40.

Fleisher, A., and Sneer, N. 1982. Oregano species and *Origanum* chemotypes. J. Sci. Food Agric. **33**: 441-446.

Fleury de la Roche, A. 1924. Les plantes bienfaisantes. Gautier et Languereau, Paris, France. 387 pp.

Flinn, J.Q. 1988. Rosemary. Cornell Plant. **44**(1): 11-13.

Foley, D.J. 1974. Herbs for use and for delight. Dover, New York, NY, USA. 324 pp.

Follett, J.M. 1990. Mitsuba and shungiku - two traditional Japanese vegetables. Horticult. N.Z. **1**(2): 22-25.

Forhan, S.C., and Tisdale, R. 1988. Mustard growers manual. Saskatchewan Agriculture, Saskatoon, SK, Canada. 24 pp.

Forsell, M. 1990. Heirloom herbs: using old-fashioned herbs in gardens, recipes, and decorations. Villard Books, New York, NY, USA. 160 pp.

Forsyth, A. 1986. Poppy culture. Harrowsmith 65(Jan./Feb.): 61-69.

Foster, S. 1987. American herbs - our neglected heritage. *In* Proceedings of the second national herb growing and marketing conference. *Edited by* J.E. Simon and L. Grant. Purdue Research Foundation, West Lafayette, IN, USA. pp. 265-270.

Foster, S. 1989. Phytogeographic and botanical considerations of medicinal plants in Eastern Asia and Eastern North America. Herbs Spices Med. Plants (Recent Adv. Bot. Hortic. Pharmacol.) **4**: 115-144.

Foster, S. 1992. Herbs of commerce. American Herbal Products Association, Austin, TX, USA. 78 pp.

Foster, S. 1992/1993. Chamomile. The Herb Companion 1992/1993 (Dec./Jan.): 64-68.

Foster, S. 1995. Europe - medicinal plant use in the modern world. The Herbarist **61**: 33-39.

Foster, S., and Duke, J.A. 1990 A field guide to medicinal plants. Eastern and Central North America. Houghton Mifflin Co., Boston, MA, USA. 366 pp.

Fournier, P. 1947-48. Le livre des plantes médicinales et vénéneuses de France. Paul Lechavalier, Paris, France. 3 vol.

Foust, C.M. 1992. Rhubarb - the wondrous drug. Princeton University Press, Princeton, NJ, USA. 371 pp.

Foust, C.M., and Marshall, D.E. 1991. Culinary rhubarb production in North America: history and recent statistics. Hortscience **26**: 1360-1363.

Fowler, M.G. 1992. Chiles: their history and place for today's herb grower. *In* Herbs '92. Proceedings seventh national herb growing and marketing conference. *Edited by* J.E. Simon and A. Kestner. International Herb Growers & Marketers Association, Mundelein, IL, USA. pp. 64-70.

Fox, H.M. 1933. Gardening with herbs. Macmillan Publishing Co., New York, NY, USA. 334 pp.

Franz, C. 1993. Genetics. *In* Volatile oil crops: their biology, biochemistry and production. *Edited by* R.K.M. Hay and P.G. Waterman. Longman Scientific &Technical, Burnt Mill, Harlow, Essex, U.K. pp. 63-95.

Franz, C., Hölzl, J., Máthé, and Winklhofer, A. 1985. Recent results on cultivation, harvest time and breeding of camomile. *In* Proceedings: Le camomille - chamomile in industrial and pharmaceutical use. *Edited by* R. Della Loggia et al. Soc. Ital. Fitochimica, Trieste, Italy. pp. 6-17.

Freeman, G.G., and Mossadeghi, N. 1972. Studies on sulphur nutrition and flavour production in watercress (*Rorippa nasturtium-aquaticum* (L.) Hayek). J. Hortic. Sci. **47**: 375-387.

Fujita, T., Funayoshi, A., and Nakayama, M. 1994. A phenyl-propanoid glucoside from *Perilla frutescens*. Phytochemistry **37**: 543-546.

Fulder, S. 1980. The drug that builds Russians. New Sci. **87**: 576-579.

Fuller, T.C., and McClintock, E. 1986. Poisonous plants of California. University of California Press, Berkeley, CA, USA. 433 pp.

Fuller, R. 1990. Pansies, violas & violettas: the complete guide. The Crowood Press, Ramsbury, U.K. 233 pp.

Fuller, R. 1994. Violas and violettas. The Garden, June: 246-249.

Furia, T.E., Bellanca, N. 1975. Fenaroli's handbook of flavor ingredients. 2nd. ed. CRC Press, Cleveland, OH, USA. 2 vol.

Gabriel, I. 1975. Herb identifier and handbook. Sterling Publishing Co., New York, NY, USA. 256 pp.

Galambosi, B. 1991. Harvesting and cleaning herb seeds. Herb Spice Med. Plant Dig. **9**(3): 1-4.

Galambosi, B., and Galambosi-Szebeni, Z. 1992. Studies on the cultivation methods of *Agastache foeniculum* (Pursh) Kuntze in Finland. Acta Agron. Hung. **41**(1-2): 107-115.

Galambosi, B. Svoboda, K.P., Deans, S.G., and Hethelyi, E. 1993. Agronomical and phytochemical investigation of *Hyssopus officinalis*. Agric. Sci. Finland **2**: 293-302.

Gallop, R.A. 1965. Variety, composition, and colour in canned fruits, particularly rhubarb. Fruit Veg. Canning Quick Freezing Res. Assoc., Sci. Bull. No. 5. Chipping Campden, Gloucestershire, U.K. 72 pp.

Galwey, N.W., and Shirlin, A.J. 1990. Selection of borage (*Borago officinalis*) as a seed crop for pharmaceutical uses. Heredity **65**: 249-257.

Gambee, E.B. 1985. An ancient herb travels to the New World, or dittany of Crete and the Roman Empire. The Herbarist **51**: 15-19.

Gandhi, M., Lal, R., Sankaranarayanan, A., and Lal Sharma, P. 1991. Post-coital antifertility activity of *Ruta graveolens* in female rats and hamsters. J. Ethnopharmacol. **34**: 49-59.

Gansberger, C. 1974. Costmary - the herb that brews fresh flavor. Org. Gard. **21**(1): 148-149.

Garbari, F., Jarvis, C.E., and Pagni, A.M. 1991. Typification of *Melissa calamintha* L., *M. nepeta* L., and *Thymus glandulosus* Req. (Lamiaceae), with some systematic observations. Taxon **40**: 499-504.

Garcia, A.A. 1986. A cultivated Saruraceae (*Houttuynia cordata*). Darwiniana (Buenos Aires) **27**: 569-570. [In Spanish]

Gardner, J. 1989. Holy land herbs revisited. The Herbarist **55**: 69-73.

Garland, S. 1979. The complete book of herbs & spices. Viking Press, New York, NY, USA. 288 pp.

Garrabrants, N.L., and Craker, L.E. 1987. Optimizing field production of dill. Acta Hortic. (The Hague) **208**: 69-72.

Gasic, O., Mimica-Dukic, N., and Adamovic, D. 1992. Variability of content and composition of essential oil of different *Mentha arvensis* L. var. *piperascens* cultivars. J. Ess. Oil Res. **4**: 49-56.

Gaskell, M. 1988. Production of fresh culinary herbs in Central America for commercial export. Herb Spice Med. Plant Dig. **6**(2): 1-4, 10.

Gaudiel, R. 1987. Herbs and spices - an overview. 15 p. (irregularly paginated). *In* Alternative Crops Conference (Lethbridge, Nov. 11-13, 1987). Alberta Agriculture, Canada.

Gelderen, D.M. van, de Jong, P.C., Oterdoom, H.J., and van Hoey Smith, J.R.P. 1994. Maples of the world. Timber Press, Inc., Portland, OR, USA. 512 pp.

Genova, E., and Balinova, A. 1970. Study on the essential oil content of certain representatives of the genera *Satureja* L. and *Calamintha* Adans. Bulgaria Akad. Nauk Bot. Inst. Izv. 20: 151-164. [In Bulgarian.]

Gentry, H.S., Mittleman, M., and McCrohan, P.R. 1990. Introduction of chia and gum tragacanth in the U.S. *In* Advances in new crops. *Edited by* J. Janick and J.E. Simon. Timber Press, Portland, OR, USA. pp. 252-256.

Ghazanfar, S.A., and Al-Sabahi, A.M. 1993. Medicinal plants of northern and central Oman (Arabia). Econ. Bot. **47**: 89-98.

Ghosh, D., Roy, K., and Mallik, S.C. 1981. Effect of fertilizers and spacing on yield and other characters of black cumin (*Nigella sativa* L.). Indian Agric. **25**: 191-197.

Gibbons, E. 1962. Stalking the wild asparagus. David McKay Company, Inc., New York, NY, USA. 303 pp.

Gibbons, E. 1966. Stalking the healthful herbs. David McKay, New York, NY, USA. 303 pp.

Gibbons, E. 1968. Tree saps - barrels of sweet fun. Org. Gard. **15**(2): 73-76.

Gibson, M.R. 1978. *Glycyrrhiza* in old and new perspectives. Lloydia **41**: 348-354.

Gibson, R.A., Lines, D.R., and Neumann, M.A. 1992. Gamma linolenic acid (GLA) content of encapsulated evening primrose oil products. Lipids **27**: 82-84.

Gilbertie, S. 1988. Kitchen herbs. The art and enjoyment of growing herbs and cooking with them. Bantam Books, Toronto, ON, Canada. 253 pp.

Gilby, A.C., and Wainwright, H. 1989. Use of tissue culture in improvement of watercress (*Rorippa nasturtium-aquaticum* L. Hayek). Acta Hortic. (The Hague) **244**: 105-113.

Girardon, P., Bessière, J.M., Baccou, J.C., and Sauvaire, Y. 1985. Volatile constituents of fenugreek seeds. Planta Med. **51**: 533-534.

Girardon, P., Sauvaire, Y., Baccou, J.C., and Bessière, J.M. 1986. Identification de la 3-hydroxy-4,5-diméthyl-2(5H)-furanone dan l'arôme des graines de fenugrec (*Trigonella foenumgraecum* L.). Lebensm.-Wiss. Technol. **19**: 44-46.

Girón, L. M., Freire, V., Alonzo, A., and Cáceres, A. 1991. Ethnobotanical survey of the medicinal flora used by the Caribs of Guatemala. J. Ethnopharmacol. **34**: 173-187.

Godhwani, S., Godhwani, J.L., and Vyas, D.S. 1987. *Ocimum sanctum*: an experimental study evaluating its anti-inflammatory, analgesic and antipyretic activity in animals. J. Ethnopharmacol. **21**: 153-163.

Godhwani, S., Godhwani, J.L., and Vyas, D.S. 1988. *Ocimum sanctum* - a preliminary study evaluating its immuno-regulatory profile in albino rats. J. Ethnopharmacol. **24**: 193-198.

Goel, B., and Kumar, A. 1989. Composition of uncommon foods. J. Food Sci. Technol. (India) **26**(1): 44-45.

Goldblatt, P. 1974. Biosystematic studies in *Papaver* section *Oxytona*. Ann. Mo. Bot. Gard. **61**: 264-296.

Goldstein, B. 1975. Ginseng: its history, dispersion, and folk tradition. Amer. J. Chinese Med. 3: 223-234.

González, C.A., Sanz, J.M., Marcos, G., Pita, S., Brullet, E., Saigi, E., Badia, A., Agudo, A., and Riboli, E. 1993. Borage consumption as a possible gastric cancer protective factor. Cancer Epidemiol. Biomarkers Prevent. **2**: 157-158.

Goode, J. 1984. Bee balm. Amer. Hortic. **63**(6): 25.

Gordon, J. 1968. The art of cooking with roses. Noonday Press, New York, NY, USA. 159 pp.

Gorunovic, M., Stosic, D., and Lukic, P. 1989. The value of agrimony (*Agrimonia eupatoria* L.) as a medicinal plant. Herba Hung. **28**(1-2): 45-50.

Govindarajan, V.S. 1982. Ginger - chemistry, technology, and quality evaluation. Part 1. CRC Crit. Rev. Food. Sci. Nutr. **17**: 1-96.

Govindarajan, V.S. 1985. *Capsicum* - production, technology, chemistry, and quality. Part I: history, botany, cultivation, and primary processing. CRC Crit. Rev. Food Sci. Nutr. **22**: 109-176.

Govindarajan, V.S. 1980*a*. *Capsicum* - production, technology, chemistry, and quality - Part II. Processed products, standards, world production and trade. CRC Crit. Rev. Food Sci. Nutr. **23**: 207-288.

Govindarajan, V.S. 1986*b*. *Capsicum* - production, technology, chemistry, and quality. Part III. Chemistry of the color, aroma, and pungency stimuli. CRC Crit. Rev. Food Sci. Nutr. **24**: 244-355.

Graham, S.A. 1966. The genera of Araliaceae in the southeastern United States. J. Arnold Arbor. **47**: 126-136.

Grant, E, and Epling, C. 1943. A study of *Pycnanthemum* (Labiatae). Univ. Calif. Publ. Bot. **20**: 195-240.

Grant, V. 1971. Plant speciation. Columbia University Press, New York, NY, USA. 435 pp.

Grayum, M.H., and Rohman, M.F. 1986. Four rare Eurasian adventives in the flora of western Massachusetts. Rhodora 88: 413-417.

Green, R.J. 1959. Mint farming. Purdue Univ. Agric. Info. Bull. **212**: 26 pp.

Green, R.J. 1985. Peppermint and spearmint production in the Midwest. Herb Spice Med. Plant Dig. **3**(1): 1-2, 5.

Green, R.J. 1987. Peppermint and spearmint production in the Midwestern States. *In* Proceedings of the second national herb growing and marketing conference. *Edited by* J.E. Simon and L. Grant. Purdue Research Foundation, West Lafayette, IN, USA. pp. 40-42.

Greene, B.E. 1992. Rhubarb recipes. University of Alaska, Fairbanks, AK, USA. 12 pp.

Greenhalgh, E 1979. The market for culinary herbs. Rep. Trop. Prod. Inst. **G121**: 171 pp.

Greuter, W., Burdet, H.M., and Long, G. (*Editors*). 1986. Med-checklist. Conservatoire et Jardin botaniques de la Ville de Genève, Switzerland. Vol. 3.

Greuter, W., Barrie, F.R., Burdet, H.M., Chaloner, W.G., Demoulin, V., Hawksworth, D.L., Jørgensen, P.M., Nicolson, D.H., Silva, P.C., Trehane, P., and McNeill, J. (*Editors*). 1994. International code of botanical nomenclature (Tokyo Code). Adopted by the Fifteenth International Botanical Congress, Yokohama, August-September 1993. (Regnum veg. 131). Otto Koeltz, Königstein, Germany. 389 pp.

Grieve, M. 1931. A modem herbal. Penguin Books, New York, NY, USA. 912 pp. Reprinted 1978.

Grieve, M. 1933. Culinary herbs and condiments. William Heinemann, London, U.K. 209 pp.

Grognet, J. 1990. Catnip: Its uses and effects, past and present. Can. Vet. J. **31**: 455-456.

Grushvitskii, I.V. 1959. A contribution to the knowledge of the biology of wild ginseng. Bot. Zh. **44**: 1694-1703. [In Russian.]

Gruss, B, Malan, F.S., Roper, N.A., Du Plessis, C.A., and Ashburner, A.J. 1988. The anthelmintic efficacy of resorantel against *Houttuynia struthionis* in ostriches. J. South Afr. Vet. Assoc. 59(4): 207-208.

Guenther, E. 1954. The French lavender and lavandin industry. Econ. Bot. 8: 166-173

Guenther, E. 1965. Oil of Verbena. *In* The essential oils 6: 37-41. *Edited by* E. Guenther. Van Nostrand Reinhold, New York, NY, USA.

Guha, S.R.D., Pant, R., and Karira, B.G. 1973. Chemical pulps for writing and printing papers from *Cymbopogon citratus* (DC.) Stapf (West Indian lemon grass). Indian For. **99**: 717-720.

Guha, S.R.D., Pant, R., and Karira, B.G. 1974. Chemical pulps for writing and printing papers from *Cymbopogon winterianus* Jowitt (Java citronella grass). Indian For. **100**: 400-403.

Gupta, B.K., and Jain, N. 1979. Contribution to the bibliography of *Cymbopogon* grasses. Indian J. For. 2: 71-96, 99-117.

Gurib-Fakim, A., Sewraj, M.D., Narod, F., and Menut, C. 1995. Aromatic plants of Mauritius: volatile constituents of the essential oils of *Coleus aromaticus* Benth., *Triphasia trifolia* (Burm.f.) and *Eucalyptus kirtoniana* F. Muell. J. Ess. Oil Res. **7**: 215-218.

Habegger, R., Kohl, M., and Fritz, D. 1989. A cultivation method for *Nasturtium officinale* (watercress) grown in greenhouse. Acta Hortic. (The Hague) **242**: 291-295.

Haber, E. 1994. Healing plant suffers ills. Recovery Newsl. (Can. Wildl. Serv.) **1994** (Winter): 12.

Hacker, C. 1993. Gardening with gusto - A handbook & cookbook for Canadian gardeners. Doubleday Canada Ltd., Toronto, ON, Canada. 262 pp.

Hackett, C., Carolane, J. 1982. Edible horticultural crops. A compendium of information on fruit, vegetable, spice and nut species. Academic Press, New York, NY, USA. 673 pp.

Haebisch, E.M.A.B. 1992. Pharmacological trial of a concentrated crude extract of *Stevia rebaudiana* (Bert.) Bertoni in healthy volunteers. Arq. Biol. Tecnol. **35**: 299-314.

Hallier, E.H. 1880-1888. Flora von Deutschland, edition 5 of D.F.L. von Schlechtendal et al. 39 vols. F.E. Köhler, Gera-Untermhaus, Germany.

Halpin, A.M. (*Editor*). 1978. Unusual vegetables. Rodale Press, Emmaus, PA, USA. 443 pp.

Hälvä, S. 1990*a*. Angelica - plant from the North. Herb Spice Med. Plant Dig. 8(2): 1-3.

Hälväi, S. 1990*b*. Producing angelica and other herbs for northern climates. *In* Herbs '90. Proceedings fifth annual conference, International Herb Growers & Marketers Association. *Edited by* J.E. Simon, A. Kestner and M.R. Buehrle. International Herb Growers & Marketers Association, Silver Springs, PA, USA. pp. 10-14.

Hälvä, S., Craker, L.E., Simon, J.E., and Charles, D.J. 1992*a*. Light levels, growth and essential oil in dill (*Anethum graveolens* L.). J. Herbs Spices Med. Plants **1** (1/2): 47-58.

Hälvä, S., Craker, L.E., Simon, J.E., and Charles, D.J. 1992*b*. Light quality, growth, and essential oil in dill (*Anethum graveolens* L.). J. Herbs Spices Med. Plants **1**(1/2): 59-70.

Hälvä, S., Craker, L.E., Simon, J.E., and Charles, D.J. 1993. Growth and essential oil in dill, *Anethum graveolens* L., in response to temperature and photoperiod. J. Herbs Spices Med. Plants **1**(3): 47-56.

Hammond, L.D. (*Editor*). 1963. Travelers in disguise, narratives of Eastern travel by Poggio Bracciolini and Ludovico de Varthema. Harvard University Press, Cambridge, MA, USA. 239 pp.

Hamon, N.W. 1987. Garlic and the genus *Allium*. Can. Pharm. J. **120**: 492-498.

Hamon, N.W. 1989. The chamomiles. Can. Pharm. J. **122**: 612-615.

Hamon, N.W., and Zuck, D.A. 1972. Peppermint as a cash crop in Saskatchewan. Can. J. Plant Sci. **52**: 837-839.

Hampstead, M. 1992. A bunch of basil. Org. Gard. 39(4): 60-64.

Hanau, O.I. 1994. *Calendula officinalis* L. - marigold. Portrait of a medicinal plant. Z. Phytother. [J. Phytother.] 16: 356-370. [In German.]

Handro, W., and Ferriera, C.M. 1989. *Stevia rebaudiana* (Bert.) Bertoni: production of natural sweeteners. *In* Biotechnology in agriculture and forestery, vol. 7, Medicinal and aromatic plants - II. *Edited by* Y.P.S. Bajaj. Springer-Verlag, Berlin. pp. 468-487.

Handwerker, T.S. 1990. A small-scale agriculture alternative. Specialty flowers. U.S. Dep. Agric., Office for Small-scale Agriculture. 2 pp.

Hanelt, P. 1990. Taxonomy, evolution, and history. *In* Onions and Allied Crops. Vol 1. Botany, physiology, and genetics. *Edited by* H.D. Rabinowitch and J.L. Brewster. CRC Press, Inc., Boca Raton, FL, USA. pp. 1-26.

Hanelt, P., Hammer, K., and Knüpffer, H. (*Editors*). 1992. The genus *Allium* - taxonomic problems and genetic resources. Inst. Pflanzen. Kulturpflanzenfors., Gatersleben, Germany. 359 pp.

Hankins, A.G. 1994. Market options for herbs and spices. *In* Herbs '94. Proceedings ninth national herb growing and marketing conference. *Edited by* A. Kestner, J.E. Simon and A.O. Tucker. International Herb Growers & Marketers Association, Mundelein, IL, USA. pp. 118-130.

Hansen, B. 1980. Mexican cookery. H.P. Books, Tucson, AZ, USA. 192 pp.

Hansen, C. E., Stoessel, P., and Rossi, P. 1991. Distribution of -linolenic acid in the comfrey (*Symphytum officinale*) plant. J. Sci. Food Agric. **54**: 309-312.

Hanson, W.I., and Hocking, G.M. 1957. Garden sage. Econ. Bot. **11**: 64-74.

Hara, H. 1962. Racial differences in widespread species, with special reference to those common to Japan and North America. Amer. J. Bot. **49**: 647-652.

Hara, H. 1970. On the Asiatic species of the genus *Panax*. J. Jpn. Bot. **45**: 197-212.

Hardacre, V. 1974. Woodland nuggets of gold. The story of American ginseng cultivation. Holland House Press, Northville, MI, USA. 331 pp.

Hardwick, W.A. 1995. History and antecedents of brewing. *In* Handbook of brewing. *Edited by* W.A. Hardwick. Marcel Dekker, Inc., New York, NY, USA. pp. 37-51.

Hardy, B.J. 1957. Rhubarb. Org. Gard. **4**(9): 54.

Harley, R.M. 1972. *Mentha. In* Flora Europaea, vol. 3. *Edited by* T.G. Tutin, V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, S.M. Walters, D.A. Webb. Cambridge University Press, Cambridge, UK. pp. 183-186.

Harrap, D. 1993. Stalking tall: rhubarb struts its stuff like no other garden vegetable. Harrowsmith **17**(6): 77, 78, 80, 83, 84, 86.

Harrington, G. 1978. Grow your own Chinese vegetables. MacMillan Pub. Co., New York, NY, USA. 268 pp.

Harris, L.J. 1975. The book of garlic. Holt, Rinehart and Winston, New York, NY, USA. 248 pp.

Harrison, H.C., Parke, J.L., Oelke, E.A., Kaminski, A.R., Hudelson, B.D., Martin, L.J., Kelling, K.A., and Binning, L.K. 1992. Ginseng. BioOptions (Newsletter, Center Alternative Plant and Animal Products) 3(4): 1-4. [Exerpt from Alternative Field Crops Manual published by Univ. Wisconsin-Extension, Center for Alternative Plant and Animal Products, and Minnesota Extension Service.]

Hart, R.H. 1976. Comfrey, miracle or mirage? Crops Soils Mag. **29**(1): 12-14.

Harter, J. (*Editor*). 1988. The plant kingdom compendium. Bonanza Books, New York, NY, USA. 374 pp.

Haunold, A. 1993. Agronomic and quality characteristics of native North American hops. Amer. Soc. Brew. Chem. J. **51**: 133-137.

Hawkes, A.D. 1984. A world of vegetable cookery. Simon and Schuster, New York, NY, USA. 283 pp.

Hayashi, K., Kamiya, M., and Hayashi, T. 1995. Virucidal effects of the steam distillate from *Houttynia cordata* and its components on HSV-1, influenza virus, and HIV. Planta Med. **61**: 237-241.

Hays, S.M. 1992. From asparagus to mint - research makes it better. Agric. Res. **40**(1): 2.

Hayward, G. 1983. Bee balm. Horticulture **51**(7): 16-19.

Hazum, E., Sabatka, J.L., Chang, K.-J., Brent, D.A, Findlay, J.W.A., and Cuatrecasas, P. 1981. Morphine in cow and human milk: could dietary morphine constitute a ligand for specific morphine ( ) receptors? Science **213**: 1010-1012.

Heath, H.B. 1981. Source book of flavors. AVI Publishing Co., Westport, CN, USA. 863 pp.

Hedrick, U.P. 1950. A history of horticulture in America to 1860. Oxford University Press, New York, NY, USA. 551 pp.

Hedrick, U.P. (*Editor*). 1972. Sturtevant's edible plants of the world. Dover Publications, New York, NY, USA. 686 pp. [Reprint of original published in 1919.]

Heinrich, M. 1992. Economic botany of American Labiatae. *In* Advances in labiate science. *Edited by* R.M. Harley and T. Reynolds. Royal Botanic Gardens, Kew, U.K. pp. 475-488.

Heiser Jr., C.B., and Pickersgill, B. 1969. Names for the cultivated *Capsicum* species (Solanaceae). Taxon **18**: 277-283.

Hemingway, J.S. 1995. Mustards. *In* Evolution of crop plants, 2nd edition. *Edited by* J. Smartt and N.W. Simmonds. Longman Scientific & Technical, U.K. pp. 82-86.

Hemphill, J., and Hemphill, R. 1984. Herbs - their cultivation and usage. Sterling Publishing, New York, NY, USA. 128 pp.

Hemsley, W.B. 1909. *Stevia rebaudiana. In* Icones plantarum. Fourth series, Vol. 9. *Edited by* W.J. Hooker. Dulau & Co., London, GB. Tabula 2816. [Irregularly paginated. Article accompanies illustration.]

Henning, J. 1994. After July - *Agastache*. Amer. Horticult. **73**(8): 32-35.

Henning, J. 1995. Aromatic *Agastache*. Amer. Nurseryman **181**(9): 59-67.

Henry, C.J., and Emery, B. 1985. Effect of spiced food on metabolic rate. Hum. Nutr. Clin. Nutr. **40C**: 165-168.

Henry, M., Edy, A.M., Desmarest, P., and Du Manoir, J. 1991. *Glycyrrhiza glabra* L. (licorice): cell culture, regeneration, and the production of glycyrrhizin. *In* Biotechnology in agriculture and forestry, Vol. 15, medicinal and aromatic plants - III. *Edited by* Y.P.S. Bajaj. Springer-Verlag, Berlin, Germany. pp. 270-282.

Hereman, S. 1868. Paxton's botanical dictionary. Bradbury, Evans, & Co., London, U.K. 623 pp.

Hériteau, J. 1975. Herbs. Grosset & Dunlap, New York, NY, USA. 95 pp.

Hériteau, J. 1983. Grow it, cook it. Perigree Books (Putnam Publishing Group), New York, NY, USA. 320 pp.

Herklots, G. A. 1972. Vegetables in south-east Asia. London George Allen & Unwin Ltd., London, Great Britain. 525 pp.

Heywood, V.H., and Zohary, D. 1995. A catalogue of the wild relatives of cultivated plants native to Europe. Flora Mediterr. **5**: 375-415.

Hills, L.D. 1953. Russian comfrey, a hundred tons an acre of stock feed or compost for farm, garden or smallholding. Faber and Faber, London, U.K. 167 pp.

Hills, L.D. 1954. Call it Quaker comfrey. Org. Gard. **1**(4): 26-29.

Hills, L.D. 1976. comfrey. Fodder, food and remedy. Universe Books, New York, NY, USA. 253 pp.

Hinman, H. R. 1990. 1990 enterprise budgets native and Scotch spearmint Lower Yakima valley, Washington. Wash. State Univ. Farm Bus. Manage. Rep. **EB956**: 41 pp.

Hinton, L. 1991. The European market for fruit and vegetables. Elsevier Science Publishing Co., New York, NY, USA. 212 pp.

Hintz, H.F. 1992. Garlic. Equine Practice **14**(9): 5-6.

Hirvi, T., Hälvä, S., Mäkinen, S., and Honkanen, E. 1987. Yield and volatile oils of caraway seeds (*Carum carvi* L.). *In* Flavour science technology. Proceedings 5th Weurman Flavour Research Symposium. *Edited by* M. Martens, G.A. Dalen, and H. Russwurm, Jr. John Wiley & Sons, Chichester, Britain. pp. 73-78.

Hitchings, C., and Bird, J. 1993. *Nigella sativa*. The Herbarist **59**: 20-32.

Hodge, W.H. 1974. Wasabi - native condiment plant of Japan. Econ. Bot. **28**: 118-129.

Holcomb, G.B. 1991. A small-scale agriculture alternative. Herbs. U.S. Dep. Agric. Circ. G.P.O.:1991-281-066: 40503/OPA. 2 pp.

Holt, G. 1989. Recipes from a French herb garden. Stoddard, Toronto, ON, Canada. 160 pp.

Holt, G. 1991. Geraldine Holt's complete book of herbs. Octopus Publishing Group, London, U.K. 224 pp.

Homes, J., Legros, M., and Jaziri, M. 1987. *In vitro* multiplication of *Crocus sativus* L. Acta Hortic. (The Hague) **212**: 675-676.

Hong, M.-W. 1978. A history of ginseng. *In* Korean ginseng. 2nd ed. *Edited by* H.-W. Bae. Korea Ginseng Research Institute, Ini-Dong, Chongro-ku, Seoul, Republic of Korea. pp. 13-41.

Hong, S.-K. 1978. Ginseng cultivation. *In* Korean ginseng. 2nd ed. *Edited by* H.-W. Bae. Korea Ginseng Research Institute, Ini-Dong, Chongro-ku, Seoul, Republic of Korea. pp. 245-272.

Hood, S.C. 1916. Commercial production of thymol from horsemint (*Monarda punctata*). U.S. Dep. Agric. Bull. **372**: 12 pp.

Hood, S.C. 1917. Possibility of the commercial production of lemon-grass oil in the United States. U.S. Dep. Agric. Prof. Pap. **442**: 12 pp.

Hook, E.B. 1978. Dietary cravings and aversions during pregnancy. Amer. J. Clin. Nutr. **31**: 1355-1362.

Hooker, A. 1971. Herb cookery. 101 Productions, San Francisco, CA, USA. 192 pp.

Hooker, W.J. 1909. Icones plantarum. Fourth series, Vol. 9. Dulau & Co., London, GB.

Horrobin, D.F. 1990. Gamma linolenic acid: an intermediate in essential faty acid metabolism with potential as an ethical pharmaceutical and as a food. Rev. Contemp. Pharmacother. **1**: 1-45.

Hosie, R.C. 1979. Native trees of Canada (8th ed.). Department of Fisheries and Forestry, Canadian Forestry Service, Ottawa. 380 pp.

Houston, D.R., Allen, D.C., and Lachance, D. 1990. Sugarbush management: a guide to maintaining tree health. U.S. Dep. Agric., For. Serv,, NE For. Exp. Stn. Gen. Tech. Rep. **NE-129**: 55 pp.

Howard, H.W. 1976. Watercress. *In* Evolution of crop plants. *Edited by* N.W. Simmonds. Longman Inc., New York, NY, USA. pp. 62-62.

Howard, H.W., and Lyon, A.G. 1952. Biological flora of the British Isles. *Nasturtium* R.Br. J. Ecol. **40**: 228-245.

Hsu, P. 1979. Why Chinese prefer American ginseng and how they use it. *In* Official proceedings first national ginseng conference. *Edited by* D.L. Hensley, S. Alexander, and C.R. Roberts. Governor's Council on Agriculture, Frankfort, KY, USA. pp. 104-106.

Hu, S.-Y. 1976. The genus *Panax* (ginseng) in Chinese medicine. Econ. Bot. **30**: 11-28.

Hu, S.-Y. 1977. A contribution to our knowledge of ginseng. Amer. J. Chin. Med. **5**: 1-23.

Hu, S.-Y. 1978. The ecology, phytogeography and ethnobotany of ginseng. Proc. 2nd internat. ginseng symposium, Seoul. pp. 149-157.

Hughes, M. 1985. The Broken Arrow Ranch cookbook. University of Texas Press, Austin, TX, USA. 200 pp.

Hughes, P. 1982. Pueblo Indian cookbook. Museum of New Mexico Press, Sante Fe, NM, USA. 64 pp.

Huizing, H.J., Gadella, T.W.J., and Kliphius, E. 1982. Chemotaxonomic investigations of the *Symphytum officinale* polyploid complex and *S. asperum* (Boraginaceae): the pyrrolizidine alkaloids. Plant Syst. Evol. **140**: 279-292.

Hultén, E., and Fries, M. 1986. Atlas of north European vascular plants north of the Tropic of Cancer. 3 vol. Koeltz Scientific Books, Kônigstein, Germany.

Hume, E.N. 1976. Beautiful and easy to grow... the myrtle of the ancients. Brooklyn Bot. Gard. Rec. Plants Gard. **32**(3): 44-46.

Hunault, G., Desmarest, P., and Du Manoir, J. 1989. *Foeniculum vulgare* Miller: cell culture, regeneration, and the production of anethole. *In* Biotechnology in agriculture and forestry, Vol. 7, medicinal and aromatic plants - II. *Edited by* Y.P.S. Bajaj. Springer-Verlag, Berlin, Germany. pp. 185-212.

Hussain, R.A., Poveda, L.J., Pezzuto, J.M., Soejarto, D.D., and Kinghorn, A.D. 1990. Sweetening agents of plant origin: phenylpropanoid constituents of seven sweet-tasting plants. Econ. Bot. **44**: 174-182.

Hutson, L. 1987. The herb garden cookbook. Texas Monthly Press, Austin, TX, USA. 278 pp.

Hutson, L. 1992. Spirited herbs of Mexico and the Southwest. *In* Herbs '92. Proceedings seventh national herb growing and marketing conference. *Edited by* J.E. Simon and A. Kestner. International Herb Growers & Marketers Association, Mundelein, IL, USA. pp. 55-63.

Huxley, A., Griffiths, M., and Levy, M. (*Editors*). 1992. The new Royal Horticultural Society dictionary of gardening. 4 Vols. Stockton Press, New York, NY, USA.

Huxtable, R. J., Lüthy, J., and Zwiefei, U. 1986. Toxicity of comfrey-pepsin preparations. N. Engl. J. Med. **315**: 1095.

Hyde, P.W. 1974. Comfrey. The Herbarist **40**: 37-39.

Ietswaart, J.H. 1980. A taxonomic revision of the genus *Origanum* (Labiatae). Leiden Bot. Ser. **4**: 1-153.

Inden, H., and Asahira, T. 1990. Japanese bunching onion (*Allium fistulosum* L.). *In* Onions and allied crops. Vol. III. Biochemistry, food science, and minor crops. *Edited by* J.L. Brewster and H.D. Rabinowitch. CRC Press, Inc., Boca Raton, FL, USA. pp. 159-178.

Inglett, G.E. 1982. Unusual sweeteners of plant origin. The Herbarist **48**: 67-78.

Ingram, J. 1961. Studies in the cultivated Boraginaceae. 5. *Symphytum*. Baileya 9: 92-99.

Irving, R.S. 1972. A revision of the genus *Poliomintha* (Labiatae). SIDA 5: 8-22.

Ishimaru, K., Hirose, M., Takahashi, K., Koyama, K., and Shimomura, K. 1990. Tannin production in root culture of *Sanguisorba officinalis*. Phytochemistry (Oxf.) **29**: 3827-3830.

Izaki, M., Hara, H., Igawa, H., Okazawa, N., and Kurihara, M. 1988. Studies on cooperation phenomenon in garden crop community: 1. The present phenomenon in *Cryptotaenia japonica* Hassk. Sci. Rep. Fac. Agric. Ibaraki Univ. No. 36: 19-24. [In Japanese].

Jackson, S.A.L., and Hay, R.K.M. 1994. Characteristics of varieties of thyme (*Thymus vulgaris* L.) for use in the UK: oil content, composition and related characters. J. Hortic. Sci. **69**: 275-281.

Jacobs, B.E.M. 1972. Growing herbs for the kitchen. Gray's Publishing Ltd., Sidney, BC, Canada. 93 pp.

Jacobsen, P.D. 1994. Herbs of the sea. The Herbarist **60**: 35-41.

Jacopin, A.C. 1979. Basil. *In* Encyclopedic Dictionary of Religion. Vol. A-E. *Edited by* P.K. Meagher, T.C. O'Brien, and C.M. Aherne. Corpus Publications, Washington, DC, USA. p. 383.

Jaffrey, M. 1975. An invitation to Indian cooking. Vintage Books/Random House, New York, NY, USA. 302 pp.

Jaffrey, M. 1981. Madhur Jaffrey's world-of-the-East vegetarian cooking. Alfred A. Knopf, Inc. New York, NY, USA. 460 pp.

Jain, M., Banerji, R., Nigam, S. K., Scheffer, J. J. C., and Chaturvedi, H. C. 1991. *In vitro* production of essential oil from proliferating shoots of *Rosmarinus officinalis*. Planta Medica **57**: 122-124.

Jalas, J. 1970. *Thymus* sectio *Serpyllum* in the Southern French Alps. Veröff. Geobot. Inst. Rübel Zürich **43**: 183-203.

Jalas, J. 1971. Notes on *Thymus* L. (Labiatae) in Europe. II. Comments on species and subspecies. Bot. J. Linn. Soc. **64**: 247-275.

Jalas, J. 1974. Notes on *Thymus* L. (Labiatae) in Europe. HI. Ann. Bot. Fenn. **11**: 262-266.

Jalas, J. 1980. Turkish taxa of *Thymus* (Labiatae) described as new or revised. Ann. Bot. Fenn. **17**: 315-324.

Janerette, C.A. 1979. Cold soaking reduces the stratification requirement of sugar maple seeds. Tree Planters' Notes (U.S. Dept. Agric. Forest Service) **30**(2): 3.

Janick, J., Simon, J.E., Quinn, J., Beaubaire, N. 1989. Borage: a source of gamma linolenic acid. Herbs, Spices, and Medicinal Plants (Recent Adv. Bot. Hortic. Pharmacol.) **4**: 145-168.

Jeanneret, B. (ed.) 1987. The new herb cook book. Southern Ontario Unit, Herb Society of America, Canada. 123 pp.

Jeffrey, C. 1989. Biological nomenclature. 3d edition. Edward Arnold, London, U.K. 86 pp.

Jeker, M., Sticher, O., Çalis, I., and Rüedi, P. 1989. Allobetonicoside and 6-O-acetyl mioporoside: two new iridoid glycosides from *Betonica officinalis*. Helvetica Chimica Acta **72**: 1787-1789.

Jenkins, D.K., Mitchell, J.C., Manku, J.S., and Horrobin, D.E 1988. Effects of different sources of gamma-linolenic acid on the formation of essential fatty acid and prostanoid metabolites. Med. Sci. Res. **16**: 525-526.

Jesiolowski, J. 1993. Grow red hot chile peppers. Org. Gard. **40**(2): 27-32.

Jessen-Klixbull, C. 1985. Herbal winemaking experiments. The Herb Quarterly **27**: 34-35.

Jirovetz, L., Jager, W., Remberg, G., Espinosa-Gonzalez, J., Morales, R., Woidich, A., and Nikiforov, A. 1992. Analysis of the volatiles in the seed oil of *Hibiscus sabdariffa* (Malvaceae) by means of GC-MS and GC-FTIR. J. Agric. Food Chem. **40**: 1186-1187.

Johns, C. 1853. Flowers of the field. Society for Promoting Christian Knowledge, London, U.K. 2 vols.

Jolliff, G.D., and Snapp, S.S. 1988. New crop development: opportunity and challenges. J. Prod. Agric. **1**: 83-89.

Jones, D.B. 1961. Rosemary - the herb of remembrance. The Herbarist **27**: 10-19.

Jones, D.B. 1962. The way of the poet's marigold. The Herbarist **28**: 53-59.

Jones, D.B. 1973. The great dittany of Crete - then and now. The Herbarist **39**: 12-18.

Jong, T.-T., and Jean, M.-Y. 1993a. Alakloids from *Houttuynia cordata*. J. Chinese Chem. Soc. (Taipei) **40**: 301-303.

Jong, T.-T., and Jean, M.-Y. 1993b. Constituents of *Houttuynia cordata* and the crystal structure of vomifoliol. J. Chinese Chem. Soc. (Taipei) **40**: 399-402.

Jyurovat, G.G. 1973. Borage for courage. The Herbarist **39**: 50-53.

Kadereit, J.W. 1986. A revision of *Papaver* L. sect. *Papaver* (Papaveraceae). Bot. Jahrb. Syst. **108**: 1-16.

Kang, J.Y., Yeoh, K.G., Chia, H.P., Lee, H.P., Chia, Y.W., Guan, R., and Yap, I. 1995. Chili - protective factor against peptic ulcer? Digestive Diseases and Sciences **40**: 576-579.

Kapadia, G.J., Rao, G.S., and Morton, J.E 1983. Herbal tea consumption and esophageal cancer. Carcinogens and Mutagens in the Environment 3: 3-12. Boca Raton, Florida, USA.

Kaplan, L. 1960. Historical and ethnobotanical aspects of domestication in *Tagetes*. Econ. Bot. **14**: 200-202.

Kapoor, L.D. 1995. Opium poppy: botany, chemistry, and pharmacology. Food Products Press, Binghamton, New York, U.S.A. 326 pp.

Kaspareck, M., Gröger, A., and Schippmann, U. 1996. Directory for medicinal plants conservation. Networks, organizations, projects, information sources. German Federal Agency for Nature Conservation, Bonn, Germany. 156 pp.

Kavasch, B. 1979. Native harvests - recipes and botanicals of the American Indian. Random House, New York, NY, USA. 202 pp.

Kavena, J.T. 1980. Hopi cookery. The University of Arizona Press, Tucson, Arizona, USA. 115 pp.

Kays, S.J., and Silva Dias, J.C. 1995. Common names of commercially cultivated vegetables of the world in 15 languages. Econ. Bot. **49**: 115-152.

Kearney, T.H., and Peebles, R.H. 1951. Arizona flora. University of California Press, Berkeley, CA, U.S.A. 1032 pp.

Kebede, S. 1988a. Domestic production of paprika as raw spice and for extraction. *Edited by* J.E. Simon and L.Z. Clavio. Proceedings of the third national herb growing and marketing conference. Purdue Research Foundation, West Lafayette, IN, USA. pp. 20-29.

Kebede, S. 1988b. Growing herbs under contract - meeting the needs of the processor. *In* Proceedings of the third national herb growing and marketing conference. *Edited by* J.E. Simon and L.Z. Clavio. Purdue Research Foundation, West Lafayette, IN, USA. pp. 84-91.

Kennedy, D. 1978. Recipes from the regional cooks of Mexico. Harper & Row, New York, NY, USA. 289 pp.

Kennedy, D. 1989a. The art of Mexican cooking. Bantam Books, New York, NY, USA. 526 pp.

Kennedy, D. 1989b. The cuisines of Mexico. Harper & Row, New York, NY, USA. 391 pp.

Kenyon, J.S. 1953. The pronunciation of *herb*. The Herbarist **19**: 7-8.

Kenyon, S. 1979. Hydroponics for the home gardener. Van Nostrand Reinhold, Toronto, ON, Canada. 146 pp.

Kernaleguen, A., Smith, R. A., and Yong, C. W. 1989. Acute mustard seed toxicosis in beef cattle. Can. Vet. J. **30**: 524.

Kerr, L. A., Johnson, B. J., and Burrows, G. E. 1986. Intoxication of cattle by *Perilla frutescens* (purple mint). Vet. Human Toxicol. **28**: 412-416.

Kerrola, K., Galambosi, B. and Kallio, H. 1994a. Volatile components and odor intensity of four phenotypes of hyssop (*Hyssopus officinalis* L.). J. Agric. Food Chem. **42**: 776-781.

Kerrola, K., Galambosi, B. and Kallio, H. 1994b. Characterization of volatile composition and odor of angelica (*Angelica archangelica* subsp. *archangelica* L.) root extracts. J. Agric. Food Chem. **42**: 1979-1988.

Kestner, A., Simon, J.E., and Tucker, A.O. 1994 (editors). Herbs '94. Proceedings ninth national herb growing and marketing conference. International Herb Growers & Marketers Association, Mundelein, Ill., USA. 176 pp.

Keys, J. 1976. Chinese herbs. Charles E. Tuttle Co., Rutland, Vermont, USA. 388 pp.

Kidston, J. 1987. Rhubarb for good measure. Penumbra Press, Kapuskasing, ON., Canada. 77 pp.

Kiehn, F.A., and Reimer, M. 1993. Alternative crops for the prairies. Agriculture Canada 1887/E. 46 pp.

Kiger, R.W. 1975. *Papaver* in North America north of Mexico. Rhodora **77**: 410-422.

Kim, I.-H. 1978. Botanical characteristics of ginseng. *In* Korean Ginseng. 2nd. edition. *Edited by* H.-W. Bae. Korea Ginseng Research Institute, Ini-Dong, Chongro-ku, Seoul, Republic of Korea. pp. 45-58.

Kimmens, A.C. 1975. (Editor). Tales of the ginseng. William Morrow and Company, New York, NY, USA. 208 pp.

Kindscher, K. 1987. Edible wild plants of the prairie. An ethnobotanical guide. University Press of Kansas, Lawrence, KA, USA. 276 pp. [1992 edition: 340 pp.]

Kinghorn, A.D. 1987. Biologically active compounds from plants with reputed medicinal and sweetening properties. J. Nat. Prod. **60**: 1009-1024.

Kinghorn, A.D., and Soejarto, D.D. 1985. Current status of stevioside as a sweetening agent for human use. *In* Economic and medical plant research, vol. 1. *Edited by* H. Wagner, H. Hikino, and N.R. Farnsworth. Academic Press, London, UK. pp. 1-52.

Kingsbury, J.M. 1964. Poisonous plants of the United States and Canada. Prentice-Hall, Engelwood Cliffs, N.J., U.S.A. 626 pp.

Kingsmill, S. 1933. Barnacle Bill and the red hot peppers. New Sci. **138**: 21.

Kirimer, N., Baser, K.H.C., Özek, T., and Kürkçüoglu, M. 1992. Composition of the essential oil of *Calamintha nepeta* subsp. *glandulosa*. J. Ess. Oil Res. **4**: 189-190.

Klayman, D.L. 1993. *Artemisia annua* - from weed to respectable antimalarial plant. I*n* Human medicinal agents from plants. *Edited by* A.D. Kinghorn and M.F. Balandrin. American Chemical Society, San Francisco, Washington, DC, USA. pp. 242-255.

Klein, R.M. 1979. Maple syrup: confection from the forest. Garden **3**(2): 9-11.

Knapke, D.; and Still, S. 1996. Winter survival of six *Lavandula* taxa. The Herbarist 62: 45-48.

Kobayashi, T. 1950. Studies on the histo-pathologic changes of experimental cases of the "Enzonegi-poisoning" in horses. Jpn. J. Vet. Sci. **12**: 209.

Kojima, A., Nagato, Y., and Hinata, K. 1992. Apomixis in *Allium tuberosum* and *A. ramosum. In* The genus *Allium* - taxonomic problems and genetic resources. *Edited by* P. Hanelt, K. Hammer and H. Knüpffer. Institut für Pflanzengenetik und Kulturpflanzenforschung, Gatersleben, Germany. pp. 161-165.

Köhler, A.D. 1883-1898. Köhler's Medizinal Pflanzen. 3 vols. Verlag yon Fr. Eugen Köhler, Germany.

Kokkalou, E., and Stefanou, E. 1990. The volatile oil of *Calarnintha nepeta* (L.) Savi subsp. *glandulosa* (Req.) P.W. Ball, endemic to Greece. Flavour Fragrance J. **5**: 23-26.

Kokkini, S. 1991. Chemical races within the genus *Mentha* L. Mod. Method. Plant Anal. New Ser. **12**: 63-78.

Kokkini, S. 1992. Essential oils as taxonomic markers in *Mentha. In* Advances in labiate science. *Edited by* R.M. Harley and T. Reynolds. Royal Botanic Gardens, Kew, U.K. pp. 325-334.

Konsler, T.R. 1987. Woodland production of ginseng and goldenseal. Station Bulletin Purdue University Agric. Exper. Sta. No. 518. pp. 175-178.

Kosuge, T., Ishida, H., Yokota, M., Yoshida, M. 1984. Studies on antihemorrhagic substances in herbs classified as hemostatics in Chinese medicine. III. On the antihemorrhagic principle in *Sanguisorba officinalis* L. Chem. Pharm. Bull. (Tokyo) **32**: 4478-4481.

Kotlinska, T., Havranek, P., Navratill, M., Gerasimova, L., Pimakhov, A., and Niekov, S. 1990. Collecting onion, garlic and wild species of *Allium* in central Asia, USSR. FAO/IBPGR Plant Gene. Resources News. **83/84**: 31-32.

Kriebel, H.B. 1957. Patterns of genetic variation in sugar maple. Ohio Agric. Expt. Stat. Res. Bull. **791**. 56 pp.

Kriebel, H.B. 1989. Genetic improvement of sugar maple for high sap sugar content. I. Clone selection and seed orchard development. Can. J. For. Res. **19**: 917-923.

Kriebel, H.B. 1990. Genetic improvement of sugar maple for high sap sugar content. II. Relative effectiveness of maternal and biparental selection. Can. J. For. Res. **20**: 837-844.

Krochmal, C. 1994. Poison honeys. American Bee J. **134**: 549-550.

Krueger, C. 1993. Behold the hummer. The Herbarist **59**: 53-54.

Kubat, N.B. 1988. Tarragon. Cornell Plantations **44**(1): 8-10.

Kublick, L. 1990. The prairie herb garden. Western Producer Prairie Books, Saskatoon, SK, Canada. 141 pp.

Kubold, U., Vostrowsky, O., Bestmann, H.J., Bisht, J.C., Pant, A.K., Melkani, A.B., and Mathela, C.S. 1987. Terpenoids from *Elsholtzia* species; II. Constituents of essential oil from a new chemotype of *Elsholtzia cristata*. Plant Medica **53**: 268-271.

Kuebel, K. R., and Tucker, A. O. 1988. Vietnamese culinary herbs in the United States. Econ. Bot. **42**: 413-419.

Kuhnlein, H.V., and Turner, N.J. 1991. Traditional plant foods of Canadian indigenous peoples - nutrition, botany and use. Gordon and Breach Science Publishers, Philadelphia, PA, U.S.A. 633 pp.

Kulkarni, R. N., and Ramesh, S. 1992. Development of lemongrass clones with high oil content through population improvement. J. Ess. Oil Res. **4**: 181-186.

Kuo, I. 1977. The key to Chinese cooking. Alfred A. Knopf, New York, NY, USA. 532 pp.

Kuusi, T., Hårdh, K., and Kanon, H. 1982. The nutritive value of dandelion leaves. Alternative/Appropriate Technol. Agric. **3**(1): 53-60.

Kuusi, T., Hårdh, K., and Kanon, H. 1984a. Experiments on the cultivation of dandelion for salads use. I. Study of cultivation methods and their influence on yield and sensory quality. J. Agric. Sci. Finland **56**(1): 9-22.

Kuusi, T., Hårdh, K., and Kanon, H. 1984b. Experiments on the cultivation of dandelion for salads use. II. The nutritive value and intrinsic quality of dandelion leaves. J. Agric. Sci. Finland **56**(1): 23-31.

Kuusi, T., Pyysalo, H., and Autio, K. 1985. The bitterness properties of dandelion. II. Chemical investigations. Lebensm. Wiss. Technol. (Zurich) **18**: 349-349.

Ladizinsky, G., and Vosa, C.G. 1986. Karyotype and C-banding in *Trigonella* section *Foenum-graecum* (Fabaceae). Pl. Syst. Evol. **153**: 1-5.

Laferrière, J.E. 1994. The Denver mint, a new genus and species. Plant Science Bull. **40**: 47.

Lamaison, J.L., Petitjean-Freytet, C., and Carnat, A. 1993. Le verbascoside, compost phénolique majeur des feuilles de franc (*Fraxinus excelsior*) et de verveine (*Aloysia triphylla*). Plantes médicinales et phytothérapie **26**(3): 225-233.

Lamarck, J.B.A.P.M. de. 1783. Encyclopédie méthodique. Botanique. Vol. 1. Chez Panckoucke, Paris.

Lamarck, J.B.A.P.M. de, and Poiret, J.L.M. 1791-1823. Tableau encyclopédique et méthodique de trois règnes de la nature. Botanique. Chez Panckoucke, Pads. 6 vol.

Lainbourne, J. 1913. The roselle. Agric. Bull. Federated Malay States **2**: 59-67.

Landing, J.E. 1969. American essence: a history of the peppermint and spearmint industry in the United States. The Public Museum, Kalamazoo, MI, U.S.A. 244 pp.

Lange, D.D., and Cameron, A.C. 1994. Postharvest shelf life of sweet basil (*Ocimum basilicum*). Holtscience **29**: 102-103.

Lappé, F. M. 1975. Diet for a small planet (revised). Ballantine Books, New York, N.Y., USA. 411 pp.

Larkcom, J. 1984. The salad garden. Viking Press, New York, N.Y., U.S.A. 168 pp.

Larkin, T. 1983. Herbs are often more toxic than magical. FDA Consumer **17**(8): 5-10.

Laufer, B. 1919. Sino-Iranica - Chinese contributions to the history of civilization in ancient Iran. Field Mus. Nat. Hist. Publ. 201, Anthrop. ser. 15, **3**: 185-630.

Launert, E. 1981. The Hamlyn guide to edible and medicinal plants of Britain and Northern Europe. Hamlyn, London, UK. 288 pp.

Laurance, J. 1997. Calming odors. Can. Bot. Assoc. Bull. **30**: 14.

Lawrence, B.M. 1982. Addition to the chemical composition of *Pycnanthemum* essential oils. *In* Cultivation and utilization of aromatic plants. *Edited by* C.K. Atal and B.M. Kapur. Regional Research Laboratory, Council of Scientific & Industrial Research, Jammu-Tawi, India. pp. 677-680.

Lawrence, B. M. 1983. Progress in essential oils - Anise oil, Bergamot oil. Perf. Flav. **8**(3): 65-74.

Lawrence, B. M. 1984a. Progress in essential oils. Perf. Flay. **9**(1): 49-60.

Lawrence, B. M. 1984b. Progress in essential oils - Thyme oil. Perf. Flav. **9**(2): 23-31.

Lawrence, B. M. 1984c. The botanical and chemical aspects of oregano. Perf. Flav. **9**(5): 41-44, 49-51.

Lawrence, B. M. 1985a. Progress in essential oils. Perf. Flav. **10**(1): 43-53.

Lawrence, B. M. 1985b. Essential oils of the *Tagetes* genus. Perf. Flav. **10**(5): 73-82.

Lawrence, B. M. 1985c [1985-1986]. Chemical composition of tagetes oil. Perf. Flav. **10**(6): 56-58.

Lawrence, B.M. 1985d. A review of the world production of essential oils (1984). Perf. Flav. **10**(5): 1-16.

Lawrence, B. M. 1987a. Progress in essential oils. Chamomile oil. Perf. Flav. **12**(1): 35, 36, 38, 40, 42, 46, 48, 50, 52.

Lawrence, B. M. 1987b. Progress in essential oils. [Anise oil, bergamot oil, cumin oil, cypress oil.] Perf. Flav. **12**(2): 67-72.

Lawrence, B. M. 1987c. Progress in essential oils. Fenugreek extract. Perf. Flav. **12**(5): 60.

Lawrence, B. M. 1987d. Progress in essential oils. Juniperberry oil. Perf. Flav. **12**(6): 59-61.

Lawrence, B.M. 1992. Chemical components of Labiatae oils and their exploitation. *In* Advances in labiate science. *Edited by* R.M. Harley and T. Reynolds. Royal Botanic Gardens, Kew, U.K. pp. 399-436.

Lawrence, B.M. 1993a. A planning scheme to evaluate new aromatic plants for the flavor and fragrance industries. *In* New crops - exploration, research, and commercialization. *Edited by* J. Janick and J.E. Simon. J. Wiley and Sons, New York, NY, USA. pp. 620-627.

Lawrence, B.M. 1993b. Progress in Essential Oils. Roman chamomile oil. Perf. Flav. **18**(4): 71-72.

Lawrence, B.M., Hogg, J.W., Terhune, S.J., and Pichitakul, N. 1972. Essential oils and their constituents. IX. The oils of *Ocimum sanctum* and *Ocimum basilicum* from Thailand. Flavour Ind. 3: 47-49.

Laws, B. A. 1981. Thyme. Amer. Hortic. **60**(12): 13-14.

Ledésert, R. P., and Ledésert, M. (eds.) 1976. Harrap's new standard French and English dictionary. 4 Vols. Revised. Harrap & Co., London, UK.

Lee, EC. 1992. Facts about ginseng - the elixir of life. Hollym Press, Seoul, Korea. 104 pp.

Lee, J.-I., Han, E.-d., Park, H.-W., and Bang, J.-K. 1989. Review of the research results on *Perilla* and its prospects in Korea. *In* Proceedings of National Symposium on Oil Crop Production and Its Utilization. Crop Experiment Station, Rural Development Administration, Suwon, Korea. pp. 40-52. [In Korean, English summary.]

Lee, S.-Y., Kim, J.-D., Lee, Y.-H., Rhee, H., and Choi, Y.-S. 1991. Influence of extract of *Rosa rugosa* roots on lipid levels in serum and liver of rats. Life Sciences **49**: 947-951.

Leggatt, J. 1987. Cooking with flowers. Century Hutchinson Ltd., London, UK. 142 pp.

Lehner, E., and Lehner, J. 1960. Folklore and symbolism of flowers, plants and trees. Tudor Publishing Company, New York, NY, USA. 128 pp.

Lehner, E., and Lehner, J. 1962. Folklore and odysseys of food and medicinal plants. Tudor Publishing Company, New York, NY, USA. 128 pp.

Leite, J. R., Seabra, M. L., Maluf, E., Assolant, K., Suchecki, D., Tufik, S, Klepacz, S., and Calil, H.M. 1986. Pharmacology of lemongrass (*Cymbopogon citratus* Stapf.). III. Assessment of eventual toxic, hypnotic and anxiolytic effects on humans. J. Ethnopharmacol. **17**: 75-83.

Leonard, J.N. 1971. Latin American cooking. Time-Life Books, New York, NY, USA. 206 pp.

le Strange, R. 1977. A history of herbal plants. Arco, New York, NY, USA. 304 pp.

Letchamo, W. 1993. Effect of storage temperatures and duration on the essential oil and flavonoids of chamomile. J. Herbs, Spices & Medicinal Plants **1**(3): 13-26.

Letchamo, W., Hö1zl, J., and Gosselin, A. 1995. Growth and essential oil content of *Angelica archangelica* as influenced by light intensity and growing media. J. Essent. Oil Res. **7**: 497-504.

Levtzion, N., and Hopkins, J.E.P. 1981. Corpus of early Arabic sources for West African history. Cambridge University Press, Cambridge, U.K. 366 pp.

Levy, F. 1987. Fresh from France vegetable creations. E.P. Dutton (Penguin Inc.), New York, NY, USA. 364 pp.

Lewis, W.H. 1979. Ginseng of northeastern China. I*n* Official proceedings first national ginseng conference. *Edited by* D.L. Hensley, S. Alexander, and C.R. Roberts. Governor's Council on Agriculture, Frankfort, KY, USA. pp. 69-77.

Lewis, W.H. 1986. Ginseng: a medical enigma. *In* Plants in indigenous medicine & diet: biobehavioral approaches. *Edited by* N.L. Etkin. Redgrave Publ. Co., Bedford Hills, NY, USA. pp. 290-305.

Lewis, W.H. 1987. Root weights of *Panax quinquefolium* (Araliaceae) correlated with age and leaf morphology. Econ. Bot. **41**: 523-525.

Lewis, W.H. 1992. Early uses of *Stevia rebaudiana* (Asteraceae) leaves as a sweetener in Paraguay. Econ. Bot. **46**: 336-337.

Lewis, W.H., and Elvin-Lewis, M.P.F. 1977. Medical botany: plants affecting man's health. John Wiley & Sons, New York, NY, USA. 515 pp.

Lewis, W.H., and Zenger, V.E. 1982. Population dynamics of the American gingseng *Panax quinquefolium* (Araliaceae). Amer. J. Bot. **69**: 1483-1490.

Lewis, Y. S. 1984. Spices and herbs for the food industry. Food Trade Press, Orpington, UK. 200 pp.

Leyel, C.F. 1938. Herbal delights. Faber and Faber, London, U.K. 429 pp.

Li, C.P, and Li, R.C. 1973. An introductory note to ginseng. Amer. J. Chin. Med. **1**: 249-261.

Li, H., Fisher, C, Keown, R.W., and Malon, C.P. 1994. Interactions of green tea catechin with polyamides. *In* Food phytochemicals for cancer prevention II. Teas spices, and herbs. *Edited by* C.-T. Ho, T. Osawa, M.-T., Huang, and R.T. Rosen. American Chemical Society, Washington, DC, USA. pp. 90-100.

Li, H.-L. 1952. Floristic relationships between Eastern Asia and Eastern North America. Trans. Amer. Phil. Soc. (N.S.) **42**: 371-424.

Li, S.C., Porter Smith, F., and Stuart, G.A. 1973. Chinese medicinal herbs. Georgetown Press, San Francisco, CA, USA. 507 pp. [Pen ts'ao kan mu, written by the 16th century S.C. Li, translated and researched by Smith and Stuart.]

Li, T.S.C. 1992*a*. A brief description of some Chinese vegetables and how to grow them. Contribution 92-02. Research Branch, Agriculture Canada Research Station. Summerland, BC. 18 pp.

Li, T.S.C. 1992*b*. Ginseng culture methods in China, Korea and Japan. Agriculture Canada Research Station. Summerland, BC. 18 pp.

Li, T.S.C. 1995. Asian and American ginseng - a review. HortTechnology **5**: 27-34.

Li, T.S.C., Mazza, G., Cottrell, A.C., and Gao, L. 1996. Ginsenosides in roots and leaves of American ginseng. J. Agric. Food Chem. **44**: 717-720.

Libert, B. 1987*a*. Genotypic and non-genetic variation of oxalate and malate content in rhubarb (*Rheum* spp. L.) J. Hortic. Sci. **62**: 513-521.

Libert, B. 1987*b*. Breeding a low-oxalate rhubarb (*Rheum* sp. L.) J. Hortic. Sci. **62**: 523-529.

Libert, B., and Englund, R. 1989. Present distribution and ecology of *Rheum rhaponticum* (Polygonaceae). Willdenowia **19**: 91-98.

Libert, B., and Franceschi, V.R. 1987. Oxalate in crop plants. J. Agric. Food Chem. **35**: 926-938.

Lima, P. 1986. The Harrowsmith illustrated book of herbs. Camden House Publishing Ltd., Camden East, ON, Canada. 175 pp.

Lindley, J. (*Editor and main contributor*). 1829-1847. Edward's Botanical Register, vol. 16-23. London, UK.

Lindsay, K.M., and Cruise, J.E. 1975. Ginseng - native plant now rare. Ont. Nat. **15**(2): 16-19.

Lipscomb, D. 1995. Women in systematics. Annu. Rev. Ecol. Syst. **26**: 323-341.

Liu, Y.-l., and Deng, Z.-f. 1979. Investigation of the chemical constituents of the essential oil of *Houttuynia cordata* Thunb. Acta Bot. Sin. **21**: 244-249.

Liukkonen-Lilja, H., and Piepponen, S. 1992. Leaching of aluminium from aluminium dishes and packages. Food Addit. Contam. **9**: 213-223.

Locock, R.A. 1985. *Capsicum*. Can. Pharm. J. **118**: 517-519.

Locock, R.A. 1990. Boneset-*Eupatorium*. Can. Pharm. J. **123**: 229, 231, 233.

Loewenfeld, C., and Back, P. 1974. The complete book of herbs and spices. David & Charles, London, UK. 315 pp. [2nd ed. in 1978.]

Long, J. 1992. Fresh herbs as a sideline. The Business of Herbs **9**(6): 1, 2, 31.

Longvah, T., and Doesthale, Y.G. 1991. Chemical and nutritional studies on hanshi (*Perilla frutescens*), a traditional oilseed from northeast India. J. Am. Oil Chem. Soc. **68**: 781-784.

Lööf, B. 1966. Poppy cultivation. Field Crop Abstr. **19**: 1-5.

Lopez, R.S., and Raymond, I.W. 1955. Medieval trade in the Mediterranean world. Columbia University Press, New York, NY, USA. 458 pp.

Lorenzetti, B.B., Souza, G.E., Sarti, S.J., Filho, D.S., and Ferreira, S.H. 1991. Myrcene mimics the peripheral analgesic activity of lemongrass tea. J. Ethnopharmacol. **34**: 43-48.

Loughton, A. 1972. Rhubarb forcing. Ontario Ministry of Agriculture and Food. 4 pp.

Love, H.K., Rakow, G., Raney, J.P., and Downey, R.K. 1990. Development of low glucosinolate mustard. Can. J. Plant Sci. **70**: 419-424.

Lozina-Lozinskaja, A.S. 1936. Sistematiceskij obzor dikorastušcich vidov roda *Rheum* L. Tr. Bot. Inst. Akad. Nauk SSSR, Ser. 1, Fl. Sist. Vysš. Rast. **3**: 67-141.

Lust, J.B. 1974. The herb book. Bantam Books, New York, NY, USA. 660 pp.

Lutomski, J. 1993. Zloty * Lan* - Polish variety of common camomile (*Chamomilla recucita* Rausch). Acta Hortic. (The Hague) **344**: 352-360.

Lutz, J.M., and Craker, L.E. 1994. Financial considerations for the herb business. Herb Spice Med. Plant Dig. **12**(4): 1-6.

Lyall, L.H. 1968. Rhubarb planting & growing. Can. Dep. Agric. Publ. **1369**: 3 pp.

Mabberly, D.J. 1987. The plant book. Cambridge University Press, Cambridge, U.K. 706 pp.

MacDonald, M.A., and Cavers, P.B. 1991. The biology of Canadian weeds. 97. *Barbarea vulgaris* R.Br. Can. J. Plant Sci. **71**: 149-166.

Macleod, D. 1968. A book of herbs. Gerald Duckworth & Co. Ltd., London, U.K. 190 pp.

Madsen, P.R. 1990. Holiday herbs. Virginia Gard. **9**(12): 2-3.

Magalhaes-Godinho, V. 1969. L'Économie de l'empire portugais au XVe et XVIe siècles. École Pratique des Hautes Études, Paris, France. 857 pp.

Maghami, P. 1979. Culture et cueillette des plants médicinales. Hachette, Paris, France. 224 pp.

Malik, M.S, Ahmed, R., Kahn, S.A., and Bhatty, R. 1985. Studies on the essential oil of the *Coleus aromaticus* plant. Pak. J. Sci. Ind. Res. **28**(1): 10-12.

Mallos, T. 1979. The complete Middle East Cookbook. McGraw-Hill, New York, NY, USA. 400 pp.

Mann, C., and Staba, E.J. 1986. Herbs, Spices, and Medicinal Plants (Recent Adv. Bot. Hortic. Pharmacol.) **1**: 235-280.

Mann, L.K., and Stearn, W.T. 1960. Rakkyo or ch'iao t'ou (*Allium chinense* G. Don, syn. *A. bakeri* Regel) a little known vegetable crop. Econ. Bot. **14**: 69-83.

Mansfeld, R. 1986. Verzeichnis landwirtschftlicher und gärtnerischer Kulturpflanzen (ohne Zierpflanzen). 2nd ed. 4 Vol. *Edited by* Schultze-Motel et al. Springer-Verlag, New York, NY, USA.

Marcin, M.M. 1983. The complete book of herbal teas. Congdon & Weed, New York, NY, USA. 224 pp.

Marshall, D.E. 1988. A bibliography of rhubarb and *Rheum* species. Bibliographies and Literature of Agriculture, **62**. U.S. Dep. Agric., Nat. Agric. Libr., Agilc. Res. Serv., Washington, DC, USA. 377 pp.

Marshall, H.H. 1983. *Monarda* for geraniol production. West. Can. Soc. Hortic. Rep. Proc. **39**: 42-44.

Martelli, A., Frattini, C., and Chialva, F. 1985. Unusual essential oils with aromatic properties - I. Volatile components of *Stevia rebaudiana* Bertoni. Flavour Fragrance J. **1**: 3-7.

Martin, E.B. 1986. *Laurus nobilis* - bay tree. The Herbarist **52**: 25-27.

Martin, J.L. 1987. *Satureja viminea*. The Herbarist **53**: 43.

Mathew, B. 1977. *Crocus sativus* and its allies (Iridaceae). Plant Syst. Evol. **128**: 89-103.

Mathew, B. 1982. The crocus: a revision of the genus *Crocus* (Iridaceae). Timber Press, Portland, OR, USA. 127 pp. + plates.

Mathias, M.E. 1994. Magic, myth and medicine. Econ. Bot. **48**: 3-7.

Mathieu, R.F. 1978. Quaker or Russian comfrey. The Herbarist **44**: 16-25.

Maurais, J. 1976. Lexique des épices et assaisonnements (anglais-français). Publications du Quebec, Quebec City, QC, Canada. 71 pp.

Mayers, A.M., and Lord, E.M. 1983. Comparative flower development in the cleistogamous species *Viola odorata*. I. A growth rate study. Amer. J. Bot. **70**: 1548-1555.

Mazza, G. 1983. Gas chromatographic - mass spectrometric investigations of the volatile components of myrtle berries (*Myrtus communis* L.). J. Chromatogr. **264**: 304-311.

Mazza, G. 1984. Volatiles in distillates of fresh, dehydrated and freeze dried horseradish. Can. Inst. Food. Sci. Technol. J. **17**: 18-23.

Mazza, G. 1991*a*. Mint, monarda and dill. *In* Special "Cropportunities" (conference). University of Saskatchewan, Saskatoon, SK, Canada. pp. 85-91.

Mazza, G. 1991*b*. Coriander and caraway. *In* Special "Cropportunities" (conference). University of Saskatchewan, Saskatoon, SK, Canada. pp. 92-96.

Mazza, G., and Kiehn, EA. 1992. Essential oil of *Agastache foeniculum*, a potential source of methyl chavicol. J. Ess. Oil. Res. **4**: 295-299.

Mazza, G., and Marshall, H.H. 1992. Geranio1, linalool, thymol and carvacrol-rich essential oils from *Monarda* hybrids. J. Ess. Oil Res. **4**: 395-400.

Mazza, G., Chubey, B.B., and Kiehn, E 1987. Essential oil of *Monarda fistulosa* L. var *menthaefolia*, a potential source of geraniol. Flavor Fragrance J. **2**: 129-132.

Mazza, G., Kiehn, EA., and Marshall, H.H. 1993. *Monarda*: a source of geraniol, linalool, thymol and carvacrol-rich essential oils. *In* New crops - exploration, research, and commercialization. *Edited by* J. Janick and J.E. Simon. J. Wiley and Sons, New York, NY, USA. pp. 628-631.

Mazza, I.G. 1976. Herbs for the kitchen. Little, Brown and Company, Toronto, ON, Canada. 366 pp.

McClintock, E. 1993. Trees of Golden Gate Park, San Francisco: 48. California bay and Mediterranean laurel. Pac. Horticult. **54**(1): 10-12.

McCormick [& Company, Inc.]. 1979. Spices of the world cookbook. McGraw-Hill, New York, NY, USA. 431 pp.

McCoy, D. 1987. Nature's hydroponic harvest. New Farm **9**(5): 38-40.

McDaniel, J. 1976. Sorrel, the neglected herb. Org. Gard. **23**(1): 158-159.

McGee, H. 1984. On food and cooking - the science and lore of the kitchen. Charles Scribner's Sons, New York, NY, USA. 684 pp.

McLaughlin, M. 1986. The Manhattan Chili Co. Southwest American cookbook. Crown Publishers, New York, NY, USA. 120 pp.

McManus, R.E. 1979. Federal scientific findings concerning exports of American ginseng harvested in 1979. *In* Official proceedings first national ginseng conference. *Edited by* D.L. Hensley, S. Alexander, and C.R. Roberts. Governor's Council on Agriculture, Frankfort, KY, USA. pp. 52-59.

MeNair, J.K. 1978. The world of herbs & spices. Ortho Books, Chevron Chemical Company, San Francisco, CA, USA. 96 pp. [1990 revised edition available.]

McNaughton, N. 1991. Rhubarb: Alberta's next Cinderella crop. Agric. For. Bull. (Univ. Alberta, Edmonton) **14**(1/4): 7-9.

Meares, P. 1987. The economic significance of herbs. HerbalGram **13**: 1, 6-8.

Meares, P, 1990. Newsletter publishing. Is it a business for you? *In* Herbs '90. Proceedings fifth annual conference, International Herb Growers & Marketers Association. *Edited by* J.E. Simon, A. Kestner, and M.R. Buehrle. International Herb Growers & Marketers Association, Silver Springs, PA, USA. pp. 198-201.

Medina, A.L., and BeMiller, J.N. 1993. Marigold flower meal as a source of an emulsifying gum. *In* New crops -exploration, research, and commercialization. *Edited by* J. Janick and J.E. Simon. J. Wiley and Sons, New York, NY, USA. pp. 389-393.

Medrano, A., Masoud, T.A., and Martinez, M.C. 1992. Mineral and proximate composition of borage. J. Food Comp. Anal. **5**: 313-318.

Medsger, O.P. 1939. Edible wild plants. Macmillan, New York, NY, USA. 323 pp.

Menounos, P., Staphylakis, K., and Gegiou, D. 1986. The sterols of *Nigella sativa* seed oil. Phytochemistry (Oxf.) **25**: 761-763.

Mercatante, A.S. 1988. The Facts On file encyclopedia of world mythology and legend. Facts On file, New York, NY, USA. 807 pp.

Mercer, J. 1994. Production of mints and chives as cut flowers. *In* Herbs '94. Proceedings ninth national herb growing and marketing conference. *Edited by* A. Kestner, J.E. Simon, and A.O. Tucker. International Herb Growers & Marketers Association, Mundelein, IL, USA. pp. 17-23.

Merlin, M.M. 1984. On the trail of the ancient opium poppy. Associated University Presses, London, U.K. 324 pp.

Merrill, E.D. 1937. *Coleus amboinicus*. Addisonia 20: 11-12, plate 646.

Mességué, M., and Peter, M. 1982. A kitchen herbal. making the most of herbs for cookery and health. Collins, London, U.K. 255 pp.

Metivier, J., and Viana, A.M. 1979. The effect of long and short day length upon the growth of whole plants and the level of soluble proteins, sugars and stevioside in leaves of *Stevia rebaudiana*. Bert. J. Expt. Bot. **30**: 1211-1222.

Michael, P. 1980. All good things around us. A cookbook and guide to wild plants and herbs. Holt, Rinehart and Winston, New York, NY, USA. 240 pp.

Miersch, J., Schlee, D., and Rosche, I. 1994. Ecological significance of allelochemicals: occurrence of canavanine in *Medicago sativa* L. *In* Allelopathy in agriculture and forestry. *Edited by* S.S. Narwal and P. Tauro. Scientific Publishers, Jodhpur, India. pp. 153-166.

Miller, R.A. 1985. The potential of herbs as a cash crop. Acres U.S.A., Kansas City, MO, USA. 230 pp.

Miller, S.K. 1992. Sex, drugs and ancient Greeks. New Sci. **136**(1845): 4.

Millers, I., Lachance, D., Burkman, W.G., and Allen, D.C. 1991. North American sugar maple decline project: organization and field methods. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. **NE-154**: 26 pp.

Millspaugh, C.F. 1884-1887. American medicinal plants. An illustrated and descriptive guide to the American plants used as homoeopathic remedies: their history, preparation, chemistry, and physiological effects. 2 vol. Boericke and Tafel, New York, NY, USA.

Millspaugh, C.F. 1974. American medicinal plants. Dover Publications, New York, NY, USA. 801 pp. [Reprint, first published 1884-1887.]

Mir, P.S., Mir, Z., and Townley-Smith, L. 1993. Comparison of the nutrient content and in situ degradability of fenugreek (*Trigonella foenum-graecum*) and alfalfa hays. Can. J. Anim. Sci. **73**: 993-996.

Miske, D. 1994. A dozen lemon-fresh herbs. Cornell Plant. **49**(1): 7-13.

Misra, L.N., and Husain, A. 1987. The essential oil of *Perilla ocimoides*: a rich source of rosefuran. Planta Med. **53**: 379-380.

Misra, P., and Chaturvedi, H.C. 1984. Micropropagation of *Rosmarinus officinalis* L. Plant Cell Tissue Organ Cult. **3**: 163-168.

Mitchell, J., and Rook, A. 1979. Botanical dermatology. Greengrass Ltd., Vancouver, BC, Canada. 787 pp.

Mitich, L.W. 1989. The intriguing world of weeds: common dandelion - the lion's tooth. Weed Technol. **3**: 537-539.

Mitich, L.W. 1993. The intriguing world of weeds: chicory. Weed Technol. **7**: 274-277.

Moerman, D.E. 1982. Geraniums for the Iroquois. Reference Publications, Inc., Algonac, MI, USA. 242 pp.

Moerman, D.E. 1986. Medicinal plants of native America. Univ. Mich. Mus. Anthropol. Tech. Rep. **19**: 2 vols.

Moldenke, H.N., and Moldenke, A.L. 1952. Plant of the bible. Chronica Botanica Company, Waltham, MA, USA. 328 pp. + plates.

Montes, M., Valenzuela, L., Wilkomirsky, T., and Arrivé, M. 1973. Sur la composition de l'essence d'*Aloysia triphylla* ("cedrón"). Planta Meal. **23**: 119-124.

Morales, M.R., Simon, J.E., and Charles, D.J. 1993. Comparison of essential oil content and composition between field and greenhouse grown genotypes of methyl cinnamate basil (*Ocimum basilicum* L.). J. Herbs Spices Med. Plants **1**(4): 25-30.

Morales Valverde, R. 1991 (1990 on front cover). The genus *Micromeria* Bentham (Labiatae) in the Iberian Peninsula and the Balearic Islands. An. Jard. Bot. Madr. **48**: 131-156. [In Spanish.]

Morash, M. 1982. The Victory Garden cookbook. Alfred A. Knopf, New York, NY, USA. 374 pp.

Morgan, R.K. 1989. Chemotypic characteristics of *Thymus vulgaris* L. in Central Otago, New Zealand. J. Biogeogr. **16**: 483-491.

Morton, J.F. 1971. Exotic plants. Golden Press, New York, NY, USA. 160 pp.

Morton, J.F. 1975*a*. Is there a safer tea. Morris Arbor. Bull. **26**(2): 24-30.

Morton, J.F. 1975*b*. Renewed interest in roselle (*Hibiscus sabdariffa* L.), the long-forgotten "Florida cranberry." Proc. Fla. State. Hortic. Soc. **87**: 415-425.

Morton, J.F. 1976. Herbs and spices. Golden Press, New York, NY, USA. 160 pp.

Morton, J.F. 1977. Major medicinal plants, botany, culture and uses. Charles C. Thomas, Springfield, IL, USA. 431 pp.

Morton, J.F. 1979. Tea with milk. Science **204**: 909.

Morton, J.F. 1981. Atlas of medicinal plants of Middle America. Charles C. Thomas, Springfield, IL, USA. 1420 pp.

Morton, J.F. 1987. Roselie. *In* Fruits of warm climates. *Edited by* C.F. Dowling Jr. Media Inc., Greensboro, NC, USA. pp. 281-286.

Morton, J.F. 1991*a*. Food, medicinal and industrial uses of perilla, and its ornamental and toxic aspects. *In* Progress on terrestrial and marine natural products of medicinal and biological interest. *Edited by* J.M. Pezzuto et al. Proceedings of a symposium, Dept. of Pharmacy, Medicinal Chemistry & Pharmacognosy, University of Illinois, Chicago, IL, USA. pp. 34-38.

Morton, J.F. 1991*b*. The horseradish tree, *Mooring pterygosperma* (Moringaceae) - a boon to arid lands? Econ. Bot. **45**: 318-333.

Morton, J.F. 1992. Country borage (*Coleus amboinicus* Lour.): a potent flavoring and medicinal plant. J. Herbs Spices Med. Plants **1**: 77-90.

Morton, J.F., and Snyder, G.H. 1978. Trial of water celery as an aquatic flavoring herb for everglades farmlands. Proc. Fla. State Hortic. Soc. **91**: 301-305.

Morton, J.K. 1962. Cytotaxonomic studies on the West African Labiatae. J. Linn. Soc. Bot. **58**:231-283.

Morton, J.K. 1987. *Monarda punctata* L. Atlas of the rare vascular plants of Ontario. National Museum of Natural Sciences Ottawa. 1 page [unpaginated loose-leaf series].

Mowat, A.B., and Walters, S.M. 1964. *Papaver*. *In* Flora Europaea, vol. 1. *Edited by* T.G. Tutin, V.H. Heywood, N.A. Burges, D.H. Valentine, S.M. Walters, and D.A. Webb. Cambridge University Press, Cambridge, Great Britain. pp. 247-250.

Muenscher, M.W. 1978. Minnie Muenscher's herb cookbook. Cornell University Press, Ithaca, NY, USA. 241 pp.

Muenscher, W.C., and Rice, M.A. 1955. Garden spice and wild pot-herbs. Comstock Publishing Associates / Cornell University Press, Ithaca, NY, USA. 211 pp.

Mulligan, G.A. 1961. The genus *Lepidium* in Canada. Madroño **16**: 77-90.

Munro, D.B., and Small, E. 1997. Vegetables of Canada. NRC Research Press, Ottawa, ON, Canada.

Munson, P.J. 1989. Still more on the antiquity of maple sugar and syrup in aboriginal eastern North America. J. Ethnobiol. **9**: 159-170.

Murphy, E.W., Marsh, A.C., and Willis, B.W. 1978. Nutrient content of spices and herbs. J. Amer. Diet. Assoc. **72**: 174-176.

Murray, M.J., Marble, P., Lincoln, D., and Hefendehl, F.W. 1988. Peppermint oil quality differences and the reasons for them. *In* Flavors and fragrances: a world perspective. *Edited by* B.M. Lawrence, B.D. Mookherjee, and B.J. Willis. Elsevier Science Publishers, Amsterdam, The Netherlands. pp. 189-210.

Naj, A. 1993. Peppers. Vintage Books, New York, NY, USA. 245 pp.

National Academy. 1975. Herbal pharmacology in the People's Republic of China. National Academy of Sciences, Washington, DC, USA. 269 pp.

National Council Against Health Fraud. 1995. National Council Against Health Fraud Newsletter **18**(4) [July/August].

Nazeem, P.A. 1995. The spices of India. Herb Spice Med. Plant Dig. **13**(1): 1-5.

Nearing, H., and Nearing, S. 1950. The maple sugar book. The John Day Company, New York, NY, USA. 271 pp.

Negbi, M. 1990. Physiological research on the saffron crocus (*Crocus sativus*). *In* Proceedings of the international conference on saffron (*Crocus sativus* L.) L'Aquila (Italy) Oct. 1989. *Edited by* F. Tammaro and L. Marra. pp. 183-207.

Neher, R.T. 1968. The ethnobotany of *Tagetes*. Econ. Bot. **22**: 317-325.

Nelson, R. 1950. Verticillium wilt of peppermint. Mich. State Coll. Agric. Exp. Stn. Tech. Bull. **221**:259 pp.

Németh, É.Z., Héthelyi, É., and Bernáth, J. 1993. Comparison studies on *Tanaceturn vulgare* L. chemotypes. J. Herbs Spices Med. Plants **2**(2): 85-92.

Nergiz, C., and Ötle, S. 1993. Chemical composition of *Nigella sativa* L. seeds. Food Chem. **48**: 259-161.

Neve, R.A. 1991. Hops. Chapman and Hall, London, U.K. 266 pp.

Ngo, B., and Zimmerman, G. 1986. The classic cuisine of Vietnam. New American Library, New York, NY, USA. 250 pp.

Nguyen, T.N. 1994. Studies on *Panax vietnamensis*. *In* International ginseng conference - Vancouver 1994. *Edited by* W.G. Bailey, A.L. Skretkowicz, A.M. Sawchuk, J.T.A. Proctor, L. Clark, and C.M. Lefebvre. Program, abstract and trade show booklet. p. 38.

Nguyêñ-Xuân-Duñg, and Dô-Tât-Loi. 1991. Selection of traditional medicines for study. J. Ethnopharmacol. **32**: 57-70.

Nguyêñ-Xuân-Duñg, La-Dinh-Moi, Lu'u-Dam-Cu, and Leclercq, P.A. 1995. Essential oil constituents form the aerial parts of *Perilia frutescens* (L.) Britton. J. Ess. Oil Res. **7**: 429-432.

Nicholson, G. (*Editor*). 1885-89. The illustrated dictionary of gardening. 4 vol. L. Upcott Gill, London, U.K.

Nickles, H.G. 1971. Middle Eastern cooking. Time-Life Books, New York, NY, USA. 206 pp.

Niethammer, C. 1974. American Indian food and lore. Macmillan, New York, NY, USA. 191 pp.

Nijs, H. den, and Bachmann, K. 1995. Clonal diversity and phylogeography of asexual *Taraxacum* in Europe. Int. Org. Plant Biosyst. Newsl. **25**: 4-7.

Nobbs, K.J. 1980. The rose as a fruit. Pomona **13**(3): 123-134.

Nonnecke, I.L. 1989. Vegetable production. AVI Book, Van Nostrand Reinhold, New York, NY, USA. 657 pp.

Nordal, I., and Stabbetorp, O.E. 1990. Morphology and taxonomy of the genus *Cochlearia* (Brassicaceae) in Northern Scandinavia. Nordic J. Bot. **10**: 249-264.

Nordal, I., Eriksen, A.B., Laane, M.M., and Solberg, Y. 1986. Biogeographic and biosystematic studies in the genus *Cochlearia* in Northern Scandinavia. Acta Univ. Ups. Symb. Bot. Ups. **27**(2): 83-93.

Nordborg, G. 1963. Studies in *Sanguisorba officinalis* L. Bot. Notiser **116**: 267-288.

Nordborg, G. 1966. *Sanguisorba* L., *Sarcopoterium* Spach, and *Bencomia* Webb et Berth. Delimitation and subdivision of the genera. Opera Bot. **11**(2): 1-103, plates 1-6.

Nordborg, G. 1967. The genus *Sanguisorba* section *Poterium*. Experimental studies and taxonomy. Opera Bot **16**: 1-166.

Nordestgaard, A. 1990. Chervil for seed production. Tidsskr. Planteavl **94**: 257-262. [In Danish]

Norman, J. 1990. The complete book of spices. Viking Penguin, New York, NY, USA. 160 pp.

Northcote, R. 1971. The book of herb lore. Dover Publications Inc., New York, NY, USA. 212 pp. [Reprint of 2nd edition of "The book of herbs" published in 1912.]

Northeastern Forest Experiment Station 1982. Sugar maple research: sap production, processing, and marketing of maple syrup. U.S. Dep. Agric. For. Serv. NE For. Exp. Stn. Gen. Tech. Rep. **NE-72**: 109 pp.

Nybom, H., and Carlson, U. 1992. Genetic variation in dogroses. The Swedish University of Agricultural Sciences/ Balsgård Institute of Horticultural Plant Breeding/ Swedish Association for Fruit Breeding Report 1990-91, pp. 69-85. [In Swedish, English summary.]

Nykänen, I. 1985. Composition of the essential oil of *Melissa officinalis* L. Dev. Food Sci. **10**: 329-338.

Nykänen, I., Holm, Y., and Hiltunen, R. 1989. Composition of the essential oil of *Agastache foeniculum*. Plant Med. **55**: 314-315.

Oakley, H. (*Editor*). 1980. The buying guide for fresh fruits, vegetables, herbs and nuts. 8th ed. Dole Castle & Cooke, Inc.; Bud of California Bud Antic, Inc.; Blue Goose Growers, Inc., USA. 136 pp.

Ochse, J.J., and Bakhuizen van den Brink, R.C. 1980. Vegetables of the Dutch East Indies. A. Asher & Co., Amsterdam. 1016 pp.

Oeder, G. C., Müller, O.F., and Vahl, M. 1761-1883. Flora Danica. 17 vol. Copenhagen, Denmark.

Ohsumi, C., Kojima, A., Hinata, K., Etoh, T., and Hayashi, T. 1992. Interspecific hybrids between onion and garlic. *In* The genus *Allium* - taxonomic problems and genetic resources. *Edited by* P. Hanelt, K. Hammer and H. Knüpffer. Institut für Pflanzengenetik und Kulturpflanzenforschung, Gatersleben, Germany. pp. 233-239.

Ohsumi, C., Kojima, A., Hinata, K., Etoh, T., and Hayashi, T. 1993. Interspecific hybrid between *Allium cepa* and *Allium sativum*. Theor. Appl. Genet. **85**: 969-975.

Ojala, A. 1986. Variation, reproduction and life history strategy of *Angelica archangelica* subsp. *archangelica* in northern Fennoscandia. Reports from the Department of Biology, University of Turku (Finland), No. 13. Irregular pagination. [Doctoral report consisting mostly of five previously published papers by Ojala.]

Okuda, T., Hatano, T., Agata, I., and Nishibe, S. 1986. The components of tannic activities in Labiatae plants: I. Rosmarinic acid from Labiatae plants in Japan. Yakugaku Zasshi **106**: 1108-1111. [In Japanese.]

Okude, T., and Hayashi, S. 1970. Sesquiterpene constituents of the essential oil of mitsuba (*Cryptotaenia japonica* Hassk.). Chem. Soc. Jpn. Bull. **43**: 2984-2985.

Oliver, A. 1993. American ginseng culture in the add climates of British Columbia (abridged version). British Columbia Ministry of Agriculture, Fisheries and Food. 6 pp.

Oliver, A., Van Lierop, B., and Buonassisi, A. 1990. American ginseng culture in the add climates of British Columbia. British Columbia Ministry of Agriculture and Fisheries. 37 pp.

Olowokudejo, J.D., and Pereira-Sheteolu, O. 1988. The taxonomic value of epidermal characters in the genus *Ocimum* (Lamiaceae). Phytomorphology **38**: 147-158.

Opdecam, M. 1991. Temmer believes garlic has potential as supplementary crop. Can. Tabacco Grower **39**(2): 8, 12, 24.

Organ, J. 1960. Rare vegetables for garden and table. Faber and Faber Limited, London, U.K. 184 pp.

Ornish, D. 1990. Dr. Dean Ornish's program for reducing heart disease. Random House, New York, NY, USA. 631 pp.

Orosa, M.Y. 1932. Roselle recipes. Bureau of Printing, Manila, Phillipines. 24 pp.

Orton, T. J. 1983. Celery and celeriac (*Apium graveolens* L.). *In* Isozymes in plant genetics and breeding, Part B. *Edited by* S.D. Tanksley and T.J. Orton. Elsevier Science Publishing Co., New York, NY, USA. pp. 351-367.

Ouellet, C.E., and Sherk, L.C. 1973. Map of plant hardiness zones in Canada. Agriculture Canada. [Fold-out map.]

Owen, M. 1978. A cook's guide to growing herbs, greens, and aromatics. Alfred A. Knopf, New York, NY, USA. 263 pp.

Pääkkfönen, K., Malmsten, T., and Hyvönen, L. 1989. Effects of drying method, packaging, and storage temperature and time on the quality of dill (*Anethum graveolens* L.). J. Food Sci. **54**: 1485-1487, 1495.

Pääkkönen, K., Malmsten, T., and Hyvönen, L. 1990. Effects of drying method, packaging, storage temperature and time on the quality of summer savory (*Satureja hortensis* L.). J. Food Qual. **13**: 411-417.

Page, M. 1980. The Observer's book of herbs. F. Warne, London, U.K. 184 pp.

Page, M., and Steam, W.T. 1993 [reprint of 1992 edition]. Culinary herbs. 3d edition. Cassell Educational Limited, London, U.K. 64 pp.

Pages, N., Fournier, G., Velut, V., and Imbert, C. 1992. Potential teratogenicity in mice of the essential oil of *Salvia lavandulifolia* Vahl. Study of a fraction rich in sabinyl acetate. Phytotherapy Res. **6**(2): 80-83.

Pagni, A.M., Catalano, S., Cioni, P.L., Coppi, C., and Morelli, I. 1990. Étude morpho-anatomique et phytochimique sur *Calamintha nepeta* s.l. (Labiées). Plant. Méd. Phytothér. **24**: 204-213.

Pailler, D. 1993. Some like it hot, hotter, hottest... The Herbarist **59**: 33-47.

Palevitch, D., and Craker, L.E. 1993. Nutritional and medical importance of red peppers. Herb Spice Med. Plant Dig. **11**(3): 1-4.

Pande, T.C., and Gupta, Y.N. 1971. Chemical examination of essential oil from the plant *Micromeria biflora*. Indian Oil Soap J. **36**: 332-334.

Pandey, B.P. 1990. Spices and condiments. Shree Publishing House, New Delhi, India. 120 pp.

Papageorgiou, C., Corbet, J.-P., Menezes-Brandao, F., Pecegueiro, M., and Benezra, C. 1983. Allergenic contact dermatitis to garlic (*Allium sativum* L.). Identification of the allergens: the role of mono-, di-, and trisulfides present in garlic. Arch. Dermatol. Res. **275**: 229-234.

Pareek, S.K., Maheshwari, M.L., and Gupta, R. 1980. Domestication studies on *Ocimum sanctum* for high oil and eugenol content. Indian Perfum. **24**: 93-100.

Parke, M. 1984. The pleasures of purple mint. Horticulture **62**(8): 14-17.

Parry, J.W. 1945. The spice handbook: spices, aromatic seeds and herbs. Chemical Publishing Co., Brooklyn, NY, USA. 254 pp.

Parry, J.W. 1969. Spices. Chemical Publishing Co., New York, NY, USA. 2 vols.

Paseador y Barrios, C. 1901. Ginseng; the crop that's worth its weight in sterling silver. The Chinese-American Ginseng Co., Joplin, MO, USA. 34 pp.

Paster, N., Juven, B. J., Shaaya, E., Menasherov, M., Nitzan, R., Wiesslowicz, H., and Ravid, U. 1990. Inhibitory effect of oregano and thyme essential oils on moulds and foodborne bacteria. Lett. Appl. Microbiol. **11**: 33-37.

Paton, A. 1992. A synopsis of *Ocimum* L. (Labiatae) in Africa. Kew Bull. **47**: 403-435.

Paton, A. 1994. Three membranous-bracted species of *Origanum*. Kew Mag. **11**: 109-117.

Paulini, H., Popp, R., Schimmer, O., Ratka, O., and Röder, E. 1991. Isogravacridonchlorine: a potent and direct acting frameshift mutagen from the roots of *Ruta graveolens*. Planta Med. **57**: 59-61.

Peddie, M. 1990*a*. The scented geraniums in history. *In* Herbs '90. Proceedings fifth annual conference, International Herb Growers & Marketers Association. *Edited by* J.E. Simon, A. Kestner, and M.R. Buehrle. International Herb Growers & Marketers Association, Silver Springs, PA, LISA. pp. 82-89.

Peddie, M. 1990*b*. Starting an herb business. *In* Herbs '90. Proceedings fifth annual conference, International Herb Growers & Marketers Association. *Edited by* J.E. Simon, A. Kestner, and M.R. Buehrle. International Herb Growers & Marketers Association, Silver Springs, PA, USA` pp. 104-112.

Peddie, M., Lewis, J., and Lewis, J. 1991. Growing & using scented geraniums. Storey Communications, Pownal, VT, USA. 32 pp.

Pellecuer, J. 1973. La sarriete des montagnes (*Satureja montana* L.). Ph.D. thesis, University of Montpellier, France. 292 pp.

Pellecuer, J. 1985. Une plante aromatique au service de l'homme "la sarriette des montagnes." Rev. Assoc. Mondiale Phytothér. **1985**(2): 5-9.

Pellett, F.C. 1947. Mountain mint. Amer. Bee J. **87**: 172-173.

Pellett, F.C. 1950. Mountain mint. Amer. Bee J. **90**: 66-67.

Peneva, P.T., Vitkova, A., and Ivancheva, S. 1988. Santonin, essential oil and flavonoid content in *Artemisia santonicum* L. Plant Science (Sofia) **25**(7): 35-42. [In Bulgarian.]

Pérez de Paz, P.L. 1994. Re. the genus *Micromeria* Benth. (Labiatae) and nomenclatural inconsistency. Taxon **43**: 241-242.

Pérez-Alonso, M.J., Velasco-Negueruela, A., and Burzaco, A. 1992. *Tanacetum balsamita* L.: a medicinal plant from Guadalajara (Spain). Acta Hortic. (The Hague) **306**: 188-193.

Perkin, J. 1993. Herbal extracts: health aid or marketing aid? Food Process (Tonbridge). **62**(10): 17, 20, 23, 24.

Perry, F. (*Editor*). 1974. Simon & Schuster's complete guide to plants & flowers. Simon & Schuster, New York, NY, USA. Unpaginated (536 pp.).

Perry, L.M., and Metzger, J. 1980. Medicinal plants of East and Southeast Asia. MIT Press, Cambridge, MA, USA. 620 pp.

Persons, W.S. 1986. American ginseng: green gold. Bright Mountain Books, Asheville, NC, USA. 172 pp. [Revised edition 1994, 203 pp.]

Persons, W.S. 1994. Growing American ginseng in its native woodland habitat. *In* Herbs '94. Proceedings ninth national herb growing and marketing conference. *Edited by* A. Kestner, J.E. Simon, and A.O. Tucker. International Herb Growers & Marketers Association, Mundelein, IL, USA. pp. 32-38.

Peterson, L. 1978. A field guide to edible wild plants of Eastern and Central North America. Houghton Mifflin Company, Boston, MA, USA. 330 pp.

Petit-Paly, G., Rideau, M., and Chenieux, J.C. 1982. Étude de quelques Rutacées à alcaloïdes II. - *Ruta graveolens*: revue botanique, chimique et pharmacologique (étude particulière des alcaloïdes quaternaires quinoléiques). Plant. Méd. Phytothér. **16**: 55-72.

Petit-Paly, G., Ramawat, K.G., Chenieux, J.C., and Rideau, M. 1989. *Ruta graveolens*: in vitro production of alkaloids and medicinal compounds. Biotechnol. Agric. For. **7**: 488-505.

Petri, G., Lemberkovics, É., Lelik, L., and Vitányi, G. 1993. Essential oil composition of chervil growing wild in Hungary. Acta Hortic. (The Hague) **344**: 52-62.

Philcox, D. 1970. A taxonomic revision of the genus *Limnophila* R. Br. (Scrophulariaceae). Kew Bull. **24**: 101-170.

Phillips, R. 1986. Wild food. Little, Brown and Co., Toronto, ON, Canada. 192 pp.

Phillips, R., and Foy, N. 1990. The Random House book of herbs. Random House, New York, NY, USA. 192 pp.

Phokas, G., Patouha-Volioti, G., and Katsiotis, S. 1980. Études des huiles essentielles de feuilles de *Micromeria juliana* (Labiées). Plantes Méd. Phytothér. **14**: 159-163.

Piccaglia, R., Marotti, M., and Galletti, G.C. 1989. Effect of mineral fertilizers on the composition of *Salvia officinalis* oil. J. Ess. Oil Res. **2**: 73-83.

Pickersgill, B. 1971. Relationships between weedy and cultivated forms in some species of chili peppers (Genus *Capsicum*). Evolution **25**: 683-691.

Pino, J.A., Hernandez, I.A., Alvarez, M., and Roncal, E. 1994. The effect of grinding on the quality of Mexican oregano. Alimentaria **31**(249): 53-54. [In Spanish]

Pino, J., Rosado, A., Baluja, R., and Borges, P. 1989. Analysis of the essential oil of Mexican oregano (*Lippia graveolens* HBK). Die Nahrung **33**: 289-295.

Pizzetti, I., and Cocker, I. 1975. Flowers - a guide for your garden. Harry N. Abrams, New York, NY, USA. 2 vols.

Planas, G.M., and Ku, J. 1968. Contraceptive properties of *Stevia rebaudiana*. Science **162**: 1007.

Pomeroy, D. 1990. Growing a small wholesale herb business. Questions and answers. The Business of Herbs 8(4): 1, 2, 16.

Poncevage, J. 1995. Grow your own herbal teas. Org. Gard. **42**(3): 90-94.

Pooter, H.L. de, Goetghebeur, P., and Schamp, N. 1987. Variability in composition of the essential oil of *Calamintha nepeta*. Phytochemistry **26**: 12.

Porsild, A.E., and Cody, W.J. 1980. Vascular plants of continental Northwest Territories, Canada. National Museum of Natural Sciences, Ottawa, ON, Canada. 667 pp.

Potter, T.L., and Fagerson, I.S. 1990. Composition of coriander leaf volatiles. J. Agric. Food Chem. **38**: 2054-2056.

Potter, T.L., Fagerson, I.S., and Craker, L.E. 1993. Composition of Vietnamese coriander leaf oil. Acta Hortic. (The Hague) **344**: 305-311.

Poulsen, N. 1990. Chives, *Allium schoenoprasum* L. *In* Onions and allied crops. Vol. III. Biochemistry, food science, and minor crops. *Edited by* J.L. Brewster and H.D. Rabinowitch. CRC Press, Inc., Boca Raton, FL, USA. pp. 231-250

Prakash, S, and Hinata, K. 1980. Taxonomy, cytogenetics and origin of crop brassicas, a review. Opera Bot. **55**: 1-57.

Prakash, V. 1990. Leafy spices. CRC Press, Inc., Boca Raton, FL, USA. 114 pp.

Prescott-Allen, C., and Prescott-Allen, R. 1986. The first resource. Yale University Press, New Haven, CN, USA. 507 pp.

Pringle, J.S. 1986. *Tagetes minuta* (Asteraceae), an addition to the adventive flora of Canada. Plant Press (Mississauga) **5**: 41-42.

Pringle, J.S. 1987. This native plant - wild bergamot, *Monarda fistulosa*. Pappus (Hamilton Royal Botanical Gardens) **7**(2): 4-5.

Pröbstle, A. 1994. Phytochemische und pharmakologische Untersuchungen von *Houttuynia cordata* Thunb. [Phytochemical and pharmacological analyses of *Houttuynia cordata* Thunb.] Doctoral dissertation, Faculty of Chemistry and Pharmacy, Ludwig Maximilians University, Munich, Germany. 160 pp. [In German.]

Pröbstle, A., and Bauer, R. 1992. Aristolactams and a 4,5-dioxoaporphine derivative from *Houttuynia cotdata*. Planta Med. **58**: 568-569.

Pröbstle, A., Neszmelyi, A., Jerkovich, G., Wagner, H., and Bauer, R. 1994. Novel pyridine and 1,4-dihydropyridine alkaloids from *Houttuynia cordata*. Nat. Prod. Lett. **4**: 235-240.

Proctor, J.T.A. 1984. Ginseng research and extension at the University of Guelph. *In* Proceedings Sixth North American ginseng conference. *Edited by* J.T.A. Proctor. University of Guelph, Guelph, ON, Canada. pp. 12-22.

Proctor, J.T.A. 1992. The ginseng industry and the Canadian Ginseng Research Foundation. The Grower **42**(10): 1-6.

Proctor, J.T.A., and Bailey, W.G. 1987. Ginseng: industry, botany, and culture. Hortic. Rev. **9**: 187-236.

Proctor, J.T.A., Lee, J.C., and Lee, S.-S. 1990. Ginseng production in Korea. HortScience **25**: 746-750.

Proctor, J.T.A., Wang, T.-S., and Bailey, W.G. 1988. East meets West: cultivation of American ginseng in China. HortScience **23**: 968-973.

Proctor, M.C.E, and Nordborg, G. 1968. *Sanguisorba. In* Flora Europaea. Volume 2. *Edited by* T.G. Turin, V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, and S.M. Walters. Cambridge University Press, New York, NY, USA. pp. 33-34.

Publications and Information Directorate. 1966. Perilla. *In* The wealth of India; a dictionary of Indian raw materials and industrial products. Vol. 7. Publications and Information Directorate, Council of Scientific & Industrial Research, New Delhi, India. pp. 311-313.

Purseglove, J.W., Brown, E.G., Green, C.L., and Robbins, S.R. 1981. Spices. 2 vol. Longman Inc., New York, NY, USA. 813 pp.

Putievsky, E. 1980. Germination studies with seed of caraway, coriander and dill. Seed Sci. Technol. **8**: 245-254.

Putievsky, E. 1983. Temperature and daylength influences on the growth and germination of sweet basil and oregano. J. Hortic. Sci. **58**: 583-587.

Putievsky, E., Ravid, U., and Dudai, N. 1986. The essential oil and yield components from various plant parts of *Salvia fruticosa*. J. Nat. Prod. (Lloydia) **49**: 1015-1017.

Putievsky, E., Ravid, U., and Sanderovich, D. 1992. Morphological observations and essential oils of sage (*Salvia officinalis* L.) under cultivation. J. Ess. Oil Res. **4**: 291-293.

Putievsky, E., Ravid, U., Snir, N., and Sanderovich, D. 1984. The essential oils from cultivated bay laurel. Israel J. Bot. **33**: 47-52.

Quelch, M.T. 1946. Herbs and how to know them. Faber & Faber, London, U.K.. 280 pp.

Quinn, J., Simon, J.E., and Janick, J. 1989. Recovery of -linolenic acid from somatic embryos of borage. J. Am. Soc. Hortic. Sci. **114**: 511-515.

Rabin, J.R. 1987. Parsley production for fresh market. *In* Proceedings of the second national herb growing and marketing conference. *Edited by* J.E. Simon and L. Grant. Purdue Research Foundation, West Lafayette, IN, USA. pp. 43-47.

Rabinowitch, H.D., and Brewster, J.L. (*Editors*). 1990. Onions and Allied Crops. Vol 1. Botany, physiology, and genetics. CRC Press, Inc., Boca Raton, FL, USA. 273 pp.

Rahman, A.-U., Rahman, Z.-U., Ahmed, S., Quresiii, S., and Quresiii, I.H. 1990. Toxicological evaluation of *Calendula officinalis* Linn. Pak. J. Sci. Ind. Res. **33**: 329-332.

Rajendrudu, G., and Rama Das, V.S. 1983. Interspecific differences in the constituents of essential oils of *Cymbopogon*. Proc. Indian Acad. Sci. (Plant Sci.) **92**: 331-334.

Rao, B.L., and Sobti, S.N. 1987. Breeding of a high oil yielding lemongrass for flavour industry. Indian Perfum. **31**(1): 32.

Rauthier, N. 1989. The foods of Vietnam. Stewart, Tabori and Chang, New York, NY, USA. 239 pp.

Ravindran, P.N., Sasikumar, B., George, J.K., Ratnambal, M.J., Babu, K.N., Zachariah, J.T., and Nair, R.R. 1994. Genetic resources of ginger (*Zingiber officinale* Rosc.) and its conservation in India. Plant Genet. Resourc. Newsl. **98**: 1-4.

Raviv, M., and Putievsky, E. 1987. Vegetative propagation of aromatic plants of the Mediterranean region. *In* Recent advances in botany, Horticulture and Pharmacology, Vol. 2. *Edited by* L.E. Craker and J.E. Simon. Oryx Press, Phoenix, AZ, USA. pp. 159-181.

Raviv, M., Putievsky, E., Senderovitch, D., Snir, N., and Roni, R. 1983. Bay laurel as an ornamental plant. Acta Hortic. (The Hague) **132**: 35-42.

Reay, D. 1965. Make room for lacy chervil. Org. Gard. 12(2): 80.

Reay, D. 1967. Two lively cresses for any garden. Org. Gard. **14**(11): 77.

Reddi, G.S., Shukla, N.P., and Singh, K.V. 1986. Chemotherapy of tuberculosis - antitubercular activity of *Ocimum sanctum* leafy extract. Fitoterapia **57**: 114-116.

Rees, A.R. 1988. Saffron - an expensive plant product. Plantsman **9**: 210-217.

Rejón, C.R., Jamilena, M., Ramos, M.G., Parker, J.S., and Rejón, M.R. 1994. Cytogenetic and molecular analysis of the multiple sex chromosome system of *Rumex acetosa*. Heredity **72**: 209-215.

Reppert, B. 1976. A heritage of herbs. Stackpole Books, Harrisburg, PA, USA. 192 pp.

Reppert, B. 1985. Sweet woodruff. Org. Gard. **32**(11): 74-75.

Reppert, B. 1987*a*. Sweet cicely. Org. Gard. **34**(5): 32.

Reppert, B. 1987*b*. Costmary. Org. Gard. **34**(12): 55.

Revolutionary Health Committee of Hunan Province. 1977. A barefoot doctor's manual. Cloudburst Press, Seattle, WA, USA. 372 pp.

Reznicek, A.A. 1988. Wildflowers, oriental and occidental. Wildflower 1988 (Spring): 24-27.

Rhodes, A.M. 1977. Horseradish - problems and research in Illinois. *In* Crop resources. *Edited by* D.S. Seigler. Academic Press, New York, NY, USA. pp. 137-148.

Rich, T.C.G. 1987. The genus *Barbarea* R.Br. (Cruciferae) in Britain and Ireland. Watsonia **16**: 389-396.

Rich, T.C.G. 1991. Crucifers of Great Britain and Ireland. Botanical Society of the British Isles, London, U.K. 336 pp.

Richards, A.J. 1985. Sectional nomenclature in *Taraxacum* (Asteraceae). Taxon **34**: 633-644.

Richardson, J. 1990. Worldwide selection of exotic fruits and vegetables. Les Éditions Héritage Inc., Saint-Lambert, QC, Canada. 256 pp.

Richardson, N. 1991. Summer delights: cooking with fresh herbs. 2nd. edition. Whitecap Books, Vancouver, BC, Canada. 154 pp.

Richardson, P.M. 1992. The chemistry of the Labiatae: an introduction and overview. *In* Advances in labiate science. *Edited by* R.M. Harley and T. Reynolds. Royal Botanic Gardens, Kew, U.K. pp. 291-297.

Richters 1994. Richters herb catalogue. Otto Richter and Sons Ltd., Goodwood, ON, Canada. 100 pp.

Richters 1995. Richters herb catalogue. Otto Richter and Sons Ltd., Goodwood, ON, Canada. 103 pp.

Richters 1997. Richters herb catalogue. Otto Richter and Sons. Ltd., Goodwood, ON, Canada. 103 pp.

Ricotta, J.A., and Masiunas, J.B. 1991. The effects of black plastic mulch and weed control strategies on herb yield. HortScience **26**: 539-541.

Riekels, J.W. 1972. Horseradish. Ont. Minist. Agric. Food Factsheet **72-102**: 2 pp.

Rinzler, C.A. 1990. The complete book of herbs, spices and condiments. Facts On File, New York, NY, USA. 199 pp.

Rivera Nuñez, D., and Obón de Castro, C. 1992. The ethnobotany of Old World Labiateae. *In* Advances in labiate science. *Edited by* R.M. Harley and T. Reynolds. Royal Botanic Gardens, Kew, U.K. pp. 455-473.

Robertson, K.R. 1974. The genera of Rosaceae in the southeastern United States. J. Arnold Arbor. **55**: 303-332, 344-401, 611-662.

Robinson, B.L. 1930*a*. Observation on the genus *Stevia*. Contrib. Gray Herb. Harv. Univ. **90**: 36-58.

Robinson, B.L. 1930*b*. The stevias of Paraguay. Contrib. Gray Herb. Harv. Univ. 90: 79-90.

Robinson, T. 1988. An introduction to the chemistry of herbs, spices, and medicinal plants. Herb Spice Med. Plant Dig. **6**(3): 2-4, 10.

Robitaille, G., Boutin, R., and Lachance, D. 1995. Effects of soil freezing stress on sap flow and sugar content of mature sugar maples (*Acer saccharum*). Can. J. For. Res. **25**: 577-587.

Roché, C. 1991. Wild chervil (*Anthriscus sylvestris* (L.) Hoffm.). Weeds (Pacific Northwest Extension Publication, Washington, Idaho, Oregon). 2 pp.

Roden, C. 1968. A book of Middle Eastern food. Thomas Nelson and Sons, London, U.K. 320 pp.

Rodway, A. 1979. Herbs and spices. MacDonald Educational Ltd, London, Great Britain. 160 pp.

Roecklein, J.C., and Leung, P. 1987. A profile of economic plants. Transaction Books, New Brunswick, USA. 623 pp.

Rogers, J. 1983. Cooking with the healthful herbs. Rodale Press, Emmaus, PA, USA. 279 pp.

Rollins, E. 1989. Origanums today. The Herbarist **55**: 1-5.

Rollins, E. 1995. Origanums: beauty and fragrance in summertime. The Herbarist **61**: 16-22.

Rollins, R.C. 1993. The Cruciferae of continental North America. Stanford University Press, Stanford, CA, USA. 976 pp.

Rollo, F. 1985. Characterization by molecular hybridization of RNA fragments isolated from ancient (1400 B.C.) seeds. Theor. Appl. Genet. **71**: 330-333.

Rose, J. 1979. Jeanne Rose's herbal guide to inner health. Grosset & Dunlap, New York, NY, USA. 239 pp.

Rosengarten, F., Jr. 1969. The book of spices. Livingston Pub., Philadelphia, PA, USA. 489 pp.

Rosengarten, F., Jr. 1973. The book of spices. Jove Publications Inc., New York, NY, USA. 475 pp. [Revised, abridged edition of Rosengarten 1969.]

Rosin, S., Tuorila, H., and Uutela, A. 1992. Garlic: a sensory pleasure or a social nuisance? Appetite **19**: 133-143.

Rothwell, S.D., and Robinson, L.W. 1986. Cold acclimation potential of watercress in relation to growing season and nutrient status. J. Hortic. Sci. **61**: 373-378.

Rousi, A. 1969. Cytogenetic comparison between two kinds of cultivated tarragon (*Artemisia dracunculus*). Hereditas **62**: 193-213.

Rowe, N.W. 1987. Quality control of mint essential oils. *In* Proceedings of the second national herb growing and marketing conference. *Edited by* J.E. Simon and L. Grant. Purdue Research Foundation, West Lafayette, IN, USA. pp. 136-138.

Rowland, W.A. 1969. Fruit & vegetable facts & pointers -rhubarb. United Fresh Fruit & Vegetable Association, Washington, DC, USA. 9 pp.

Roy, R., and Reeleder, R. 1994. Ginseng replant study. *In* Ginseng Report. *Edited by* P. Fisher. Ginseng Growers Association of Canada, Simcoe, ON. Vol. 2 (July) (unpaginated).

Ryding, O. 1994. Notes on the sweet basil and its wild relatives (Lamiaceae). Econ. Bot. **48**: 65-67.

Sackett, C. 1975. Dandelions. Fruit & vegetable facts & pointers. United Fresh Fruit and Vegetable Association, Alexandria, VA, USA. 7 pp.

Sagrero-Nieves, L., and Bartley, J.P. 1995. Volatile constituents from the leaves of *Chenopodium ambrosioides* L. J. Ess. Oil Res. **7**: 221-223.

Sahni, J. 1990. Moghul microwave - cooking Indian food the modem way. William Morrow and Company, New York, NY, USA. 513 pp.

Saikia, A., and Shadeque, S. 1993. Nutritional evaluation of underexploited leafy vegetables of Assam. Indian J. Agric. Sci. **63**: 409-411.

Sainsbury, M., and Sofowora, E.A. 1971. Essential oil from the leaves and inflorescence of *Ocimum gratissimum*. Phytochemistry **10**: 3309-3310.

Saito, S. 1990. Chinese chives, *Allium tuberosum* Rottl. *In* Onions and allied crops. Vol. III. Biochemistry, food science, and minor crops. *Edited by* J.L. Brewster and H.D. Rabinowitch. CRC Press, Inc., Boca Raton, FL, USA. pp. 219-230.

Sakina, M.R., Dandiya, P.C., Hamdard, M.E., and Hameed, A. 1990. Preliminary psychopharmacological evaluation of *Ocimum sanctum* leaf extract. J. Ethnopharmacol. **28**: 143-150.

Salamon, I. 1992. Chamomile: a medicinal plant. Herb Spice Med. Plant Dig. **10**(1): 1-4.

Salamon, I., and Honcariv, R. 1994. Growing condition and breeding of chamomile (*Chamomilla recutita* (L.) Rauschert) regarding the essential oil qualitative-quantitative characteristics in Slovakia. Herba Pol. **40**(1-2): 68-74.

Saling, A. 1978. Rhubarb renaissance. Pacific Search Press, Seattle, WA, USA. 159 pp.

Salmerón, J.G. 1966. Studies of the botany, ecology, biology and pasciology of the principal existing species in the spontaneous pasture grounds of the mountains of our semi-arid regions. *Poterium*. Final report of project No. E25/FS/1. Instituto Forestal de Investigaciones y Experiencias, Madrid, Spain. [Unpaginated, ca. 20 pp.]

Sampathu, S.R., Shivashankar, S., and Lewis, Y.S. 1984. Saffron (*Crocus sativus* Linn.) - cultivation, processing, chemistry and standardization. CRC Crit. Rev. Food Sci. Nutr. **20**: 123-157.

Sanecki, K.H. 1974. The complete book of herbs. Macmillan, New York, NY, USA. 247 pp.

Sanecki, K.N. 1992. History of the English herb garden. Ward Lock, London, UK. 128 pp.

Sannai, A., Fujimori, T., and Kat, K. 1982. Studies on flavor components of roasted chicory root. Agric. Biol. Chem. **46**: 429-433.

Sansregret, J. 1974. Coriander- a useful herb. Horticulture **1974** (Aug.): 48-49.

Sargent, C.S. 1890. The silva of North America. Vol. 10. Liliaceae - Coniferae. Houghton, Mifflin and Company, Boston, MA, USA. 159 pp.

Sargent, C.S. 1891. The silva of North America. Vol. 2. Cyrillaceae - Sapindaceae. Houghton, Mifflin and Company, Boston, MA, USA. 117 pp.

Sargent, C.S. 1905. Manual of the trees of North America. Houghton, Mifflin and Company, Boston, MA, USA. 826 pp.

Sarojini, G., Rao-K.C., Tulpule, P.G., and Lakshminarayana, G. 1985. Effects of processing on physicochemical properties and fatty acid composition of *Hibiscus sabdariffa* seed oil. J. Amer. Oil Chem. Soc. **62**: 728-730.

Schaden, G., and Hesse, C. 1976. Über das ätherische Öl des kretischen Diptams, *Origanum dictamnus* L. Monatschefte für Chemie **107**: 929-931.

Schambelan, M. 1994. Licorice ingestion and blood presssure regulating hormones. Stereoids **59**: 127-130.

Schmidt, M. 1980. It's thyme for an adaptable herb. Org. Gard. **27**(3): 62, 64, 66.

Schneider, E. 1986. Uncommon fruits and vegetables. A commonsense guide. Harper & Row Pub., New York, NY, USA. 547 pp.

Schreiber, M.M., and Fertig, S.N. 1955. The chemical composition of yellow rocket (*Barbarea vulgaris*). Agron. J. **47**: 104-105.

Schreiner, J. 1994. Root of success. Can. Geogr. **114**(6): 42-46, 48, 50.

Scobey, J., and Myers, N. 1975. Gifts from your garden. Bobbs-Merrill Company, Indianapolis, IN, USA. 160 pp.

Scoggan, H.L. 1978-79. The flora of Canada. 4 vols. Nat. Mus. Nat. Sci. (Ottawa) Publ. Bot. **7**: 1711 pp.

Scortichini, M. 1986. The myrtle. Rivista di Frutticoltura **48**(12): 47-53. [In Italian, English summary.]

Secrétariat d'État. 1974. Flore du Canada. Bulletin de terminologie n° 156 (anglais-latin-français). Canada Secrétariat d'État, Bureau des Traductions. Information Canada, Ottawa, ON, Canada. 634 pp.

Seelig, R.A. 1974. Watercress. Fruit & vegetable facts & pointers. United Fresh Fruit and Vegetable Association, Alexandria, VA, USA. 7 pp.

Sermsri, N., Tipayarek, S., and Murata, Y. 1987*a*. Studies on roselle (*Hibiscus sabdariffa* var. *altissima* L.) cultivation in Thailand: I. Growth analysis. Jpn. J. Crop Sci. **56**: 59-63.

Sermsri, N., Duyapat, C., and Murata, Y. 1987*b*. Studies on roselle (*Hibiscus sabdariffa* var. *altissima* L.) cultivation in Thailand: II. Effect of planting time, harvesting time and climatic factors on fiber yield. Jpn. J. Crop Sci. **56**: 64-69.

Sethi, V., and Anand, J.C. 1982. Preserving ginger all the year round. Indian Hortic. **27**(3): 13.

Shaath, N.A., Griffin, P., Dedeian, S., and Paloympis, L. 1988. The chemical composition of Egyptian parsley seed, absolute and herb oil. *In* Flavors and fragrances: a world perspective. *Edited by* B.M. Lawrence, B.D. Mookherjee, and B.J. Willis. Elsevier Science Publishers, Amsterdam, The Netherlands. pp. 715-729.

Shahidi, E 1990. Rapeseed and canola: global production and distribution. *In* Canola and rapeseed - production, chemistry, nutrition, and processing technology. *Edited by* F. Shahidi. Van Nostrand Reinhold, New York, NY, USA. pp. 3-46.

Sharma, A., Tewari, R., and Virmani, O.P. 1987. French basil (*Ocimum bacilicum* L.). A review. Curr. Res. Med. Aromat. Plants **9**: 136-151.

Shaw, E.A. 1977. Saccharum or saccharophorum? Rhodora **79**: 123-127.

Shear, G.M. 1968. Commercial growing of watercress. U.S. Dep. Agric. Farmers' Bull. **2233**: 12 pp.

Sheen, L.-Y., Ou, Y.-H. T., and Tsai, S.-J. 1991. Flavor characteristic compounds found in the essential oil of *Ocimum basilicum* L. with sensory evaluation and statistical analysis. J. Agric. Food Chem. **39**: 939-943.

Shepard, S.M. 1979. Natural food feasts. Arco Publishing, New York, NY, USA. 455 pp.

Sheppard, J.S., and Wills, B.J. 1985. Sheep's burnet - a forage herb for soil conservation in New Zealand. N.Z. Agric. Sci. **19**: 115-118.

Sheppard, J.S., and Wills, B.J. 1986. Management and uses of *Sanguisorba minor* (sheep's burnet). *In* Plant materials handbook for soil conservation, vol. 2, introduced plants. *Edited by* C.W.S. van Kraayenoord and R.L. Hathaway. National Water and Soil Conservation Organisation, Wellington, N.Z. pp. 282-286.

Sherk, L.C., and Buckley, A.R. 1968. Ornamental shrubs for Canada. Can. Dep. Agric. Res. Br. Publ. **1286**: 187 pp., map.

Sherry, C.J., and Koontz, J.A. 1979. Pharmacologic studies of "catnip tea:" the hot water extract of *Nepeta cataria*. Q. J. Crude Drug Res. **17**(2): 68-72.

Shimizu, H.H. 1982. Favorites from the National Arboretum's herb garden. Plants Gard. (Brooklyn) **38** (2): 16-20.

Shimizu, H.H. 1991. Mint condition. Nat. Gard. **14**(4): 44-47, 73, 75.

Shimizu, H.H., and Pailler, D. 1993. New and noteworthy herbs. The Herbarist **59**: 5-10.

Shirley, C. 1989. Growing basil indoors. Org. Gard. **36**(9): 26-27.

Shock, C.C. 1982*a*. Experimental cultivation of Rebaudi's *Stevia* in California. Univ. Calif., Davis Agron. Progr. Rep. **122**: 9 pp.

Shock, C.C. 1982*b*. Rebaudi's stevia: natural noncaloric sweeteners. Calif. Agric. **1982**(Sept.-Oct.): 4-5.

Shoemaker, J.S. 1939. Rhubarb in Alberta. Univ. Alta. Coll. Agric. Circ. No. **25**: 23 pp.

Schofield, J.J. 1989. Discovering wild plants - Alaska, western Canada, the Northwest. Alaska Northwest Books, Bothell, WA, USA. 354 pp.

Schultes, R.E., and Hofmann, A. 1980. The botany and chemistry of hallucinogens. 2nd. ed. Thomas, Springfield, IL, USA. 437 pp.

Schultze, W., Zänglein, A., Hose, S., Kubeczka, K.H., and Czygan, F.C. 1992. Volatiles in flowers of balm (*Melissa officinalis* L.). *In* Advances in labiate science. *Edited by* R.M. Harley and T. Reynolds. Royal Botanic Gardens, Kew, U.K. pp. 357-366.

Shukla, H.S., and Tripathi, S.C. 1987. Studies on physico-chemical, phytotoxic and fungitoxic properties of essential oils of *Foeniculum vulgare* Mill. Bietr. Biol. Pflanz. **62**: 149-158.

Shulman, M.R. 1991. The spice of vegetarian cooking. Healing Arts Press, Rochester, VT, USA. 196 pp.

Siegel, R.K. 1979. Ginseng abuse syndrome. JAMA **241**: 1614-1615.

Sievers, A.F. 1948. Production of drug and condiment plants. U.S. Dep. Agric Farmers' Bull. **1999**: 99 pp.

Simmonds, N.W. (*Editor*). 1976. Evolution of crop plants. Longman Inc., New York, NY, USA. 339 pp.

Simmons, A.G. 1964. Herb gardening in five seasons. D. Van Nostrand Co., Inc., London, UK. 353 pp.

Simmons, A.G. 1969. Herbs to grow indoors. Hawthorn Books, Inc., New York, NY, USA. 146 pp.

Simmons, G. 1988. Pupple Weekly. Perigree Books/Putnam Publishing Group, New York, NY, USA. 80 pp.

Simon, D.Z., Beliveau, J., and Aubé, C. 1986. Extraction by hydrodiffusion of the essential oil of *Monarda fistulosa* grown in the province of Quebec: assay of geraniol in the hydrodiffused oil. Int. J. Crude Drug Res. **24**: 120-122.

Simon, J. E. 1985. Sweet basil: a production guide. Purdue Univ. Coop. Ext. Serv. Home Econ. **HO189**: 2 pp.

Simon, J.E. 1989. Fennel: new specialty vegetable. Herb Spice Med. Plant Dig. **7**(4): 5.

Simon, J.E. 1990. Essential oils and culinary herbs *In* Advances in new crops. *Edited by* J. Janick and J.E. Simon. Timber Press, Portland, OR, USA. pp. 472-483.

Simon, J.E., and Cebert, E. 1988. *Artemisia annua*: a production guide. *In* 1988 Proceedings of the third national herb growing and marketing conference. *Edited by* J.E. Simon and L.Z. Clavio. Purdue Research Foundation, West Lafayette, IN, USA. pp. 78-83.

Simon, J.E., and Clavio, L.Z. (*Editors*). 1988. Proceedings of the third national herb growing and marketing conference. Purdue Research Foundation, West Lafayette, IN, USA. 333 pp.

Simon, J.E., and Craker, L.E. 1983. Introduction of culinary herbs for commercial production: a management question. Herb Spice Med. Plant Dig. **1**(2): 1, 2, 6.

Simon, J.E., and Craker, L.E. 1984. Introduction to sweet basil cultivation. Herb Spice Med. Plant Dig. **2**(2): 1, 2, 6.

Simon, J.E., and Craker, L.E. 1989. Sweet Annie in medicine. Herb Spice Med. Plant Dig. **7**(2): 5-6.

Simon, J.E., and Grant, L. (*Editors*). 1987*a*. Proceedings of the first national herb growing and marketing conference. Purdue University, West Lafayette, IN, USA. 333 pp.

Simon, J.E., and Grant, L. (*Editors*). 1987*b*. Proceedings of the second national herb growing and marketing conference. Purdue Research Foundation, West Lafayette, IN, USA. 342 pp.

Simon, J.E., and Quinn, J. 1988. Characterization of essential oil of parsley. J. Agric. Food Chem. **36**: 467-472.

Simon, J.E., and Reiss-Bubenheim, D. 1987. Characteristics of American basil varieties. *In* Proceedings of the second national herb growing and marketing conference. *Edited by* J.E. Simon and L. Grant. Purdue Research Foundation, West Lafayette, IN, USA. pp. 48-51.

Simon, J.E., and Reiss-Bubenheim, D. 1988. Field performance of American basil varieties. Herb Spice Med. Plant Dig. **6**(1): 1-4.

Simon, J.E., Chadwick, A.F., and Craker, L.E. 1984. Herbs: an annotated bibliography, 1971-1980. The Shoe String Press, Inc., Hamden, CN, USA. 770 pp.

Simon, J.E., Morales, M.R., and Charles, D. 1994. The wonderful world of basils. *In* Herbs '94. Proceedings ninth national herb growing and marketing conference. *Edited by* A. Kestner, J.E. Simon, and A.O. Tucker. International Herb Growers & Marketers Association, Mundelein, IL, USA. pp. 5-8.

Simon, J.E., Reiss-Bubenheim, D., Joly, R.J., and Charles, D.J. 1992. Water stress-induced alterations in essential oil content and composition of sweet basil. J. Ess. Oil. Res. **4**: 71-75.

Simpson, M.J.A. 1993. A description and code of development of borage (*Borago officinalis*). Ann. Appl. Biol. **123**: 187-192.

Simpson, W.R., Beaver, R.G., Colt, W.M., and Baird, C.R. 1985. Carrot, parsnip & parsley. Pac. NW Ext. Publ. **272**: 4 pp.

Sing, P. 1981. Traditional recipes of Laos. Prospect Books, London, U.K. 318 pp.

Singh, A., Randhawa, G.S., and Mahey, R.K. 1987. Oil content and oil yield of dill (*Anethum graveolens* L.) herb under some agronomic practices. Acta Hortic. (The Hague) **208**: 51-60.

Singh, D.K., and Singh, A. 1993. *Allium sativum* (garlic), a potent new molluscicide. Biol. Agric. Hortic. **9**: 121-124.

Singh, H.G. 1982. Cultivation of opium poppy. *In* Cultivation and utilization of medicinal plants. *Edited by* C.K. Atal and B.M. Kapur. Regional Research Laboratory, Council of Scientific & Industrial Research, Jammu-Tawi, India. pp. 120-138.

Singh, J., Gupta, K., and Arora, S.K. 1994. Changes in the anti-nutritional factors of developing seeds and pod walls of fenugreek (*Trigonella foenum-graecum* L.). Plant Foods Hum. Nutr. (Dordr.) **46**: 77-84.

Singh, N., Luthra, R., and Sangwan, R.S. 1989. Effect of leaf position and age on the essential oil quantity and quality in lemongrass (*Cymbopogon flexuosus*). Planta Med. **55**: 254-256.

Singh, S.P., Khanna, K.R., Shukla, S., Dixit, B.S., and Banerji, R. 1995. Prospects of breeding opium poppies (*Papaver somniferum* L.) as a high-linoleic-acid crop. Plant Breed. **114**: 89-91.

Sinskaya, E.N. 1950. Fenugreek - *Trigonella* L. *In* Flora of cultivated plants of the USSR. *Edited by* E.N. Sinskaya. Ministry of Agriculture of the USSR, Leningrad. Vol. **13**(1): 503-518. (Transl. from Russian, 1961, by Israel Progr. for Sci. Transl., Jerusalem.)

Skalický, V. 1968. *Agrimonia. In* Flora Europaea. Vol. 2. *Edited by* T.G. Tutin, V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, and S.M. Walters. Cambridge University Press, New York, NY, USA. pp. 32-33.

Skaltsa, H., and Shammas, G. 1988. Flavonoids from *Lippia citriodora*. Planta Med. **54**: 465.

Small, E. 1978. A numerical and nomenclatural analysis of morpho-geographic taxa of *Humulus*. Syst. Bot. **3**: 37-76.

Small, E. 1979. The species problem in *Cannabis*: science and semantics. Corpus, Toronto, ON, Canada. 2 vols.

Small, E. 1980. The relationships of hop cultivars and wild variants of *Humulus lupulus*. Can. J. Bot. **58**: 676-686.

Small, E. 1981. A numerical analysis of morpho-geographic groups of cultivars of *Humulus lupulus* L. based on samples of hops. Can. J. Bot. **59**: 311-324.

Small, E. 1989. Systematics of biological systematics (or, taxonomy of taxonomy). Taxon **38**: 335-356.

Small, E. 1993. The economic value of plant systematics in Canadian agriculture. Can. J. Bot. **71**: 1537-1551.

Small, E. 1995. Crop diversification in Canada with particular reference to genetic resources. Can. J. Plant Sci. **75**: 33-43.

Small, E. 1996*a*. Cannabaceae. *In* Flora of North America, north of Mexico, vol. 3. *Edited by* Flora North America Editorial Committee. Oxford University Press, New York. (In press)

Small, E. 1996*b*. Confusion of common names for toxic and edible "star anise" (*Illicium*) species. Econ. Bot. **50**: 280-282.

Small, E., and Catling, P.M. 1996. Poorly known economic plants of Canada - 9. Dandelion species, *Taraxacum* spp. Can. Bot. Assoc. Bull. **29**: 24-26.

Small, E., Jurzysta, M., and Nozzolillo, C. 1990. The evolution of hemolytic saponin content in wild and cultivated alfalfa. Econ. Bot. **44**: 226-235.

Smart, J. 1991. The rhubarb cookbook. Gallimaufry Press, Nanaimo, BC, Canada. 131 pp.

Smith, A. 1992. The doctrine of signatures. Cornell Plant. **47**(3): 11-14.

Smith, A. (*Editor*). 1995. A dandy plant. Cornell Plant. **50**(2): 22.

Smith, L.W. 1973. The forgotten art of flower cookery. Pelican Publ. Co., Gretna, LA, USA. 180 pp. [Reprinted 1985.]

Smith, L.W. 1977. How to double your pleasure from violets. Flower and Garden (Northern Ed.) **21**(6): 38-39.

Smith, P.G., Villalon, B., and Villa, P.L. 1987. Horticultural classification of peppers grown in the United States. HortScience **22**: 11-13.

Smith, R.M. 1974. The essential oil of the medicinal plant *Coleus amboinicus* from Fiji. Fiji Agric. J. **36**(1): 21.

Snider, S. 1991. Herbal teas and toxicity. FDA Consumer **25**(4): 30-33.

Snow, F.L. 1924. The humble rhubarb of many uses and ancient lineage. Gard. Mag. **39**: 298.

Soejarto, D.D., and Farnsworth, N.R. 1978. The correct name for Siberian ginseng. Bot. Mus. Leafl. (Harv. Univ.) **26**: 339-343.

Soejarto, D.D., Compadre, C.M., Medon, P.J., Kamath, S.K., and Kinghorn, A.D. 1983. Potential sweetening agents of plant origin. II. Field search for sweet-tasting *Stevia* species. Econ. Bot. **37**: 71-79.

Sokolov, R. 1979. Lickerish delights. Nat. Hist. **88**(6): 92-96.

Sokolov, R. 1985. A matter of taste. Nat. Hist. **94**(8): 74-77.

Solecki, R.S., and Shanidar, I.V. 1975. A Neanderthal flower burial in northern Iraq. Science **190**: 880-881.

Solomon, C. 1992. The complete Asian cookbook. Raincoast Books, Vancouver, BC, Canada. 511 pp.

Song, K.M., Osborn, T.C., and Williams, P.H. 1988. *Brassica* taxonomy based on nuclear restriction fragment length polymorphisms (RFLPs). 2. Preliminary analysis of subspecies within *B. rapa* (syn. *campestris*) and *B. oleracea*. Theor. Appl. Genet. **76**: 593-600.

Song, K.M., Osborn, T.C., and Williams, P.H. 1990. *Brassica* taxonomy based on nuclear restriction fragment length polymorphisms (RFLPs). 3. Genome relationships in *Brassica* and related genera and the origin of *B. oleracea*. Theor. Appl. Genet. **79**: 497-506.

Song, Y.-D. 1978. Manufacture of ginseng products. *In* Korean ginseng. 2nd ed. *Edited by* H.-W. Bae. Korea Ginseng Research Institute, Ini-Dong, Chongro-ku, Seoul, Republic of Korea. pp. 221-238.

Sopher, D.E. 1977. The sea nomads - a study of the maritime boat people of Southeast Asia. National Museum, Singapore. 444 pp.

Soreng, R.J., and Cope, E.A. 1991. On the taxonomy of cultivated species of the *Chrysanthemum* genus-complex (Anthemideae; Compositae). Baileya **23**: 145-165.

S rensen, P.D., and Matekaitis, P.A. 1981. A lemon-scented *Pycnanthemum* (Lamiaceae). Rhodora **83**: 145-146.

Sorvig, K. 1983. The genus *Nigella*. The Plantsman **4**: 229-235.

Soskov, Yu.D., and Bairamov, S.S. 1990. Subspecies of fenugreek (*Trigonella foenum-graecum*). Nauchno-tekhn. Byull. Inst. Rastenievod. (Sci.-Tech. Bull. Inst. Plant Growing) **198**: 23-26. [In Russian.]

Soule, J.A. 1993*a*. Systematics of *Tagetes* (Asteraceae -Tageteae). Doctoral dissertation, University of Texas at Austin, Austin, TX, USA. 785 pp.

Soule, J.A. 1993*b*. *Tagetes minuta*: a potential new herb from South America. *In* New crops - exploration, research, and commercialization. Edited by J. Janick and J.E. Simon. J. Wiley and Sons, New York, NY, USA. pp. 649-654.

Souleles, C., and Argyriadou, N. 1990. The volatile constituents of *Calamintha grandiflora*. Planta Med. **56**: 234-235.

Souleles, C., and Shammas, G. 1985. Constituents of the leaves and flowers of *Calamintha nepeta* (L.) Savi. Plant. Méd. Phytothér. **19**: 268-290.

Souleles, C., Argyriadou, N., and Philianos, S. 1987. Constituents of the essential oil of *Calamintha nepeta*. J. Nat. Prod. **50**: 510-511.

Souleles, C., Harvala, C., and Chinou, J. 1991. Flavonoids from *Calamintha grandiflora*. Int. J. Pharmacog. **29**: 317-319.

Spence, R.-M.M., and Tucknott, O.G. 1983. Volatiles from the epicuticular wax of watercress (*Rorippa nasturtium-aquaticum*). Phytochemistry **22**: 2251-2253.

Spice Trade Association. 1985. A history of spices. American Spice Trade Association, Englewood Cliffs, NJ, USA. 13 pp.

Splittstoesser, W.E. 1990. Vegetable growing handbook. 3rd ed. AVI Book, Van Nostrand Reinhold, New York, NY, USA. 355 pp.

Staba, E.J., and Chen, S.-E. 1979. An overview of ginseng chemistry, pharmacology and anti-tumor effects. *In* Official proceedings first national ginseng conference. *Edited by* D.L. Hensley, S. Alexander, and C.R. Roberts. Governor's Council on Agriculture, Frankfort, KY, USA. pp. 91-100.

Stace, C.A. 1990. New names and combinations in the British flora. Watsonia **18**: 212-213.

Standal, B.R., Ako, H., and Standal, G.S.S. 1985. Nutrient content of tribal foods from India: *Flemingia vestita* and *Perilla frutescens*. J. Plant Foods **6**: 147-153.

Stapf, O. 1906. The oil grasses of India and Ceylon. (*Cymbopogon, Vetiveria* and *Andropogon* spp.). Kew Bull. **8**: 313-364.

Starý, F., and Jirásek, V. 1973. Herbs. Hamlyn, London, England. 239 pp. (Translated from Czech.)

Statistics Canada. 1993. Field Crop Reporting Series, Report **72**(8). 23 pp.

Steam, W.T. 1992*a*. Stearn's dictionary of plant names for gardeners. Cassell Publishers, London, U.K. 363 pp.

Stearn, W.T. 1992*b*. Botanical Latin: history, grammar, syntax, terminology, and vocabulary. 4th ed. David & Charles, Newton Abbot, Devon, U.K. 546 pp.

Steam, W.T. 1992*c*. How many species of *Allium* are known? Kew Mag. **9**: 180-182.

Stebbins, D.E. 1974. Let there be lavender. Org. Gard. **21**(2): 118-119.

Steiner, L.F. 1952. Methyl eugenol as an attractant for oriental fruit fly. J. Econ. Entomol. **45**: 241-248.

Steinmetz, E.F. 1957. Codex vegetabilis. 2nd. ed. E.F. Steinmentz, Amsterdam, Netherlands. 154 pp.

Stengele, M., and Stahl-Biskup, E. 1993. Seasonal variation of the essential oil of European pennyroyal (*Mentha pulegium* L.). Acta Hortic. (The Hague) **344**: 41-51.

Stephanou, E., and Kokalou, E. 1990. Phytochemical study of *Chaerophyllum bulbosum* L., growing wild in Greece and *Calamintha nepeta* L., endemic to Greece. Dev. Food Sci. **24**: 839-845.

Stephens, J.M. 1978. Know your minor vegetables. Fla. Agric. Ext. Serv. Rep. **17**: 51 pp.

Steuart, G. 1987. Growing alkaloid-free comfrey. Herb Spice Med. Plant Dig. **5**(4): 9.

Stevens, C.P. 1972. Watercress. Agriculture (London) **79**: 1-5.

Stevens, R. 1967. The chemistry of hop constituents. Chem. Rev. **67**: 19-71.

Stobart, T. 1977. Herbs, spices and flavourings. Penguin Books, New York, NY, USA. 320 pp.

Stock, M.T., and Hunter, K. 1995*a*. The healing powers of peppers. Part 1: cayenne as a curative. Chile Pepper [Mag.] **9**(3): 18-21, 37, 39-41.

Stock, M.T., and Hunter, K. 1995*b*. The healing powers of peppers. Part 2. Chile Pepper [Mag.] **9**(4): 20-23, 52.

Stockberger, W.W. 1953. Ginseng culture. U.S. Dep. Agric. Farmers' Bull. **1184**: 12 pp. [Revised by A.F. Sievers and L.M. Pultz.]

Stokes, G.W. 1955. Seed development and failure in horseradish. J. Hered. **46**: 15-21.

Straley, G.B. 1986. Wild bergamot, *Mondarda fistulosa* (Lamiaceae), new to the Northwest Territories. Can. Field-Nat. **100**: 380-381.

Stuart, M. (*Editor*). 1979. The encyclopedia of herbs and herbalism. Grosset and Dunlap, New York, NY, USA. 304 pp.

Stuart, M. (*Editor*). 1981. Encyclopedic des herbes. Éditions Atlas, Paris, France. 303 pp.

Sturm, J. 1900-1907. J. Sturm's Flora yon Deutschland. 15 vols. Verlag yon K.G. Lutz, Stuttgart, Germany.

Sturtivant, L. 1988. Profits from your backyard herb garden. 4th ed. San Juan Naturals, Friday Harbor, WA, USA. 118 pp.

Sturtivant, L. 1994. Herbs for sale. Growing and marketing herbs, herbal products, and herbal know-how. San Juan Naturals, Friday Harbor, WA, USA. 246 pp.

Su, H.C. 1991. Toxicity and repellency of *Chenopodium* oil to four species of stored-product insects. J. Entomol. Sci. **26**: 178-182.

Sudekum, M., Poppenga, R.H., Raju, N., and Braselton, Jr., W.E. 1992. Pennyroyal oil toxicosis in a dog. J. Amer. Vet. Med. Assoc. **200**: 817-818.

Sundue, B. 1994. An assessment of selected ethnic food markets in Canada: summary report. Market and Business Analysis Division, Food Bureau, Market and Industry Services Branch, Agriculture and Agri-Food Canada, Ottawa, ON, Canada. 106 pp.

Sutton, S., Humphries, C., and Hopkinson, J. 1985. Tarragon. The Garden **110**: 237-240.

Sváb, J. 1992. Hyssop. *In* Cultivation and processing of medicinal plants. *Edited by* L. Hornok. Akadémiai Kiadó, Budapest. pp. 196-200.

Svoboda, K.P., and Hay, R.K. 1990. Growing summer savory (*Satureja hortensis*) in Scotland: quantitative and qualitative analysis of the volatile oil and factors influencing oil production. J. Sci. Food Agric. **53**: 193-202.

Svoboda, K.P., Hay, R.K.M., and Waterman, P.G. 1990. The growth and volatile oil yield of summer savory (*Satureja hortensis*) in a cool wet environment. J. Hortic. Sci. **65**: 659-665.

Svoboda, K.P., Galambosi, B., Deans, S.G., and Hethelyi, E. 1993. Agronomical and biochemical investigation. of *Hyssopus officinalis* L. from various geographical sources. Acta Hortic. (The Hague) **344**: 434-443.

Swahn, J.O. 1991. The lore of spices. Grange Books, London, England. 208 pp.

Swanston-Flatt, S.K., Day, C., Bailey, C.J., and Flatt, P.R. 1990. Traditional plant treatments for diabetes: Studies in normal and streptozotocin diabetic mice. Diabetologia **33**: 462-464.

Sychev, S.I., and Shmanaeva, T.N. 1989. Dill breeding for quality production. Acta. Hortic. **244**: 243-248.

Syme, J.T. 1873. English Botany. Vol. 1, Ranunculaceae to Cruciferae. George Bell & Sons, Convent Garden, U.K.

Syme, J.T. [also J.E. Smith, J. Sowerby, and others] 1863-1886. English Botany. 12 vol. 3rd ed. (revised). George Bell & Sons, Convent Garden [and other publishers], U.K.

Szczawinski, A.F., and Turner, N.J. 1978. Edible garden weeds of Canada. National Museums of Canada, Ottawa, ON, Canada. 184 pp.

Szczawinski, A.F., and Turner, N.J. 1980. Wild green vegetables of Canada. National Museums of Canada, Ottawa, ON, Canada. 179 pp.

Takagi, H. 1990. Garlic, *Allium sativum* L. *In* Onions and allied crops. Vol. III. Biochemistry, food science, and minor crops. *Edited by* J.L. Brewster and H.D. Rabinowitch. CRC Press, Inc., Boca Raton, FL, USA. pp. 109-146.

Takahashi, M. 1986. Microsporogenesis in a parthenogenetic species, *Houttuynia cordata* Thunb. (Saururaceae). Bot. Gaz. **147**: 47-54.

Talbert, R.H. 1994. Za'atar. The Herbarist **60**: 53-56.

Tamura, Y., Nakamura, S., Fukui, H., and Tabata, M. 1984. Comparison of *Stevia* plants grown from seeds, cuttings and stem tip cultures for growth and sweet diterpene glycosides. Plant Cell Rep. **3**: 180-182.

Tanaka, O. 1994. Ginseng and its congeners - traditional Oriental food drugs. *In* Food phytochemicals for cancer prevention II - teas, spices, and herbs. *Edited by* C-T. Ho, T. Osawa, M-T. Huang, and R.T. Rosen. American Chemical Society, Washington, DC, USA. pp. 335-341.

Tanaka, T. 1976. Tanaka's cyclopedia of edible plants of the world. Keigaku Publishing, Tokyo, Japan. 924 pp. [Edited by S. Nakao.]

Tateo, E, Santamaria, L., Bianchi, L., and Bianchi, A. 1989. Basil oil and tarragon oil: composition and genotoxicity evaluation. J. Ess. Oil Res. **1**: 111-118.

Tateo, F., Fugazza, M., Faustle, S., Bianchi, A., Tateo, S., Berte, F., and Bianchi, L. 1990. Technical and toxicological problems connected with the formulation of low-energy foods. 2. Mutagenic and fertility-modifying activity of extracts and constituents of *Stevia rebaudiana* Bertoni. Rev. Soc. Ital. Sci. Alliment. **19**: 1-2, 13-22. [In Italian.]

Taylor, R.J. 1987. Populational variation and biosystematic interpretation in weedy dandelions. Bull. Torrey Bot. Club **114**: 109-120.

Taylor, R.L. 1976. *Houttuynia cordata*, dokudami. Davidsonia **7**(4): 63.

Teranishi, R., Buttery, R.G., and Sugisawa, H. (*Editors*). 1993. Bioactive volatile compounds from plants. American Chemical Society, Washington, D.C., USA. 309 pp.

Thanos, C.A., Kadis, C.C., and Skarou, F. 1995. Ecophysiology of germination in the aromatic plants thyme, savory and oregano (Labiatae). Seed Sci. Res. **5**: 161-170.

The Furrow. 1990. Growing borage for the health of it. The Furrow **95**(6): 19.

The Furrow. 1992. High value, low volume: a look at the ultraspecialty crops. The Furrow **97**(4): 16-17.

The Ottawa Citizen. 1993. Pepper paint hot stuff for mussels. The Ottawa Citizen, Thurs. May 5, page Fl.

Theimer, R.R., and Moelleken, H. 1995. Analysis of the oils from different hemp (*Cannabis sativa* L.) cultivars -perspectives for economic utilization. *In* Bioresource hemp proceedings of the symposium, Frankfurt am Main, Germany, March 2-5, 1995. 2nd ed. *Edited by* Nova Institute. Hemptech, Ojai, CA, USA. pp. 536-545A.

Thomé, O.W. 1903-1905. Prof. Dr. Thomé's Flora von Deutschland, Österreich und der Schweiz. H.V. Verlag, Berlin-Lichterfelde, Germany. Vol. 1-4. [Reissue with amended text.]

Thompson, B. 1978. Syrup trees. Walnut Press, Fountain Hills AZ, USA. 164 pp.

Thompson, G.A. 1987. The field cultivation of American ginseng. Stn. Bull. Purdue Univ. Agric. Exp. Sta. **518**: 179-185.

Thompson, T. 1986. Cajun-Creole cooking. HP Books, Tucson, AZ, USA. 176 pp.

Tindall, H.D. 1983. Vegetables in the tropics. AVI Publishing Co., Westport, CT, USA. 533 pp.

Tkachenko, K.G., and Zenkevich, I.G. 1993. Chemical composition of the leaf oil of *Myrrhis odorata* (L.) Scop. J. Ess. Oil Res. **5**: 329-331.

Toghrol, F., and Pourebrahimi, M. 1976. Estimation of vitamin C in fenugreek, coriander and ribes. Plant Foods for Man **2**: 1-5.

Tolley, E., and Mead, C. 1985. Herbs - gardens, decorations, and recipes. Clarkson N. Potter, New York, NY, USA. 244 pp.

Toskulkao, C., Deechakawan, W., Leardkamolkam, V., and Glinsukon, T. 1994. The low calorie natural sweetener stevioside: nephrotoxicity and its relationship to urinary enzyme excretion in the rat. Phytother. Res. **8**: 281-286.

Toulemonde, B., and Noleau, I. 1988. Volatile constituents of lovage (*Levisticum officinale* Koch.). Dev. Food Sci. **18**: 641-657.

Toussaint-Samat, M. 1992. A history of food. Blackwell Publishers, Cambridge, MA, USA. 801 pp. [Translated by A. Bell, from the French: Histoire naturelle et morale de la nourriture, 1987, Bordas, Paris, France.]

Touw, M. 1982. Roses in the Middle Ages. Econ. Bot. **36**: 71-83.

Toxopeus, H., and Lubberts, H.J.[sic; correctly J.H.] 1994. Effect of genotype and environment on carvone yield and yield components of winter-caraway in the Netherlands. Ind. Crops Prod. **3**: 37-42.

Toxopeus, H., Lubberts, J.H., Neervoort, W., Folkers, W., and Huisjes, G. 1995. Breeding research and in vitro propagation to improve carvone production of caraway (*Carum carvi* L.) Ind. Crops Prod. **4**: 33-38.

Toyama, M., and Wakamiya, I. 1990. Rakkyo, *Allium chinense* G. Don, *In* Onions and allied crops. Vol. III. Biochemistry, food science, and minor crops. *Edited by* J.L. Brewster and H.D. Rabinowitch. CRC Press, Inc., Boca Raton, FL, USA. pp. 197-218.

Trehane, P., Brickell, C.D., Baum, B.R., Hetterscheid, W.L.A., Leslie, A.C., McNeill, J., Spongberg, S.A., and Vrugtman, F. (*Editors*). 1995. The international code of nomenclature for cultivated plants - 1995. (ICNCP or cultivated plants code). 6th ed. Quarterjack Publishing, Wimborne, U.K. 192 pp.

Tripp, N. 1985. The miracle berry. Horticulture **63**(1): 58-72.

Tsankova, E.T., Konaktchiev, A.N., and Genova, E.M. 1993. Chemical composition of the essential oils of two *Hyssopus officinalis* taxa. J. Ess. Oil Res. **5**: 609-611.

Tsuji, S. 1980. Japanese cooking. Kodansha International/USA Ltd., New York, NY, USA. 517 pp.

Tucker, A.O. 1981. The correct name of lavandin and its cultivars (Labiatae). Baileya **21**: 131-133.

Tucker, A.O. 1986. Botanical nomenclature of culinary herbs and potherbs. Herbs Spices Med. Plants (Recent Adv. Bot. Hortic. Pharmacol.) **1**: 33-80.

Tucker, A.O. 1990. The oregano mystery: a guide to the oreganos. *In* Herbs '90. Proceedings fifth annual conference, International Herb Growers & Marketers Association. *Edited by* J.E. Simon, A. Kestner, and M.R. Buehrle. International Herb Growers & Marketers Association, Silver Springs, PA, USA. pp. 8-9.

Tucker, A.O. 1994. North American herbs of flavor and fragrance. The Herbarist **60**: 57-63.

Tucker, A.O., and Fairbrothers, D.E. 1990. The origin of *Mentha gracilis* (Lamiaceae). I. Chromosome numbers, fertility, and three morphological characters. Econ. Bot. **44**: 183-213.

Tucker, A.O., and Maciarello, M.J. 1986. The essential oils of some rosemary cultivars. Flavour Fragrance J. **1**: 137-142.

Tucker, A.O., and Maciarello, M.J. 1987. Plant identification. *In* Proceedings of the first national herb growing and marketing conference. *Edited by* J.E. Simon and L. Grant. Purdue University, West Lafayette, IN, USA. pp. 126-172.

Tucker, A.O., and Maciarello, M.J. 1989. Ethnic today, trendy tomorrow. Herb Spice Med, Plant Dig. **5**(3): 3-4.

Tucker, A.O., and Maciarello, M.J. 1990. Essential oils of cultivars of Dalmatian sage (*Salvia officinalis* L.). J. Ess. Oil Res. **2**: 139-144.

Tucker, A.O., and Maciarello, M.J. 1993. Is this plant a hoax? A lecture in honor of Otto Richter. *In* Herbs '93. Proceedings eighth national herb growing and marketing conference. *Edited by* A. Kestner and J.E. Simon. International Herb Growers & Marketers Association, Mundelein, IL, USA. pp. 177-182.

Tucker, A.O., and Maciarello, M.J. 1994. Oregano: botany, chemistry, and cultivation. *In* Spices, herbs and edible fungi. *Edited by* G. Charalambous. Elsevier, London, U.K. pp. 439-456.

Tucker, A.O., and Rollins, E.D. 1989. The species, hybrids, and cultivars or *Origanum* (Lamiaceae) cultivated in the United states. Baileya **23**: 14-27.

Tucker, A.O., and Tucker, S.S. 1988. Catnip and the catnip response. Econ. Bot. **42**: 214-231.

Tucker, A.O., Maciarello, M.J., and Howell, J.T. 1980. Botanical aspects of commercial sage. Econ. Bot. **34**: 16-19.

Tucker, A.O., Hendriks, H., Bos, R., and Fairbrothers, D.E. 1991. The origin of *Mentha gracilis* (Lamiaceae) II. Essential oils. Econ. Bot. **45**: 200-215.

Turner, B.L. 1994. Taxonomic treatment of *Monarda* (Lamiaceae) for Texas and Mexico. Phytologia **77**: 56-79.

Turner, D.M. 1938. The economic rhubarbs: a historical survey of their cultivation in Britain. J. R. Hortic. Soc. **63**: 355-370.

Turner, N.J., and Szczawinski, A.F. 1978. Wild coffee and tea substitutes of Canada. National Museums of Canada, Ottawa, ON, Canada. 111 pp.

Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., and Walters, S.M. (*Editors*). 1968. Flora Europaea. Vol. 2. Cambridge University Press, New York, NY, USA. 455 pp.

Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., and Walters, S.M. (*Editors*). 1972. Flora Europaea. Vol. 3. Cambridge University Press, New York, NY, USA. 370 pp.

Tutupalli, L.V., and Chaubal, M.G. 1975. Saururaceae. V. Composition of essential oil from foliage of *Houttuynia cordata* and chemosystematics of Saururaceae. Phytochemistry (Oxf.) **38**: 92-96.

Tyler, V.E. 1984. Hazardous herbs - a brief review. Herb Spice Med. Plant Dig. **2**(1): 1, 2, 4, 6.

Tyler, V.E. 1985. Hoosier home remedies. Purdue University Press, West Lafayette, IN, USA. 212 pp.

Tyler, V.E. 1993*a*. The honest herbal. 3d ed. Pharmaceutical Products Press (Haworth Press), Binghamton, NY, USA. 375 pp.

Tyler, V.E. 1993*b*. Phytomedicines in western Europe -potential impact on herbal medicine in the United States. *In* Human medicinal agents from plants. *Edited by* A.D. Kinghorn and M.F. Balandrin. American Chemical Society, Washington, DC, USA. pp. 25-37.

Tyler, V.E. 1994. Herbs of choice - the therapeutic use of phytomedicinals. Pharmaceutical Press Inc., New York, NY, USA. 209 pp.

Tyner, G.E. 1975. The geography of California's culinary herb industry. The Herbarist **41**: 42-47.

Ucciani, E. 1995. Sources potentielles d'acide gamma-linolénique: une revue. Oléagineux Corps Gras Lipid. **2**: 319-322.

Ueda, Y., Sakaguchi, M., Hirayama, K., Miyajima, R., and Kimizuka, A. 1990. Characteristic flavor constituents in water extract of garlic. Agric. Biol. Chem. **54**: 163-169.

Ulubelen, A., and Öksüz, S. 1984. Eremophilenolides as oxidative artifacts of furanoeremophilanes. J. Nat. Prod. **47**: 177-178.

Ulubelen, A., Öksüz, S., Gören, N., Mabry, T.J., and Bohlmann, F. 1985. A furanoeudesmane from the fruits of *Smyrnium olusatrum*. Phytochemistry (Oxf.) **24**: 1105-1106.

Undset, S. 1945. Some notes upon the use of herbs in Norwegian households. The Herbarist **11**: 9-14.

Uphof, J.C. Th. 1968. Dictionary of economic plants. 2nd. ed. Verlag Von J. Cramer, Lehre, Germany. 591 pp.

Uribe-Hernández, C.J., Hurtado-Ramos, J.B., Olmedo-Arcega, E.R., and Matinez-Sosa, M.A. 1992. The essential oil of *Lippia graveolens* H.B.K. from Jalisco, Mexico. J. Ess. Oil. Res. **4**: 647-649.

U.S. Dep. Justice. 1992. Opium poppy cultivation and heroin processing in Southeast Asia. U.S. Department of Justice, Drug Enforcement Administration, Washington, DC, USA. 31 pp.

U.S. Dep. Justice. 1994. Worldwide heroin situation report -1992. U.S. Department of Justice, Drug Enforcement Administration, Washington, DC, USA. 45 pp.

Üstun, G., Kent, L., Çekin, N., and Civelekoglu, H. 1990. Investigation of the technological properties of *Nigella sativa* (black cumin) seed oil. J. Am. Oil Chem. Soc. **67**: 958-960.

Vadivel, B., Govindarasu, P., and Sampath, V. 1981. Effect of seed treatments with gibberellic acid on germination of *Perilla frutescens* Brit. Indian Perfum. **25**(2): 4-5.

Van Beck, T. A. 1991. Special methods for the essential oil of ginger. Mod. Method. Plant Anal. New Ser. **12**: 79-97.

Van Brunt, E.R. 1972. Lemon-verbena. Plants Gard. **28**(4): 56-57.

van der Walt, J.J.A. 1985. A taxonomic revision of the type section of *Pelargonium* L'Hérit. Bothalia **15**: 345-385.

van der Wait, J.J.A., Vorster, P.J., and Ward-Hilhorst, E. 1988. Pelargoniums of southern Africa. Vol. 3. Annals of Kirstenbosch Bot. Gard. 16.

Van Hooren, D.L., and Lester, H.R. 1992. Stevia drying in small scale bulk tobacco kilns. *In* Methods to utilize tobacco kilns for curing, drying and storage of alternate crops, final report. *Edited by* D.L. Van Hooren and H.R. Lester. Ontario Ministry of Agriculture and Food, Delhi, ON, Canada. pp. 159-164.

Van Pelt Wilson, H. 1947. Scented geraniums. The Herbarist **13**: 17-27.

van Soest, L.J.M. 1993. New crop development in Europe. *In* New crops - exploration, research, and commercialization. *Edited by* J. Janick and J.E. Simon. J. Wiley and Sons, New York, NY, USA. pp. 30-38.

Vaughan, J.G., and Hemingway, J.S. 1959. The utilization of mustards. Econ. Bot. **13**: 196-204.

Verhagen, L.C. 1988. Hop analysis. *In* Beer analysis. *Edited by* H.F. Linskens, J.F. Jackson, and S. Aastrup. Mod. Methods Plant Anal. New Ser. **7**: 67-87.

Verlet, N. 1990. New markets for herbs in France and Europe. Herb Spice Med. Plant Dig. **8**(2): 1-5.

Verlet, N. 1993. Commercial aspects. *In* Volatile oil crops: their biology, biochemistry and production. *Edited by* R.K.M. Hay and P.G. Waterman. Longman Scientific & Technical, Burnt Mill, Harlow, Essex, UK. pp. 137-174.

Vienne, M., Braemer, R., Paris, M., and Couderc, H. 1989. Chemotaxonomic study of two cultivars of *Artemisa dracunculus* L.: ("French" and "Russian" tarragon). Biochem. Syst. Ecol. **17**: 373-374.

Vilmorin-Andrieux et C^{ie} (Vilmorin, H. de, et Vilmorin, M. de). 1883. Les plante potagères. Vilmorin-Andrieux et C^{ie,} Paris, France. 650 pp. [Robinson, W. (Director of English Translation). 1885. The vegetable garden. John Murray, London, Great Britain. 620 pp.]

Vilmorin-Andrieux et C$^{ie.}$ 1884. Supp1ément aux fleurs de pleine terre. Vilmorin-Andrieux et C^{ie,} Paris, France. 203 pp.

Visvanath, S., Ravishankar, G.A., and Venkataraman, L.V. 1990. Induction of crocin, crocetin, picrocroccin, and safranal sythesis in callus cultures of saffron - *Crocus sativus* L. Biotechnol. Appl. Biochem. **12**: 336-340.

Vogelmann, J.E., and Gastony, G.J. 1987. Electrophoretic enzyme analysis of North American and eastern Asian populations of *Agastache* section *Agastache* (Labiatae). Amer. J. Bot. **74**: 385-393.

Vokou, D., Kokkini, S., and Bessière, J.-M. 1988. *Origanum onites* (Lamiaceae) in Greece: distribution, volatile oil yield, and composition. Econ. Bot. **42**: 407-412.

von Welanetz, D., and von Welanetz, P. 1982. The von Welanetz guide to ethnic ingredients. J.P. Tarcher, Inc., Los Angeles, CA, USA. 731 pp.

Wagner, J.J. 1979. The cultivation of parsley. Farm. S. Afr., **A.2**: 3 pp.

Wainwright, H., and Marsh, J. 1986. The micropropagation of watercress (*Rorippa nasturtium-aquaticum* L.). J. Hortic. Sci. **61**: 251-256.

Waller, G.R., and Johnson, R.D. 1984. Metabolism of nepetalactone and related compound in *Nepeta cataria* L. and components of its bound essential oil. Proc. Okla. Acad. Sci. **64**: 49-56.

Wallich, N. 1831. Plantae Asiaticae Rariores. Vol. 2. Treuttel and Würtz, London, U.K.

Wallis, K., and Dickieson, M. 1996. The root of success. Guelph Alumnus **29**(1): 17-21.

Wang, Y., Zhang, S., Burdette, M., and Craker, L.E. 1993. Seed germination in herbs. Herb Spice Med. Plant Dig. **11**(4): 1-5.

Wannmacher, L., and nine others. 1990*a*. Plants employed in the treatment of anxiety and insomnia. I. An ethnopharmacological survey in Porto Alegre, Brazil. Fitoterapia **61**: 445-448.

Wannmacher, L., and seven others. 1990*b*. Plants employed in the treatment of anxiety and insomnia. II. Effect of infusions of *Aloysia triphylla* on experimental anxiety in normal volunteers. Fitoterapia **61**: 449-453.

Ward, D.R. 1988. Flowers are a mine for a spice more precious than gold. Smithsonian 19 (Aug.): 104-111.

Warwick, S.I., and Black, L.D. 1991. Molecular systematics of *Brassica* and allied genera (subtribe Brassicineae, Brassiceae) - chloroplast genome and cytodeme congruence. Theor. Appl. Genet. **82**: 81-92.

Warwick, S.I., and Francis, A. 1994. Guide to the wild germplasm of *Brassica* and allied crops. Part V. Life history and geographical data for wild species in the tribe Brassiceae (Cruciferae). Agric. Can. Tech. Bull. **1994-2E**: 61 pp.

Watt, J.M., and Breyer-Brandwijk, M.G. 1962. The medicinal and poisonous plants of southern and eastern Africa. E. & S. Livingstone, London, U.K. 1457 pp.

Webster, H.N. 1936. Seven basils. The Herbarist **2**: 34-41.

Weiland, G.S., Broughton, L.B., and Metzger, J.E. 1935. Wormseed oil production. Univ. Md. Agric. Exp. Stn. Bull. **384**: 315-335.

Weinberg, J. 1978. Gourmet bouquet. Butterick Pub., New York, NY, USA. 159 pp.

Weiner, M.A. 1991. Earth medicine, earth foods: plant remedies, drugs, and natural foods of the North American Indians. Ballantine Books, New York, NY. 230 pp.

Weiss, G., and Weiss, S. 1985. Growing & using the healing herbs. Rodale Press, Emmaus, PA, USA. 360 pp.

Weiss, R.F. 1988. Herbal medicine. Beaconsfield Publishers Ltd., Beaconsfield, U.K. 362 pp.

Wester, P.J. 1911. Contributions to the history and bibliography of the roselle. Bull. Torrey Bot. Club **38**: 91-98.

Wester, P.J. 1912. Roselle, its cultivation and uses. Philip. Agric. Rev. **5**: 123-132.

Wester, P.J. 1920. The cultivation and uses of roselle. Philip. Agric. Rev. **13**: 89-99.

Wetherbee, A. 1986. History of violets. The Herbarist **52**: 14-19.

Weyerstahl, P., Marschall, H., Manteuffel, E., and Huneck, S. 1992. Volatile constituents of *Agastache rugosa*. J. Essent. Oil. Res. **4**: 585-587.

Whallon, A.P. 1954. Roselle: a forgotten plant. Org. Gard. **1**(4): 64-66.

Whallon, D., and Whallon, R. 1977. The herbal teas of Crete: thryba (*Satureja thymbra* L.). The Herbarist **43**: 43-45.

Widrlechner, M.P. 1981. History and utilization of *Rosa damascena*. Econ. Bot. **35**: 42-58.

Widrlechner, M.P. 1987. Mint family as plants for honeybee forage. *In* Proceedings of the second national herb growing and marketing conference. *Edited by* J.E. Simon and L. Grant. Purdue Research Foundation, West Lafayette, IN, USA. pp. 66-76.

Widrlechner, M.P. 1989. The national plant germplasm system: herb and spice resources. Herb Spice Med. Plant Dig. **7**(2): 1-4.

Widrlechner, M.P. 1992. A field evaluation of native mint family plants as honey bee forage in Iowa. *In* Proceedings of the twelfth North American Prairie Conference: recapturing a vanishing heritage. *Edited by* D.D. Smith and C.A. Jacobs. University of Northern Iowa, Cedar Falls, IA, USA. pp. 39-42.

Widrlechner, M.P., and Foster, S. 1991. Chinese medicinal plants in the U.S. National Plant Germplasm System. Herb Spice Med. Plant Dig. **9**(4): 1-5.

Wiebe, J., and Zubeckis, E. 1967 (reprinted 1969). Rhubarb -culture and physiology, chemistry and technology. Ontario Dep. Agriculture and Food. 32 pp.

Wijk, H.L.G. van. 1911. A dictionary of plant names. Martinus Nijhoff, The Hague, The Netherlands. 1444 pp.

Wilde, M.P. 1981. The best of ethnic home cooking. J.P. Tarcher Inc., Los Angeles, CA, USA. 336 pp.

Wiley, R.C., Schales, F.D., and Corey, K.A. 1989. Sweet corn. *In* Quality and preservation of vegetables. *Edited by* N.A. Eskin. CRC Press, Inc., Boca Raton, FL, USA. pp. 121-157.

Williams, B. 1994. Weddings and herbs. *In* Herbs '94. Proceedings ninth national herb growing and marketing conference. *Edited by* A. Kestner, J.E. Simon, and A.O. Tucker. International Herb Growers & Marketers Association, Mundelein, IL, USA. pp. 101-105.

Williams, L.O. 1973. Growing ginseng. U.S. Dep. Agric. Farmers' Bull. **2201**: 8 pp.

Williams, L.O., and Duke, J.A. 1978. Growing ginseng. U.S. Dep. Agric. Farmers' Bull. **2201**: 8 pp.

Williams, P.M. 1972. The ginseng mystique. Field Mus. Nat. Hist. Bull. **43**(2): 10-12.

Wilson, E.W. 1963. A study in ethnobotany. Gard. J. **13**: 206-208.

Wilson, F.D. 1994. The genome biogeography of *Hibiscus* L. section *Furcaria* DC. Genet. Resourc. Crop Evol. **41**: 13-25.

Wilson, F.D., and Menzel, M.Y. 1964. Kenaf (*Hibiscus cannabinus*), roselle (*Hibiscus sabdariffa*). Econ. Bot. **18**: 80-91.

Wilson, F.D., and Summers, T.E. 1966. Reaction of kenaf, roselle, and related species of *Hibiscus* to root knot nematodes. Phytopathology **56**: 687-690.

Wilson, L.A., Senechal, N.P., and Widrlechner, M.P. 1992. Headspace analysis of the volatile oils of *Agastache*. J. Agric. Food Chem. **40**: 1362-1366.

Winship, K.A. 1991. Toxicity of comfrey. Adverse Drug React. Toxicol. Rev. **10**: 47-59.

Woerner, M., and Schreier, P. 1991. The composition of volatiles from woodruff (*Galium odoratum* L. Scop.). Z. Lebensm.-Unters. -Forsch. **193**: 317-320. [In German]

Wolfe, L. 1972. Recipes: the cooking of the Caribbean Islands. Revised edition. Time-Life Books, New York, NY, USA. 144 pp.

Wood, J. 1957. On fennel - only slightly botanical. The Herbarist **23**: 31-34.

Wyse Jackson, P.S., and Akeroyd, J.R. 1993. *Cochlearia. In* Flora Europaea, Volume 1. 2nd edition. *Edited by* G.T. Tutin, N.A. Burges, A.O. Chater, J.R. Edmondson, V.H. Heywood, D.M. Moore, D.H. Valentine, S.M. Walters, and D.A. Webb. Cambridge University Press, U.K. pp. 378-380.

Xiao, P.-G. 1989. Excerpts of the Chinese Pharmacopoeia. Herbs Spices Med. Plants Recent Adv. Bot. Hortic. Pharmacol. **4**: 43-114.

Yamaguchi, M. 1973. Production of Oriental vegetables in the United States. Hortscience **8**: 362-370.

Yamaguchi, M. 1983. World vegetables. AVI Book, Van Nostrand Reinhold, New York, NY, USA. 415 pp.

Yamaguchi, M. 1990. Asian vegetables. *In* Advances in new crops. *Edited by* J. Janick and J.E. Simon. Timber Press, Portland, OR, USA. pp. 387-390.

Yamawaki, K., Morita, N., Murakami, K., and Murata, T. 1993. Contents of ascorbic acid and ascorbate oxidase activity in fresh herbs. J. Jpn. Soc. Food Sci. Technol. **40**: 636-640. [Partly in Japanese.]

Yamazaki, T. 1978. On *Limnophila aromatica* (Lam.) Merr. and *L. chinensis* (Osb.) Merr. J. Jpn. Bot. **53**: 312-313.

Yang, D-q. 1981. Cytotaxonomic studies on several species of *Panax* L. Acta Phytotax. Sinica **19**: 298-303. [In Chinese.]

Yang, L. 1985. Rosemary, right? Horticulture **63**: 46-49.

Yashiroda, K. 1968. A dictionary of popular Japanese herbs and their uses today. Plants Gard. (Brooklyn) **24**(2): 44-58.

Yawney, H.W. 1984. How to root and overwinter sugar maple cuttings. Amer. Nurseryman **160**(8): 95-96, 98-102.

Ye, J., Duhui, L., and Shengzhen, G. 1991. Application of the grey system theory in deciding climatic regions suitable to introduce *Panax quinquefolium*. Int. J. Biometeorol. **35**: 55-60.

Young, C. 1983. Traditional Chinese medicine. Plants Gard. (Brooklyn) **39**(2): 60-62.

Youngken, H.W., Jr. 1983. On herbal medicines - the last half century. The Herbarist **49**: 92-98.

Yuba, A., Honda, G., Koezuka, Y., and Tabata, M. 1995. Genetic analysis of essential oil variants in *Perilla frutescens*. Biochem. Genet. **33**: 341-348.

Zennie, T. M. 1987. Edible and poisonous plants of Indiana. *In* Proceedings of the second national herb growing and marketing conference. *Edited by* J.E. Simon and L. Grant. Purdue Research Foundation, West Lafayette, IN, USA. pp. 278-285.

Zeven, A.C., and de Wet, J.M.J. 1982. Dictionary of cultivated plants and their regions of diversity. Pudoc, Wageningen, Netherlands. 263 pp.

Zheng, S.Z., Shen, X.W., and Lu, R.H. 1990. The chemical constituents of *Elsholtzia ciliata* (Thunb.) Hyland. Acta Bot. Sin. **32**: 215-219. [In Chinese.]

Ziegler, J. 1989. A sweet spice for diabetics. Amer. Health Nov.: 96-97.

Zimmer, R.C. 1984. Cercospora leaf spot and powdery mildew of fenukgreek, a potential new crop in Canada. Can. Plant Dis. Surv. **64**: 33-34.

Zobel, A.M., and Brown, S.A. 1990. Dermatitis-inducing furanocoumarins on leaf surfaces of eight species of rutaceous and umbelliferous plants. J. Chem. Ecol. **16**: 693-700.

Zobel, A.M., and Brown, S.A. 1991. Dermatitis-inducing psoralens on the surfaces of seven medicinal plant species. J. Toxicol. Cutaneous Ocul. Toxicol. **10**: 223-231.

Zohary, D., and Hopf, M. 1993. Domestication of plants in the Old World. Second edition. Oxford University Press, New York, NY, USA. 278 pp.

Zou, Z.M., and Cong, P.Z. 1991. Studies on the chemical constituents from roots of *Agastache rugosa*. Acta Pharm. Sin. **26**(12): 906-910. [In Chinese]

Zverina, F.S. 1976. Libation herbs. The Herbarist **42**S: 61-65.

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