A Selected and Annotated BIBLIOGRAPHY of PITCH PINE (*Pinus rigida* Mill.)

by **Silas Little**
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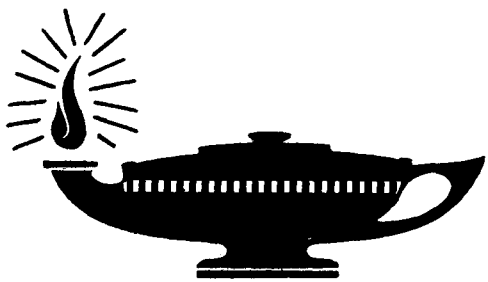

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RICHARD D. LANE, DIRECTOR

FOREWORD

THE AUTHORS have attempted to include in this bibliography all articles that contain significant original information about pitch pine or that are comprehensive reviews. Secondary sources, such as textbooks that briefly review the literature on specific subjects, are omitted. Articles on local floras are included only if they provide new, revised, or more detailed information about the distribution or abundance of pitch pine.

The bibliography is undoubtedly incomplete. Significant articles in foreign languages may have escaped our notice—as well as some published in this country. In addition, publications on new research results will soon make this bibliography out of date. The authors will welcome references to articles that should be included in any revision.

The table of contents lists the subjects under which the references have been placed. The arrangement is by (1) subject, (2) author in alphabetical order, and (3) date of publication. Papers that include information on more than one of the subject categories are listed only under the subject most strongly emphasized in the paper. Consequently, users of this bibliography should examine references listed under related subjects for papers that might be pertinent to their interests. For example, references to papers dealing with prescribed burning may be found in four places: (1) in the section on *Silviculture and Management* under *Natural Regeneration;* in the section on *Forest Ecology* under both (2) *Plant Sociology* and (3) *Atmospheric and Biotic Relations;* and (4) in the section on *Forest Damage and Protection* under *Fire*.

To facilitate use of the bibliography, an index of authors is included. This index is arranged alphabetically by authors' surnames and initials, and it lists for each author or co-author the numbers of references included in the bibliography. A few committee reports and government publications are listed under the titles of the organization or committee, but only those in which the principal author is not identified.

Though in the annotations the authors attempted to abstract very briefly the information in each paper, the abstracts are necessarily incomplete.

THE AUTHORS

SILAS LITTLE is a principal silviculturist for the Northeastern Forest Experiment Station, Upper Darby, Pa. He received his B.S. degree from Massachusetts State College and M.F. and Ph.D degrees from Yale University. Since 1936 he has been employed by the USDA Forest Service, mostly on silvicultural and fire research in New Jersey, Maryland, and Pennsylvania. Several of his studies in New Jersey have dealt with pitch pine.

JACK McCORMICK is chairman of the Department of Ecology and Land Management of The Acadamy of Natural Sciences of Philadelphia. His degrees include a B.S. from Butler University and a Ph.D from Rutgers University. He was formerly in charge of vegetation studies at The American Museum of Natural History and later was an assistant professor of botany at Ohio State University. He became interested in pitch pine while studying the vegetation of the New Jersey Pine Barrens for his Ph.D thesis.

JOHN W. ANDRESEN is chairman of the Forestry Department of Southern Illinois University, Carbondale. He received his B.S. degree from the New York State University College of Forestry at Syracuse University and his Ph.D. degree from Rutgers University. He taught at Rutgers University and Michigan State University before going to Southern Illinois University. Like McCormick, he became interested in pitch pine while a graduate student at Rutgers University.

CONTENTS

DISTRIBUTION & RESOURCE STATISTICS

Distribution

1. Ashe, W. W.
   1893. **Notes on the forest resources of North Carolina.** J. Elisha Mitchell Sci. Soc. 10: 5-25.
   Pitch pine occurs in Surry, Wilkes, Caldwell, Burke, McDowell, and Polk Counties as well as in the mountain counties south of the French Broad River.

2. Bartholomew, Elizabeth Ann.
   1948. **Flora of Wirt County, West Virginia.** Castanea 13: 145-166.
   Occurrence of pitch pine is mentioned.

3. Besley, F. W.
   1916. **The forests of Maryland.** 152 pp., illus. Md. State Board Forestry.
   Pitch pine occurs in southern, central, and western Maryland, but not on the Eastern Shore.

4. Bicknell, Eugene P.
   1908. **The ferns and flowering plants of Nantucket.** Torrey Bot. Club Bull. 35: 49-62.
   Pitch pine is the most abundant and conspicuous tree on Nantucket Island.

5. Billings, W. D., S. A. Cain, and W. B. Drew.
   1937. **Winter key to the trees of eastern Tennessee.** Castanea 2: 29-44.
   Pitch pine is included in the key and is listed among trees occurring in Great Smoky Mountains National Park.

6. Blakeslee, A. F., and C. D. Jarvis.
   1911. **New England trees in winter.** Conn. Agr. Exp. Sta. Bull. 69. 576 pp., illus. Storrs.
   Contains a key to tree species and a description of each, including its range, especially in New England. Pitch pine occurs rarely in Litchfield County, but is common elsewhere in Connecticut.

7. Brooks, A. B.
   1920. **West Virginia trees.** W. Va. Agr. Exp. Sta. Bull. 175. 242 pp., illus.
   Contains a key to and description of tree species in West Virginia. Pitch pine occurs in 27 West Virginia counties, mostly on dry sandy soils of hillsides.

8. Brown, H. P.
   1921. **Trees of New York State, native and naturalized.** N. Y. State Coll. Forestry Tech. Pub. 15. 433 pp., illus.
   Briefly describes the habit, leaves, flowers, fruit, bark, habitat,

range, and use of pitch pine. Contains leaf, fruit, and twig keys to the New York species.

9. Burnham, Stewart H.
1913. **The flora of the sand barrens of southern Staten Island.** Torreya 13: 249-255.
Between Rossville and Kreischerville, Staten Island, N. Y., pitch pine occurs in sandy wastes, along with blackjack, post, and black oaks. Other associated plants are mentioned.

10. Carr, Lloyd G.
1940. **Further notes on coastal flora elements in the bogs of Augusta County, Virginia.** Rhodora 42: 86-93.
Pitch pine occurs in Magnolia Swamp.

11. Chittenden, Alfred K.
1905. **Forest conditions of northern New Hampshire.** U. S. Dep. Agr. Bur. Forestry Bull. 55. 100 pp., illus.
Pitch pine occurs chiefly on sandy soils in the Saco watershed, especially near Silver and Ossipee Lakes. Most pitch pine stands have been burned repeatedly, and trees are short and stunted.

12. Core, Earl L.
1950. **Notes on the plant geography of West Virginia.** Castanea 15: 62-79, illus.
Pitch pine occupies large areas in the Appalachians on dry ridges, flats, and slopes, often in pure stands, and especially on old fields. Pitch pine occurs in 28 counties—in the shale barrens and in the scrub oak, chestnut oak, scarlet oak-black oak, shortleaf pine-scrub pine, and white pine-chestnut oak-chestnut types.

13. Critchfield, William B., and Elbert L. Little, Jr.
1965. **Geographic distribution of the pines of the world.** U. S. Dep. Agr. Misc. Pub. 991. 97 pp., illus.
Briefly describes and illustrates the range of pitch pine. Pitch pine is thought to cross naturally with shortleaf and loblolly pines and to intergrade in Delaware and southern New Jersey with pond pine.

14. Dayton, William A.
1953. **Geography of commercially important United States trees.** J. Forestry 51: 276-279.
Pitch pine is merely listed as a species occurring only east of the Mississippi River.

15. Deam, Charles C.
1931. **Trees of Indiana.** Ind. Dep. Conserv. Pub. 13. 326 pp., illus.
Though pitch pine had been reported in Clark County, it is not native.

16. Deane, Walter.
1909. **Notes from Shelburne, New Hampshire.** Rhodora 11: 21-22.

Pitch pine occurs in limited numbers in Coos County, the largest tree being 60 feet tall. (See also Rhodora 12: 99.)

17. Dutlinger, F. H.
1923. **The Sproul State Forest.** Forest Leaves 19: 24-26.
Pitch pine formed the original stands at higher elevations in the Sproul Forest of Clinton and Centre Counties, Pa.

18. Eggleston, W. W., George L. Kirk, and J. G. Underwood.
1915. **Flora of Vermont. List of ferns and seed plants growing without cultivation.** Vt. Agr. Exp. Sta. Bull. 187: 139-258.
Pitch pine is common on sandy soil in the northern Champlain Valley and in the Connecticut Valley north to Wells River.

19. Ferguson, William C.
1925. **Ferns and flowering plants of the Hempstead Plains, Long Island, New York.** Torreya 25: 109-113.
Pitch pine is common south of Hicksville, near the edge of the Plains.

20. Fernald, M. L.
1901. **Notes on some trees and shrubs of western Cheshire County, New Hampshire.** Rhodora 3: 232-236.
Pitch pine occurs on the Drewsville sand plain and on lower slopes of Fall Mountain to an elevation of 1,100 feet.

21. Fernald, M. L.
1919. **Lithological factors limiting the ranges of *Pinus banksiana* and *Thuja occidentalis*.** Rhodora 21: 41-67, illus.
The range of pitch pine in New England is briefly discussed.

22. Fogg, John M., Jr.
1930. **The flora of the Elizabeth Islands, Massachusetts.** Rhodora 32: 147-161, 226-258.
Pitch pine occurs occasionally, as at the east end of Naushon Island.

23. Freer, Ruskin S.
1950. **A preliminary checklist of plants of the central Virginia Blue Ridge.** Castanea 15: 1-37.
Pitch pine is listed as occurring in Bedford, Botetourt, Amherst, Rockbridge, Nelson, and Augusta Counties.

24. Graves, Arthur H.
1910. **Woody plants of Brooklin, Maine.** Rhodora 12: 173-184, illus.
In Brooklin (near Mt. Desert Island) pitch pine is rather rare, but is locally abundant in one tract.

25. Graves, C. B., *et al.* (Committee of Conn. Bot. Soc.).
1910. **Catalogue of the flowering plants and ferns of Connecticut.** Conn. Geol. and Natur. Hist. Surv. Bull. 14. 569 pp.
Pitch pine is rare in Litchfield County, but common elsewhere on sandy soils.

26. Griggs, Robert F.
1914. **Observations on the behavior of some species at the edges of their ranges.** Torrey Bot. Club Bull. 41: 25-49, illus.
On sandstone soils in Fairfield County, Ohio, pitch pine is common, fruits abundantly, and has many seedlings although it is at the edge of its range.

27. Hanmer, Charles C.
1940. **Plants of Fishers Island.** Torreya 40: 65-81.
A few old pitch pines occur on Fishers Island, N. Y.

28. Harper, Arthur R.
1951. **The conifers of Ohio.** Ohio Conserv. Bull. 15(3): 8-9, 28-29, illus.
Pitch pine occurs in almost every county of southeastern Ohio, with colonies as far north as Columbiana, Jefferson, Belmont, Guernsey, and Licking Counties.

29. Harper, Roland M.
1908. **The pine-barrens of Babylon and Islip, Long Island.** Torreya 8: 1-9, illus.
The Pine Barrens of Long Island, N. Y., are mostly in the southern half of Suffolk County, but extend a few miles into Nassau County —with patches west to near Hicksville. Plants associated with pitch pine are listed for both upland and swamp sites.

30. Harper, Roland M.
1914. **The coniferous forests of eastern North America.** Pop. Sci. Mo. 84: 338-361, illus.
Although pitch pine occurs from New Brunswick west to Ohio and south to northern Georgia, extensive stands are limited to southeastern Massachusetts, eastern Long Island, and southern New Jersey—usually on sites of little value for agriculture.

31. Harper, Roland M.
1919. **A forest reconnaissance of the Delaware Peninsula.** J. Forestry 17: 546-555, illus.
Pitch pine, which is rare elsewhere on the Peninsula, predominates in the coastal strip toward Cape Henlopen. This species is occasional in a Choptank zone, frequent in a Pocomoke zone.

32. Harper, Roland M.
1921. **Cape Cod vegetation.** Torreya 21: 91-98, illus.
On Cape Cod, Mass., pitch pine is more abundant than all other trees combined. Associated species are listed.

33. Harshberger, John W.
1910. **The vegetation of the Navesink Highlands.** Torreya 10: 1-10, illus.
In the Navesink Highlands on the northeastern Coastal Plain of New Jersey, pitch pine occurs occasionally on summits and slopes in predominantly deciduous forests.

34. Harshberger, John W.
1911. **Phytogeographic survey of North America.** 790 pp., illus. Wilhelm Englemann, Leipzig; G. E. Stechert & Co., New York.

Occurrence of pitch pine and associated plants is mentioned in Kittatinny Mountains of northern New Jersey, the Pennsylvania Poconos, New Jersey dunes, New England islands, New England hill tops and sand plains, Long Island, New Jersey Pine Barrens, Maryland and Virginia, southeastern Pennsylvania, Pennsylvania mountains, southern Appalachians, lake region of New York, and Ohio.

35. Hawes, Austin F.
1923. **New England forests in retrospect.** J. Forestry 21: 209-224.

Pitch pine forests occurred on drier soils and were boxed by early settlers for tar and turpentine. Lack of underbrush in coastal forests was due to fires set by Indians.

36. Hill, Albert F.
1914. **Notes on the flora of the Penobscot Bay Region, Maine.** Rhodora 16: 189-192.

Pitch pine occurs on Mount Desert, Mount Champlain at Isle au Haut, and at Brooklin.

37. Hitchcock, A. S., and Paul C. Standley.
1919. **Flora of the District of Columbia and vicinity.** U. S. Nat. Mus. Contrib. U. S. Nat. Herb. 21: 13-329, illus.

Pitch pine occurs on sandy soil, scattered among Virginia pines.

38. Hollick, Arthur.
1902. **Geological and botanical notes: Cape Cod and Chappaquidick Island, Mass.** N. Y. Bot. Gard. Bull. 2: 381-407, illus.

Most trees near Provincetown are pitch pine and oaks. Pitch pine has been planted or seeded to stabilize dunes.

39. Hollick, Arthur.
1924. ***Pinus rigida,* Eastern pitch pine.** Addisonia 9: 45-46, illus.

Briefly describes the range, distinguishing characteristics, and wood of pitch pine.

40. House, Homer Doliver.
1910. **The vegetation of Lookingglass Mountain.** Torreya 10: 29-34, illus.

Pitch pine occurs along the backbone of Lookingglass Mountain and on adjacent dry ridges, and is common in the adjacent region of Transylvania County, N. C. Associated plant species are mentioned.

41. House, Homer D.
1924. **Annotated list of the ferns and flowering plants of New York State.** N. Y. State Mus. Bull. 254. 759 pp.

Pitch pine is generally distributed throughout the State below 1,500 feet altitude on dry rocky or sandy soil. Pitch pine is very common on Long Island and Staten Island, on hills up the Hudson Valley, on sand plains between Albany and Schenectady, and west of Lake Champlain.

42. Hyland, Fay.
1946. **The conifers of Maine.** Maine Ext. Bull. 345. 20 pp., illus.
Contains a key to native coniferous species and a description of each, including appearance, bark, leaves, fruit, and occurrence. Pitch pine is found chiefly in barrens of southern Maine and on sandy soil or rocks northeastward along the coast to Hancock, Waldo, Kennebec, and Oxford Counties.

43. Hyland, Fay, and Ferdinand H. Steinmetz.
1944. **The woody plants of Maine, their occurrence and distribution.** Univ. Maine Stud. Second Ser. 59. 72 pp., illus.
Pitch pine is frequent and locally abundant but is sporadic northeastward. It is found throughout Maine on sandy soils or rocks south of Latitude 44°30'N. except in Waldo County.

44. Illick, Joseph S.
1926. **Common trees of New Jersey.** 107 pp., illus. Amer. Tree Assoc., Wash., D. C.
Gives distinguishing characteristics of various species, including pitch pine. Briefly describes its distribution in New Jersey.

45. Illick, Joseph S.
1928. **Pennsylvania trees.** Ed. 5, Pa. Dep. Forests and Waters Bull. 11. 237 pp., illus.
Keys to and descriptions of each species. The chestnut-rock (chestnut) oak-pitch pine type is widely distributed on mountain slopes in eastern, southern, south-central, and north-central Pennsylvania; and pitch pine is also a principal member of the scrub oak type in south-central and northeastern Pennsylvania. Pitch pine is rare in southeastern and southwestern Pennsylvania, but forms excellent pure stands in Franklin, Centre, Huntingdon, and Pike Counties.

46. Jones, Herbert L.
1892. **Catalogue of the phanerogams and ferns of Licking County, Ohio.** Denison Univ. Sci. Lab. Bull. 7: 1-103, illus.
Pitch pine is listed as rare on dry, rocky hillsides.

47. Kearney, Thomas H., Jr.
1897. **The pine barren flora in the east Tennessee mountains.** Plant World 1: 33-35.
Pitch pine occurs on sandy flats along French Broad River in Cocke County, Tennessee.

48. Keller, Ida A., and Stewardson Brown.
1905. **Handbook of the flora of Philadelphia and vicinity.** 360 pp. Phila. Bot. Club, Phila.

Localities are cited for pitch pine in seven counties of Pennsylvania and New Castle County, Delaware.

49. King, Wilbur L.
1912. **The flora of Northampton County, Pennsylvania.** Torreya 12: 97-107, illus.
Pitch pine occurs on dry, sandy, or rocky soil in the county.

50. Knoblock, Irving William.
1935. **Some recent observations on and additions to the flora of western New York.** Torreya 35: 7-10.
Pitch pine occurred sparingly along the Allegany River, and some seedlings of this species have been planted in Allegany State Park.

51. Knowlton, C. H.
1900. **On the flora of Chesterville, Maine.** Rhodora 2: 123-124.
Pitch pine is the common pine on a large sand plain in Franklin County.

52. Knowlton, C. H., J. A. Cushman, Walter Deane, and A. K. Harrison.
1908. **Reports on the flora of the Boston District—II.** Rhodora 10: 59-64.
Pitch pine is abundant on dry soils.

53. Latham, Roy.
1934. **Flora of the State Park, Orient, Long Island, N. Y.** Torreya 34: 139-149.
Pitch pine is common on ridges of sand and gravel. Associated species are mentioned.

54. Littlefield, E. W.
1928. **An uncommon association of pines in northern New York.** Rhodora 30: 129-131.
Pitch pine occurs on both sides of Lake Champlain, and is abundant in Ausable Valley to Ausable Forks. Near Clintonville, N. Y., one area contained stems of pitch, jack, red, and white pines.

55. Lyford, Charles A., and Louis Margolin.
1906. **Forest conditions in southern New Hampshire.** N. H. Forestry Comn. 1905-06 Rep.: 161-276, illus.
Pitch pine and scrub oak occupy areas northeast of Lake Winnipesaukee; these sites have coarse sand or gravel soils and have been burned repeatedly. Similar areas occur elsewhere.

56. Lyon, Charles J., and James W. Goldthwait.
1934. **An attempt to cross-date trees in drowned forests.** Geogr. Rev. 24: 605-614, illus.
Pitch pine occurs at Scarboro, near Portland, Maine; and pitch pine stumps have been found there under marsh and at Provincetown, Mass., under sand.

57. McAtee, W. L.
1916. **Plants collected on Matinicus Island, Maine, in late fall, 1915.** Rhodora 18: 29-45.
On Matinicus Island (18 miles from Rockland) numerous pitch pines grow on a rocky hill and on Northeast Point. Many are badly deformed, and others have been killed by the wind (salt spray?).

58. McCauley, O.D.
1951. **The woody plants of Coopers Rock State Forest.** Castanea 16: 49-63.
Pitch pines occurs along Quarry Run on the drier sites in Monongalia County, West Virginia.

59. McCormick, Jack, and John W. Andresen.
1963. **The role of *Pinus virginiana* Mill. in the vegetation of southern New Jersey.** N. J. Natur. News 18: 27-38, illus.
Map shows boundaries of pitch pine barrens, oak-pine fringe, and Virginia pine areas in southern New Jersey. Pitch pine covered 9 percent of the ground in a 67-year-old Virginia pine stand on formerly tilled land in Cumberland County.

60. McVaugh, Rogers.
1935. **Recent changes in the composition of a local flora.** Torrey Bot. Club Bull. 62: 479-489.
Pitch pine occurs in dry woods near Kinderhook, Columbia County, New York.

61. Millspaugh, C. F.
1913. **The living flora of West Virginia.** W. Va. Geol. Surv. V (A): 1-389, illus.
Pitch pine occurs in six counties.

62. Morton, B. R., and R. G. Lewis.
1917. **Native trees of Canada.** Canada Dep. Interior Forestry Br. Bull. 61. 233 pp., illus.
Pitch pine is usually about 30 feet tall and 6 to 8 inches in diameter. Brief descriptions of form, bark, twigs, leaves, and cones are given. Pitch pine barely extends into Canada, being found in New Brunswick, Quebec, and Ontario (at Thousand Islands).

63. Morton, B. R., R. G. Lewis, G. A. Mulloy, and G. C. Cunningham.
1963. **Native trees of Canada.** Canada Dep. Forestry Bull. 61. 6th ed., 291 pp., illus.
Pitch pine is found on Thousand Islands and adjacent mainland in Ontario, in Chateauguay County, Quebec, and reportedly in New Brunswick.

64. Munns, E. N.
1938. **The distribution of important forest trees of the United States.** U. S. Dep. Agr. Misc. Pub. 287. 176 pp., illus.
A map shows botanical distribution of pitch pine as known at that time.

65. Murrill, William Alphonso.
1920. **An excursion to Mountain Lake, Virginia.** Torreya 20: 116-119.
Pitch pine occurs on Brush Mountain near Blacksburg.

66. Newberry, J. S.
1860. **Catalogue of the flowering plants and ferns of Ohio.** Ohio State Board Agr. 14th Annu. Rep. (1859): 235-273.
Pitch pine is listed from central and southern Ohio.

67. Nichols, George E.
1920. **The vegetation of Connecticut. VI. The plant associations of eroding areas along the seacoast.** Torrey Bot. Club Bull. 47: 89-117, illus.
On many rocky islands pitch pines predominates.

68. Ogden, E. S., F. H. Steinmetz, and F. Hyland.
1948. **Check-list of the vascular plants of Maine.** Josselyn Bot. Soc. Bull. 8. 70 pp., illus.
Pitch pine occurs in 11 of the 16 counties of Maine.

69. Ohmann, Lewis F., and Murray F. Buell.
1968. **Forest vegetation of the New Jersey Highlands.** Torrey Bot. Club Bull. 95: 287-298.
Pitch pine occurs to a limited extent, mostly at high elevations and on sandy soils.

70. Pepoon, H. S.
1927. **An annotated flora of the Chicago Area.** Chicago Acad. Sci. Natur. Hist. Surv. Bull. 8. 554 pp., illus.
Pitch pine is naturalized on sand flats north of Waukegan, Ill.

71. Pinchot, Gifford, and W. W. Ashe.
1897. **Timber trees and forests of North Carolina.** N. C. Geol. Surv. Bull. 6. 227 pp., illus.
Pitch pine occurs in the western part of the Piedmont and in the mountains south of French Broad River.

72. Radford, Albert E., Harry E. Ahles, and C. Ritchie Bell.
1968. **Manual of the vascular flora of the Carolinas.** 1183 pp., illus. Univ. N. C. Press, Chapel Hill.
Pitch pine occurs on poor soils in low mountains, but rarely in the Piedmont. Dot map shows that pitch pine grows in 24 North Carolina counties and 4 South Carolina counties.

73. Rigg, G. B., and P. D. Strausbaugh.
1949. **Some stages in the development of sphagnum bogs in West Virginia.** Castanea 14: 129-148, illus.
Pitch pine occurs in Big Droop Bog, Pocahontas County, at 3,060 feet elevation—along with red spruce, hemlock, white pine, red maple, and blackgum.

74. Rouleau, Ernest.
1955. ***Pinus rigida* Miller in Quebec.** Rhodora 57: 299.
A natural stand of pitch pine, growing with some white and red pines, covers about a square mile at Cairnside in Chateauquay County.

75. Schaffner, John H.
1921. **Additions to the catalog of Ohio vascular plants for 1920.** Ohio J. Sci. 21: 128-135.
Pitch pine occurs near Marietta, Washington County.

76. Selby, A. D., and J. W. T. Duvel.
1899. **Sources of the Ohio flora.** Columbus Hort. Soc. Proc. 14: 35-39.
Pitch pine is listed as a typical species in the unglaciated southeastern part of Ohio and the glaciated hills of southwestern Ohio.

77. Shanklin, John F.
1954. **Natural areas.** J. Forestry 52: 375-383.
Two natural areas of the pitch pine type are in George Washington National Forest, Augusta and Rockingham Counties, Virginia.

78. Small, John K., and Anna Murray Vail.
1893. **Report of the botanical exploration of southwestern Virginia during the season of 1892.** Torrey Bot. Club. Mem. 4: 93-201, illus.
Pitch pine was found on Peak Mountain at 2,200 feet elevation and on Round Top Mountain at 2,600 feet.

79. Smith, L. B., *et al.*
1933. **Reports on the flora of Massachusetts—II.** Rhodora 35: 351-359.
Pitch pine is common on sandy soil in southeastern Massachusetts, frequent elsewhere in eastern Massachusetts, only occasional westward.

80. Stone, Witmer.
1911. **The plants of southern New Jersey with especial reference to the flora of the Pine Barrens and the geographic distribution of the species.** N. J. State Mus. Annu. Rep. 1910: 21-828, illus.
Contains keys for identification and brief description of geographic distribution. Pitch pine, though occurring occasionally in the North and Middle Districts, is called the common pine of the Pine Barrens.

81. Svenson, H. K.
1923. **Plant notes from Squam Lake, New Hampshire.** Rhodora 25: 183-185.
Pitch pine occurs on southern slopes of Rattlesnake Mt.

82. Taber, William S.
1960. **Delaware trees: a guide to the identification of the**

native tree species. Del. State Forestry Dep Ed. 2, 254 pp., illus.

Describes tree form, leaves, bark, buds, flowers, fruit, seed, wood, distribution, and habitat of pitch pine. In Delaware pitch pine is present in all counties, but chiefly in Sussex County.

83. Tatnal, Robert R.
1946. **Flora of Delaware and the Eastern Shore.** An annotated list of the ferns and flowering plants of the peninsula of Delaware, Maryland and Virginia. 313 pp., illus. Del. Soc. Natur. Hist. Wilmington.

Pitch pine occurs usually as scattered trees in dry woods, swamps, and coastal sand dunes—infrequent in New Castle County but more common in Sussex County and southward.

84. Taylor, Norman.
1915. **Flora of the vicinity of New York, a contribution to plant geography.** N. Y. Bot. Gard. Mem. 5:1-683, illus.

Pitch pine is the predominant tree in the New Jersey Pine Barrens and is common on Long Island. It is found throughout Connecticut, New Jersey, southeastern New York, and eastern Pennsylvania, decreasing northward in all these states.

85. Tidestrom, Ivar.
1913. **Notes on the flora of Maryland and Virginia—I.** Rhodora 15: 101-106.

Pitch pine is a northern tree, not found on the Virginia Coastal Plain. It is common in the mountains, as at Cumberland, Md., and Covington, Va., where it grows with table-mountain pine and white pine. In the Coastal Plain north of Lewes, Del., and in the Piedmont, it grows with Virginia pine and sometimes with loblolly pine.

86. Transeau, E. N., and P. E. Williams.
1929. **Distribution maps of certain plants in Ohio.** Ohio Biol. Surv. Bull. 20: 179-217, illus.

Distribution of pitch pine in Ohio and neighboring portions of Pennsylvania, West Virginia, and Kentucky, is shown on county outline map.

87. Twitchell, D. G., and M. B. Harris.
1925. **Some results of the first season's work at the University of Maine's summer biological station at Mt. Desert Island (1924). Part II. Pitch pine region, Pickett Mountain.** Maine Natur. 5: 11-23, illus.

Pitch pine occurs on the southern slope in the scanty soil of ledges, but is stunted. Associated plants and fauna are listed or briefly described.

88. Vermeule, C. C.
1900. **The forests of New Jersey.** N.J. State Geol. Annu. Rep. 1899: 13-101, 137-172, illus.

Pitch pine, usually accompanied by scrub oak, occurs on rocky mountain crests (Kittatinny, Bearfort, Green Pond, and Copperas) in northern New Jersey and on the highest sandy ground in the Pine Region of southern New Jersey. Heights, diameters, and yields of some pitch pine stands are given. Especially along the edges of the Pine Region, oaks replace pine after latter is cut; but in abandoned clearings pure pine stands develop. Some large fires in the Pine Region are described.

89. Weatherby, C. A., C. H. Knowlton, and R. C. Bean.
1926. **Fifth report of Committee on Floral Areas., Preliminary lists of New England plants—XXX.** Rhodora 28: 43-46.

Pitch pine occurs chiefly in the three southern states, but also at low altitudes in Champlain, Connecticut, Androscoggin, and lower Kennebec valleys, near Lake Ossipee, N. H., and along the Maine coast to Mt. Desert Island.

90. Wiegand, Karl M., and Arthur J. Eames.
1925. **The flora of the Cayuga Lake Basin, New York. Vascular plants.** Cornell Univ. Agr. Exp. Sta. Mem. 92. 491 pp., illus.

Pitch pine is frequent in the Basin on scattered ravine crests, on high hills south of Ithaca, along lake cliffs, and on sands north of the Lake.

Resource Statistics

91. Armstrong, George R., and John C. Bjorkbom.
1956. **The timber resources of New York.** USDA Forest Serv. NE Forest Exp. Sta., 37 pp., illus. Upper Darby, Pa.

The area in pitch pine and pitch pine-oak types was reported to be 161,000 acres; and as a major type pitch pine is restricted mostly to a portion of Long Island.

92. Clepper, Henry E.
1936. **The Mont Alto State Forest.** J. Forestry 34: 30-35. 522.

In 1934, 87 percent of the 23,537 acres of the Forest (in Franklin and Adams Counties, Pa.) was in the mixed oak-pitch pine type; 6 percent of the stems 4 inches and larger in diameter (b.h.) were pitch pines.

93. Conway, Emmett A.
1950. **Timber survey of the Hocking State Forest.** Ohio Agr. Exp. Sta. Res. Circ. 3. 29 pp., illus.

Pitch pine is very aggressive on farmland abandoned since 1900 in Hocking County, Ohio. Tabular data indicate density, volume, mean diameter, cull percentage, and growth rate. Pitch pine is sixth among species in board-foot volume.

94. Cook, H. O.
1929. **A forest survey of Massachusetts.** J. Forestry 27: 518-522.

The pitch pine-oak type made up 8 percent of the forest land, but some pitch pine areas were also included in the 2 percent of "other softwoods". Only about 10 percent of the type had stands with trees 6 inches and larger in diameter. Bear oak prevails among oaks in frequently burned areas, tree oak species elsewhere.

95. Craig, Ronald B.
1949. **Virginia forest resources and industries.** U. S. Dep. Agr. Misc. Pub. 681. 64 pp., illus.

The shortleaf-pitch pine type covers 573,900 acres of commercial forest land in the mountains of western Virginia, occurring as bands on the eastern slopes. A type map indicates distribution. The volume of pitch pine exceeds that of shortleaf pine.

96. Ferguson, Roland H.
1958. **The timber resources of Pennsylvania.** USDA Forest Serv., NE. Forest Exp. Sta. 46 pp., illus. Upper Darby, Pa.

The pitch-Virginia pine type covers 210,000 acres of commercial forest land, the yellow pine-oak type 153,000 acres, and the oak-pitch pine type 81,000 acres. Pitch pine sawtimber and growing-stock volumes are about three times those of Virginia pine.

97. Ferguson, Roland H.
1964. **The timber resources of West Virginia.** USDA Forest Serv. Resource Bull. NE-2. 123 pp., illus. NE. Forest Exp. Sta., Upper Darby, Pa.

Growing-stock volume in pitch and Virginia pines on commercial forest land was 234 million cubic feet. Map shows general location of main forest types, including shortleaf-pitch pine.

98. Ferguson, Roland H.
1967. **The timber resources of Maryland.** USDA Forest Serv. Resource Bull. NE-7. 93 pp., illus. NE. Forest Exp. Sta., Upper Darby, Pa.

The southern pine type covers 600,000 acres, and oak-pine type 299,000 acres, but only small amounts of pitch pine are included therein.

99. Ferguson, Roland H.
1968. **The timber resources of Pennsylvania.** USDA Forest Serv. Resource Bull. NE-8. 147 pp., illus. NE. Forest Exp. Sta., Upper Darby, Pa.

The Virginia-pitch pine type covers 208,000 acres of commercial forest land in Pennsylvania, the oak-pine type 135,000 acres. Volumes in other yellow pines (presumably mostly pitch pine) are far more than in Virginia pine: in sawtimber volume five times that in Virginia pine.

100. Ferguson, Roland H., and Milford C. Howard.
1956. **The timber resource in Massachusetts.** USDA Forest Serv. NE. Forest Exp. Sta. 45 pp., illus. Upper Darby, Pa.
The pitch pine type covers 114,000 acres, pitch pine-oak type 51,000 acres, and oak-pitch pine 46,000 acres of commercial forest land. Volumes include 36 million board feet of pitch pine sawtimber and 47 million cubic feet of pitch pine growing stock. As a major type, pitch pine occurs chiefly in Barnstable and Plymouth Counties.

101. Ferguson, Roland H., and Franklin R. Longwood.
1960. **The timber resources of Maine.** USDA Forest Serv., NE. Forest Exp. Sta., 75 pp., illus. Upper Darby, Pa.
The pitch pine and jack pine types cover 15,000 acres in Maine.

102. Ferguson, Roland H., and John R. McGuire.
1957. **The timber resources of Rhode Island.** USDA Forest Serv., NE. Forest Exp. Sta. 38 pp., illus. Upper Darby, Pa.
The oak-pitch pine type covers 3,000 acres.

103. Northeastern Forest Experiment Station.
1954. **Forest statistics for New York Forest District No. 13.** USDA Forest Serv. NE. Forest Exp. Sta. 19 pp. Upper Darby, Pa.
In Orange, Rockland, Sullivan, and Ulster Counties there are 14.4 million cubic feet of pitch pine growing stock or 53.2 million board feet of sawtimber. Pitch pine types cover about 3 percent of the commercial forest land.

104. Northeastern Forest Experiment Station.
1954. **Forest statistics for New York District No. 15.** USDA Forest Serv. NE. Forest Exp. Sta. 19 pp. Upper Darby, Pa.
In 1950 the pitch pine type covered 88,200 acres of commercial forest land on Long Island. Pitch pine volumes were 44.6 million board feet of sawtimber or 21.9 million cubic feet of growing stock.

105. Northeastern Forest Experiment Station.
1955. **Forest statistics for New York.** USDA Forest Serv. NE. Forest Exp. Sta. 63 pp., illus. Upper Darby, Pa.
The pitch pine type, in which pitch pine forms 75 percent or more of the stand, covers 107,800 acres, or 1 percent of the commercial forest area of the State.

106. Northeastern Forest Experiment Station.
1955. **The timber resource in Maryland.** USDA Forest Serv. NE. Forest Exp. Sta. 41 pp., illus. Upper Darby, Pa.
Pitch pine-Virginia pine, pitch pine-Virginia pine-oak, and oak-pitch pine-Virginia pine forest types occupy 16 percent of the commercial forest land in Maryland. Pitch pine volumes are estimated as 85 million board feet of sawtimber, 37 million cubic feet of growing stock.

107. Webster, Henry H., and Carl H. Stoltenberg.
1958. **The timber resources of New Jersey.** USDA Forest Serv. NE. Forest Exp. Sta. 41 pp., illus. Upper Darby, Pa.
Pitch, shortleaf, and Virginia pine types cover 534,000 acres; hard pine-oak and oak-hard pine, 261,000 acres. Pitch pine sawtimber and growing-stock volumes are given as 222 million board feet and 132 million cubic feet.

BOTANICAL CHARACTERISTICS

Taxonomy

108. Allard, H. A.
1940. **A globose form of pitch pine *(Pinus rigida)* in Virginia.** Rhodora 42: 308.
A technical description of a new form, *globosa,* based on a single tree near Hopewell Gap, Fauquier County. The tree was 7.5 feet tall, 6.5 inches in diameter at base, and had a crown spread of 12 feet.

109. Anonymous. (G. H. Collingwood?)
1936. **Pitch pine. *Pinus rigida* Miller.** Amer. Forests 42: 224-225, illus.
Briefly describes the range, species characteristics (including leaves, flowers, cones, sprouts), wood, and site requirements. Pitch pine seed is mentioned as a food source for squirrels, quail, and small birds.

110. Best, G. N.
1890. **A preliminary study of the seed-wings of the Abietineae.** Microscope 10(1): 1-6.
Briefly describes the cell structure of the seed wings in pitch pine, indicating differences from other species.

111. Clausen, Robert T.
1939. **Contributions to the flora of New Jersey.** Torreya 39: 125-133.
Range is not a basis for distinguishing pitch pine from pond pine, and the nature of the prickles on cone scales is too variable; so length of leaves is the best criterion. Specimens considered typical of pond pine were collected from three counties in southern New Jersey, and specimens intermediate between pitch and pond pines from two counties.

112. Duffield, J. W.
1952. **Relationships and species hybridization in the genus *Pinus*.** Silvae Genetica 1: 93-97.
Taxonomic arrangements in the sub-genus Diploxylon by Pilger and by Shaw were reviewed and revised on the basis of hybridization results and supplementary evidence from biochemistry, anat-

omy, and morphology. Pitch pine was placed in group XI, made up of pines of the southeastern United States.

113. Engelmann, George.
1886. **Revision of the genus *Pinus*, and description of *Pinus Elliottii*.** Acad. Sci. St. Louis Trans. 4: 161-190, illus.
Briefly describes cotyledonous, primary, and secondary leaves of pines; size of pollen grains, retention of cones, number of cotyledons, flower and needle structure of pitch pine. The author could not distinguish pitch and pond pines because of variability in each.

114. Everett, T. H.
1946. **Plant portraits.** Gard. Chron. Amer. 50: 14-15, illus.
A brief description of the distinguishing characteristics of pitch pine, its role, and wood uses.

115. Fiske, Jessie G.
1935. **Fruits and seeds of some common New Jersey trees.** N. J. Agr. Exp. Sta. Circ. 355. 52 pp., illus.
Contains a brief description of pitch pine flowers, fruit, and seed.

116. Gordon, George, and Robert Glendinning.
1858. **The Pinetum: being a synopsis of all the coniferous plants at present known, with descriptions, history, and synonymes, and comprising nearly one hundred new kinds.** 353 pp. Henry G. Bohn, London.
Synonyms listed for *Pinus rigida* are *P. taeda rigida* Aiton, *P. fraseri* Loddiges, *P. canadensis trifolia* DuHamel, and *P. loddigesii* Loudon. Leaves, branches, cones, and seeds of pitch pine are described, as well as its height and distribution.

117. Harger, E. B.
1899. ***Liquidambar* at Greenwich, Connecticut.** Rhodora 1: 130-131.
A pitch pine near Stamford had leaves 7 inches long.

118. Harlow, W. M.
1931. **The identification of the pines of the United States, native and introduced, by needle structure.** N. Y. State Coll. Forestry Tech. Pub. 32. 21 pp., illus.
A brief description of terms, then a key followed by plates and a brief description for each species. Length of pitch pine needles is listed as 7 to 14 cm., the number as three per fascicle; and the distribution of resin canals, nature of hypoderm, structure of endodermis, and number of fibrovascular bundles are described.

119. Illick, J. S.
1921. **The hard pines of the Northeast.** Amer. Forestry 27: 487-496, illus.
Keys to the pine species. Common names of pitch pine are listed; and some effects of fires, distinguishing characters of pitch pine, and its role in forestry are described briefly.

120. Kellerman, W. A.
1892. **Note on yellow pitch pine.** Bot. Gaz. 17: 280.
A form of pitch pine having thinner, scarcely furrowed, reddish-yellow bark and deeper yellow, more durable heartwood was found in Fairfield County, Ohio, and was named *P. rigida* var. *lutea* Kellerman.

121. Little, Elbert L., Jr.
1944. **Notes on nomenclature in Pinaceae.** Amer. J. Bot. 31: 587-596.
Includes discussion of scientific names and authorities for calling pond pine either a variety of pitch pine or a separate species.

122. Loudon, J. C.
1838. **Arboretum et fructicetum britannicum.** 8 vols. (vol. 4: 2239-2242, illus.) Published by author, London.
Gives synonyms of *Pinus rigida* and brief descriptions of leaves, buds, cones, seed, and wood—as well as a description of pitch pine distribution and sites. Mentions production of tar from pitch pines of northern states, other uses of the wood, and the planting of pitch pine in England before 1759.

123. Michaux, F. Andrew.
1819. **The North American sylva, or a description of the forest trees, of the United States, Canada and Nova Scotia.** Vol. 3, 286 pp., illus. C. D. 'Hautel, Paris.
A scientific description of pitch pine, and a brief description of its buds, leaves, aments, cones, bark, growth habits, and wood, as well as the distribution. Cones open on some trees the first autumn, but "on solitary stocks" remain closed for several years. Mentions occurrence of pitch pine near Brunswick, Maine, and Burlington, Vermont; on the ridges of the Alleghenies; and in southern New Jersey and Maryland. Pitch pine withstands flooding by sea-water and commonly grows on sandy soils. It reaches heights of 70 to 80 feet and diameters of 20 to 28 inches. Describes uses of wood, including the production of tar in New England, New Jersey, and the Allegheny Mountains (last for Ohio River shipbuilders).

124. Miller, Philip.
1768. ***Pinus. In* Gardener's Dictionary, Ed. 8.** London: printed for author.
Contains original, but exceedingly brief description of pitch pine in Latin and English.

125. Sargent, Charles Sprague.
1897. ***Pinus rigida.* Pitch pine. *In* The silva of North America, a description of the trees which grow naturally in North America exclusive of Mexico. Vol. 11, Coniferae (*Pinus*):** 115-118, illus. Houghton, Mifflin and Company, Boston and New York.
Cites authors dealing with the nomenclature of pitch pine, and gives detailed descriptions of leaves (including primary leaves of

sprouts), bark, buds, form, flowers, cones, and seeds. Briefly describes the distribution of the species and the sites it inhabits; the wood and its uses; the production of turpentine and tar from pitch pine stands of New England and the Middle Atlantic States.

126. Sargent, Charles Sprague.
1933. **Manual of the trees of North America (exclusive of Mexico).** Ed. 2, 910 pp., illus. Houghton Mifflin Company, Boston and New York.
Leaves, flowers, fruit, seeds, bark, wood, tree form, and geographic distribution of pitch pine are described.

127. Shaw, George Russell.
1914. **The genus *Pinus*.** Arnold Arboretum Pub. 5. 96 pp., illus.
Describes genus characters for cotyledon, bud and branchlet, primary and secondary leaves, flowers, cones, seeds, wood and bark. For each species, including pitch pine, descriptions of shoots, leaves, cones, and range are given. Pitch pine cones are rarely serotinous, but the species is placed in the Insignes group.

Chemistry, Physiology, and Morphology (Including radiation effects)

128. Abbe, Lucy B., and A. S. Crafts.
1939. **Phloem of white pine and other coniferous species.** Bot. Gaz. 100: 695-722, illus.
Phloem is described in detail, including changes associated with sieve-tube initiation, maturation, senility, and death. Pitch pine is mentioned as one of the species investigated.

129. [Avebury] Lubbock, Sir John.
1892. **A contribution to our knowledge of seedlings.** 2 vol., 608 + 646 pp., illus. Kegan Paul, Trench, Trubner & Co., London.
Pitch pine seedlings have four to six acicular cotyledons, which reach a length of 1.4 to 1.6 cm. The primary root tapers downward, unbranched for some time after germination. The hypocotyl is 8 to 18 mm. long, erect, glabrous, deep glaucous-green, and stained with red near base. Cotyledons and primary and secondary leaves are described.

130. Bailey, I. W., and W. W. Tupper.
1918. **Size variation in tracheary cells: I. A comparison between the secondary xylems of vascular cryptogams, gymnosperms, and angiosperms.** Amer. Acad. Arts and Sci. Proc. 54: 149-204, illus.
In pitch pine wood more than 60 rings from the pith, the maximum, minimum, and mean lengths of tracheids were 5.3, 3.2, and 4.0 mm.

131. Bean, W. J.
1909. ***Pinus rigida.*** Gardeners' Chron. 45: 178-179, illus.
Some of the planted pitch pines in England are described, as well as their leaves, buds, cones, and short twigs along boles. Planted trees have reached 75 feet in height and 11 feet in girth. Illustration shows clusters of cones on one tree.

132. Chang, Ying-Pe.
1954. **Bark structure of North American conifers.** U. S. Dep. Agr. Tech. Bull. 1095. 86 pp., illus.
Describes specific and generic characteristics, diagnostic features, and significance of bark structure, and gives an artificial key to families and genera. Pitch pine was one of the species studied, but no specific description of its bark is presented.

133. Hong, S. O.
1963. **The effect of some growth regulators upon the development of male gametophyte of pitch pine.** Korean Inst. Forest Genet. Res. Rep. 3: 57-60, illus.
To induce male sterility in pitch pine, gibberellin, 2,4-D, phosfon, and some other compounds were tried as sprays. 2,4-D was the most effective, but damaged trees.

134. Jackson, Robert Tracy.
1899. **Localized stages in development in plants and animals.** Boston Soc. Natur. Hist. Mem. 5: 89-153, illus.
Of 100 pitch pine seedlings, 55 had 5 cotyledons; the others had 4, 6, or 7 (1 seedling had 7). Gives detailed descriptions of cotyledons and primary and mature leaves, and mentions where these occur on seedlings and sprouts. Includes several drawings of pitch pine.

135. Mergen, François, and T. Strøm Johansen.
1963. **Effect of ionizing radiation on microsporogenesis in *Pinus rigida* Mill.** Radiat. Bot. 3: 321-331, illus.
Trees receiving 82 r/day and higher since November were unable to resume cell division in the spring. At 56 r/day meiosis occurred, but viable microspores were collected at no higher levels than 11 r/day. At even lower levels strobili length was adversely affected, and the proportion of cells with visible chromosome aberrations was increased. Pollen abortion increased as radiation was increased.

136. Mergen, François, and T. Strøm Johansen.
1964. **Effect of ionizing radiation on seed germination and seedling growth of *Pinus rigida* (Mill.).** Radiat. Bot. 4: 417-427, illus.
Pitch pine seeds in cones on the trees were exposed to gamma irradiation from 0.36 r/day to 840 r/day, with total exposures up to 22,700 r. Germination was not affected at rates up to 130 r/day and a total of 16,000 r. At 295 r/day germination was reduced after 8,000 r. At 6,000 to 8,000 r, root length was stimulated, and fresh weight increased, but overall growth was reduced

above 8,000 r. Within 2 years differences in seedling height between irradiated and control seeds had disappeared.

137. Mergen, F., and G. R. Stairs.
1962. **Low level chronic gamma irradiation of a pitch pine-oak forest—its physiological and genetical effects on sexual reproduction.** Radiat. Bot. 2: 205-216, illus.
Stages in the development of normal pitch pine flowers are briefly described. With an increase in gamma radiation accumulated by trees, the cone length, seed germination, and height of resulting seedlings all declined. Under certain circumstances seed stored in cones could regenerate a pitch pine forest killed by radiation.

138. Mergen, François, and G. R. Stairs.
1963. **Cumulative radiation effects on sexual reproduction in pine and oak.** Forest Tree Impr. Comm. Pub. 22(1962 Forest Genet. Workshop Proc.): 79-87, illus.
Pitch pines severely damaged by low-level radiation did differentiate floral structures and produce viable seed, but flower phenology was retarded, pollen abortion increased and pollen germination decreased, morphological aberrations occurred, and resulting seedlings showed several abnormalities.

139. Mergen, François, and G. R. Stairs.
1963. **Progeny test from a pitch pine-oak forest damaged by low level chronic gamma radiation.** NE. Forest Tree Impr. Conf. Proc. 10: 3-8, illus.
Decrease in germination of pitch pine seed was not associated with radiation accumulated by seed lot, but with total dose received by the parent tree before and during seed formation. At the cotyledon stage seedlings from irradiated seed were significantly shorter. Pitch pine was more sensitive than associated oaks.

140. Meyer, Bernard S.
1928. **Seasonal variations in the physical and chemical properties of the leaves of the pitch pine, with especial reference to cold resistance.** Amer. J. Bot. 15: 449-472, illus.
Total water content of mature pitch pine leaves does not vary markedly with season, but is lowest in late spring. During summer months leaves are easily killed by freezing in an ice-salt bath, but in winter are not killed—possibly because of increase in colloidal gels that increase the proportion of bound water. Sugar content of leaves is high in winter, and this may also be important in cold resistance.

141. Meyer, Bernard S.
1932. **Further studies on cold resistance in evergreens, with special reference to the possible role of bound water.** Bot. Gaz. 94: 297-321, illus.
Pitch pine branches collected in winter have leaves resistant to cold even if first kept at greenhouse temperatures for 3 weeks. Foliage

of summer-collected branches is very susceptible. Summer foliage has greater amounts of bound and free water, but there is no evidence that bound water accounts for pitch pine's cold resistance.

142. Mirov, N. T.
1951. **Composition of gum turpentines of pines: a report on *Pinus echinata, P. rigida,* and *P. ponderosa* from Utah.** Amer. Pharm. Assoc. J. Sci. Ed. 40: 410-413.
Similar information as in 1961 paper.

143. Mirov, N. T.
1961. **Composition of gum turpentines of pines.** U. S. Dep. Agr. Tech. Bull. 1239. 158 pp., illus.
The turpentine yield of pitch pine oleoresin, and the physical properties and chemical composition of turpentine, are described for one sample collected near Asheville, N. C.

144. Murrill, W. A.
1901. **The generative divisions in Gymnosperms.** Torreya 1: 131-132.
A brief description of the division of the pitch pine pollen ovule into two cells, one taking an active part in fertilization and the smaller one becoming a total loss.

145. Parr, Thaddeus.
1943. **Voltage gradients in trees as an indicator of susceptibility to insect attack.** J. Forestry 41: 417-421, illus.
Millivoltage data for potted pitch pines 3 to 5 feet tall. Negative values were obtained in winter; positive values of 7 to 20 mv. were obtained during the growing season.

146. Shaw, George Russell.
1907. **Characters of *Pinus:* the lateral cone.** Bot. Gaz. 43: 205-209, illus.
In pines having uninodal shoots, the position of the pistillate flower is subterminal; but in multinodal shoots, such as pitch pine may have, the position may be subterminal or lateral or both.

147. Smith, Richard H.
1967. **Monoterpene composition of pine species and hybrids.** USDA Forest Serv. Res. Note PSW-135. 14 pp. Pacific Southwest Forest & Range Exp. Sta., Berkeley, Calif.
The hybrid *rigida* X *taeda* had a composition generally intermediate between the two parents.

148. Smith, William H.
1969. **Release of organic materials from the roots of tree seedlings.** Forest Sci. 15: 138-143, illus.
Root exudates of 18-day-old seedlings of pitch pine, three other pines, and black locust were analyzed by thin-layer chromatography. Of the four pines, pitch pine released the lowest amount of soluble compounds. Compounds released by pitch pine in-

cluded glucose and sucrose, eight amino acids or amides, and three organic acids.

149. Spalt, Karl W., and William E. Reifsnyder.
1962. **Bark characteristics and fire resistance: a literature survey.** USDA Forest Serv. S. Forest Exp. Sta. Occas. Paper 193. 19 pp., illus. New Orleans, La.
Presents previously unpublished data obtained by P. W. Stickel on the ratio of outer bark to total bark for pitch pines 5, 10, and 50 years old and on moisture content of bark at different seasons (minimum in winter). Stickel concluded that fire resistance of pitch pine boles is due to the deep-seated location of the periderm from an early age—so that the cork layer is constantly being augmented by a great amount of phloem that assumes a cork-like character.

150. Sparrow, A. H., L. A. Schairer, and G. M. Woodwell.
1965. **Tolerance of *Pinus rigida* trees to a ten-year exposure to chronic gamma irradiation from cobalt-60.** Radiat. Bot. 5: 7-22, illus.
After 8 years of exposure, 50 percent of the trees were killed by rates of 3.1 r/day; after 10 years 20 percent were killed by rates as low as 2.5 r/day. None survived cumulative exposures above 13 kr. Radial increment and needle length were reduced—50 percent growth reduction at about 3 r/day. Number of mature seeds was reduced to about 10 percent of the control by average exposure of 3.5 r/day, and no cones formed above 7.4 kr cumulative exposure.

151. Sparrow, A. H., and G. M. Woodwell.
1962. **Prediction of the sensitivity of plants to chronic gamma irradiation.** Radiat. Bot. 2: 9-26, illus.
Both vegetative growth and the sexual reproductive process of pines seem highly susceptible to radiation, and pines are among the most sensitive plants known. Detectable effects were found on pitch pine at rates as low as 2 r/day over 9-year period. Reasons for sensitivity of pines are their large nuclear volume and the long period involved in sexual reproduction. *Gaylussacia baccata* is one of the most resistant of the associated species.

152. Stairs, G. R., and F. Mergen.
1964. **Potential uses of irradiated pollen in forest genetics.** NE. Forest Tree Impr. Conf. Proc. 11: 38-41.
As much as 70 percent of pitch pine pollen that had been exposed to radiation levels up to 30,000 r germinated, and 61 percent of the pollen that had been exposed to 300,000 r germinated after storage for 10 months in a refrigerated desiccator.

153. Tepper, Herbert B.
1963. **Leader growth of young pitch and shortleaf pines.** Forest Sci. 9: 344-353, illus.
Leader elongation often involves formation and elongation of

several buds. Winter buds of pitch pine are often multinodal: the basal internode expands first, then the second, and later the third (if any)—and each achieves its peak growth after the one below it. As internodes elongate, terminal bud forms, but in pitch pine this only occasionally elongates as a summer shoot in the same season. Height growth may take 2½ to 4 months in New Jersey, but 90 percent occurs in about 65 days.

154. Williams, Allette L., and M. H. Bannister.
1962. **Composition of gum turpentines from twenty-two species of pines grown in New Zealand.** J. Pharm. Sci. 51(10): 970-975, illus.

Yield of turpentine from pitch pine in New Zealand was 17.8 percent. Its chemical composition is described.

155. Woodwell, G. M., and Lee N. Miller.
1963. **Chronic gamma radiation affects the distribution of radial increment in *Pinus rigida* stems.** Sci. 139: 222-223, illus.

Exposure to rates of 1 to 5 r/day for several years reduces radial increment throughout pitch pine stems, but especially near the base. Trees with large crowns showed little effect at low exposures except during drought years.

156. Woodwell, G. M., and A. L. Rebuck.
1967. **Effects of chronic gamma radiation on the structure and diversity of an oak-pine forest.** Ecol. Monogr. 37: 53-69.

Pitch pine was the most sensitive plant, and it was selectively killed over the largest area. It was eliminated from a devastated zone where all indigenous plants were killed, from a zone where *Carex* was the principal survivor, from a shrub zone where *Carex* and shrubs survived, and from an oak-forest zone where pines were killed. Factors affecting species survival are discussed.

157. Woodwell, G. M., and A. H. Sparrow.
1963. **Predicted and observed effects of chronic gamma radiation on a near-climax forest ecosystem.** Radiat. Bot. 3: 231-237, illus.

Shoot growth and mortality of pitch pine and five associated woody species that were subjected to radiation were compared with responses predicted on the basis of nuclear volume and chromosome number. Pitch pine and the other species were generally more sensitive than predicted.

158. Yim, K. B.
1963. **Karotype analysis of *Pinus rigida*.** Hereditas 49: 274-276, illus.

The haploid karotype of pitch pine has six chromosomes, each with secondary constriction. However, the author's data were not entirely consistent.

Races and Hybrids

159. Ahn, K. Y.
1963. **Studies on interspecific hybridization in the sub-genus Diploxylon of genus Pinus.** Korean Inst. Forest Genet. Res. Rep. 3: 29.
Controlled pollinations were made between *P. rigida* and *P. densiflora, P. elliottii, P. taeda, P. echinata,* or *P. radiata.* Much fertile hybrid seed was obtained by crossing *P. rigida* and *P. radiata,* but the cross between *P. rigida* and *P. taeda* was the most promising. Growth rate, cold hardiness, and some other characteristics were intermediate between parents.

160. Austin, Lloyd.
1929. **The Eddy Tree Breeding Station.** Madroño 1: 203-227, illus.
G. S. Perry reported a natural hybrid between pitch and shortleaf pines near Mt. Alto, Pa.

161. Hyun, S. K.
1962. **Improvement of pines through hybridization.** Int. Union Forest Res. Organ. Proc. 13th Congr. vol. 1, part 2, sect. 22, paper 11. 11 pp.
Presents data on growth of 3-year-old pitch-loblolly hybrids compared to pitch pine, and discusses the mass production of hybrids, source of pollen, and other breeding efforts for pitch pine hybrids in Korea.

162. Hyun, Sin Kyu.
1962. **Mass production of control-pollinated seed of conifers.** Fifth World Forestry Congr. Proc. 2: 787-791.
Similar to other articles on pitch-loblolly hybrids in Korea, but in somewhat more detail.

163. Hyun, Sin-kyu, and Kun-Yong Ahn.
1959. **Mass production of pitch-loblolly hybrid pine (X *Pinus rigitaeda*) seed.** Korean Inst. Forest Genet. Res. Rep. 1: 11-24, illus.
For 5 years 10- to 14-year-old pitch pine plantations have been used to mount 11,000 to 30,000 pollination bags. Pitch pine flowers were pollinated with loblolly pine pollen imported from U. S. A.; 20 seeds were obtained per cone from the crossing. Costs are given for different steps.

164. Hyun, Sin-kyu, and Kun-Yong Ahn.
1959. **Principal characteristics of X *Pinus rigitaeda.*** Korean Inst. Forest Genet. Res. Rep. 1: 35-50, illus.
Pitch-loblolly pine hybrids are intermediate between parent species in rapidity of germination, length and width of needle, length of needle sheath, needle color, and cold hardiness. In form and size of cones and seeds and the distribution of vascular bundles in the leaf, hybrids resemble pitch pine. Growth over 3 years is superior to that of pitch pine.

165. Hyun, Sin Kyu, Chung Suk Kim, and Suk Goo Lee.
1967. **A study on the variants of *Pinus rigida* X (*P. rigida* X *P. taeda*) appeared in the forest nursery.** Korean Inst. Forest Genet. Res. Rep. 5: 1-18, illus.

Backcross hybrids were classed into four types based on length and form of needles. These types differed in chromosome number, height growth, width and thickness of needles, number of resin canals in needles, stomata length, length and thickness of tracheids, and diameter and behavior of pollen grains.

166. Hyun, Sin Kyu, and Kun Hoe Koo.
1964. **Some characteristics of backcross hybrids of X *Pinus rigitaeda*.** Korea Min. Agr. and Forestry Office Rural Develop. 7(2): 63. (English summary only). (Also 1965. Korean Inst. Forest Genet. Res. Rep. 4: 11).

Backcrosses with loblolly pine outgrew crosses of F_1 hybrid and pitch pine, but the latter were distinctly more cold-hardy.

167. Hyun, Sin Kyu, Kun Hoe Koo, Sung Ho Hong, and Bo Sik Lee.
1967. **Some characteristics of X *Pinus rigida* • *radiata*.** Korean Inst. Forest Genet. Res. Rep. 5: 33-42, illus.

The hybrid has intermediate characteristics in form of cone, seed, and needle, and has shown good cold hardiness and better growth than pitch pine in South Korea.

168. Keng, Hsuan, and Elbert L. Little, Jr.
1961. **Needle characteristics of hybrid pines.** Silvae Genetica 10(5): 131-146, illus.

Lists the needle number and length, the number of cell layers in the hypodermis, and the number and position of resin canals for loblolly, pond, and pitch pines and for hybrids between each of the other two species and pitch pine.

169. Kim, Chung Suk, Suk Koo Lee, and Min Sup Chung.
1967. **Studies on artificial polyploid forest trees. IV. On some characteristics of induced polyploids of *Pinus rigida* Mill.** Korean Inst. Forest Genet. Res. Rep. 5: 19-31, illus.

The results of morphological and cytological investigations are described for three types of colchiploids obtained from treating pitch pine seeds with colchicine.

170. Koo, Kun Hoe, and Sung Ho Hong.
1967. **Tracheid length and compression strength of X *Pinus rigitaeda* and its backcross hybrid.** Korean Inst. Forest Genet. Res. Rep. 5: 85-90.

Tracheid length of the hybrid was about the same as that of loblolly pine, and longer than that of pitch pine. A backcross to pitch pine was intermediate between parents in some respects.

171. Little, Elbert L., Jr., and Francis I. Righter.
1965. **Botanical descriptions of forty artificial pine hybrids.** U. S. Dep. Agr. Tech. Bull. 1345. 47 pp., illus.

Botanical descriptions of artificial hybrids between pitch pine and

shortleaf, loblolly, or pond pines, and brief descriptions of their growth at Placerville, California.

172. Little, Elbert L., Jr., Silas Little, and Warren T. Doolittle.
1967. **Natural hybrids among pond, loblolly, and pitch pines.** USDA Forest Serv. Res. Paper NE-67. 22 pp., illus. NE. Forest Exp. Sta., Upper Darby, Pa.
Discusses the comparative characteristics of the three species and their hybrids, the importance of distinguishing the species in forestry practice, and the possible role of pitch-loblolly hybrids. Botanical descriptions of the species and hybrids are given, and their distribution is described, especially in the Northeast.

173. Little, S., and H. A. Somes.
1951. **No exceptional vigor found in hybrid pines tested.** USDA Forest Serv. NE. Forest Exp. Sta. NE. Res. Note 10. 4 pp. Upper Darby, Pa.
Hybrids of pitch X loblolly pine grew well on a poor site in New Jersey, but were outgrown by ordinary loblolly pine stock on a moister site in Maryland. Shortleaf X pitch hybrids grew slower than shortleaf pine stock of the same age, and many of these hybrids still had a prostrate form 6 years after planting in both states.

174. Lorenz, R. W., and J. N. Spaeth.
1953. **The growth of two hybrid pines tested in southern Illinois.** Univ. Ill. Agr. Exp. Sta. Forestry Note 38. 2 pp.
Shortleaf X pitch hybrids tried were worthless. Pitch X loblolly hybrids were more cold-hardy than loblolly and shortleaf pines, and almost equal in growth rate to shortleaf pine, but much slower than loblolly pine. Its cold-hardiness may make the pitch X loblolly hybrid valuable in Illinois.

175. Schmitt, Dan.
1968. **Performance of southern pine hybrids in south Mississippi.** USDA Forest Serv. Res. Paper SO-36. 15 pp., illus. S. Forest Exp. Sta., New Orleans, La.
Data on 6-year survival and growth of plantings that included pitch pine from New Jersey and hybrids of pitch and loblolly or pond pines. Survival and growth of these were relatively low.

Silvical Characteristics

176. Andresen, John W.
1957. **Precocity of *Pinus rigida* Mill.** Castanea 22: 130-134, illus.

Staminate flowers were observed in the greenhouse on one seedling 22 months old, and in the field on a 2-year-old seedling shortly after planting. Two 2-year-old seedlings bore female flowers that developed into mature cones. One cone yielded 18 seeds, only 1 viable. Two cones had 44 to 57 seeds, about half of which germinated.

177. Baker, Frederick S.
1949. **A revised tolerance table.** J. Forestry 47: 179-181.

In a survey of 55 foresters, species were classified by degree of tolerance. The majority called pitch pine intolerant; others called it intermediate; and still others classed it as very intolerant.

178. Brown, Harry P.
1912. **Growth studies in forest trees. I. *Pinus rigida* Mill.** Bot. Gaz. 54: 386-403, illus.

Describes cambial activity and the formation of double rings in pitch pine. Its histological characteristics do not differ widely from the normal for conifers. Growth near Ithaca, N. Y., began by 15 April in 20- to 25-year-old trees below the apical shoot and spread upward. Growth spreads down the main axis faster than along laterals, but spread is affected by conditions of insolation and other factors.

179. Cain, Stanley A.
1940. **The identification of species in fossil pollen of *Pinus* by size-frequency determinations.** Amer. J. Bot. 27: 301-308, illus.

From measurements of grain lengths (exclusive of wings) of 150 pollens of each of the 12 species of *Pinus* native to the eastern United States, size-frequency curves were developed. Grains of pitch pine pollen had a mean length of 61.9 microns and could not be separated from those of *P. palustris.*

180. Choi, S. K., and M. R. Kim.
1963. **Plus trees in Korea. II.** Korean Inst. Forest Genet. Res. Rep. 3: 85-94, illus.

Three selected pitch pines 25 years old were 12.4 to 16.6 m. tall and 25.1 to 25.9 cms. d.b.h.

181. Cook, David B.
1941. **The period of growth in some Northeastern trees.** J. Forestry 39: 956-959, illus.

Planted pitch pine 4½ feet tall grew 13.5 inches in height during

59 days, starting 12 May 1940 at Stephentown, Rensselaer County, New York.

182. Deevey, Edward S., Jr.
1939. **Studies on Connecticut lake sediments. I. A postglacial climatic chronology for southern New England.** Amer. J. Sci. 237: 691-724 illus.
Sizes of pollen grains of different species of pines are too variable and overlap, preventing accurate separation of pitch pine pollen grains from those of white, red, and jack pines. Pollen grains of pitch pine in this study were 39 to 55 microns long.

183. Dixon, Dorothy.
1961. **These are the champs. Part II.** Amer. Forests 67(2): 41-47, illus.
A pitch pine near Mays Landing, N.J., was reported to be 97 feet tall, with a circumference of 8 feet 3 inches.

184. Dorman, Keith W., and John C. Barber.
1956. **Time of flowering and seed ripening in southern pines.** USDA Forest Serv. SE. Forest Exp. Sta. Sta. Paper 72. 15 pp., illus. Asheville, N. C.
In 1954 pitch pine pollen ripened between 29 April and 11 May in Buncombe County, N. C., at a 2,300-foot elevation; between 8 April and 29 April in California at a 2,700-foot elevation.

185. Duffield, J. W.
1953. **Pine pollen collection dates—annual and geographic variation.** USDA Forest Serv. Calif. Forest and Range Exp. Sta. Res. Note 85. 9 pp. Berkeley, Calif.
Over a 6-year period the collection of pitch pine pollen at Eddy Arboretum varied from 17 April to 10 May, with a mean date of 26 April.

186. Emig, W. H.
1935. **The megagametophyte of *Pinus*. I. Introduction.** Amer. J. Bot. 22: 500-503, illus.
Describes stages in the development of the gametophyte of *Pinus*. The percentage of viable seeds depends on seasonal differences and may be less than 1 percent of the ovules in pitch pine. Continued growth of the gametophyte depends on food supply from digestion of nucellus, which requires an adequate supply of water. Extent of development in ovules aborting at different ages is described.

187. Ferguson, Margaret C.
1904. **Contributions to the knowledge of the life history of *Pinus* with special reference to sporogenesis, the development of the gametophytes and fertilization.** Wash. Acad. Sci. Proc. 6: 1-202, illus.
A report on a detailed study of pollen grains, ovules, and of fertilization, with frequent references to and numerous illustra-

tions of pitch pine. Pistillate cones collected in mid-March consisted of broad axis with marginal bract initials, but no evidence of ovules. Ovules were apparent in cones collected in late April to early May, and by 8 May nucellus and integument were differentiated. Number of archegonia per ovule varies from one to five, but usually is three. Mitosis of antheridial cells was observed from mid-April to mid-May. Pollen grains germinate and tubes develop within 2 days of pollination.

188. Fowells, H. A.
1965. **Silvics of forest trees of the United States.** U. S. Dep. Agr. Agr. Handb. 271. 762 pp., illus.
Contains a revision of the paper by S. Little (1959), dealing with the silvical characteristics of pitch pine. It includes a revised map of the range of pitch pine.

189. Gifford, John.
1896. **Forest fires in New Jersey.** Franklin Inst. J. 142: 102-110.
Dormant buds along the boles of large pitch pines may sprout after a fire or after the stem is cut.

190. Illick, J. S.
1919. **When trees grow.** Pa. Forest Leaves 17: 60-64.
In Pennsylvania, pitch pine often begins a second period of terminal growth 10 to 25 days after the first growth ceases. As a result, fictitious rings are formed.

191. Kienholz, Raymond.
1934. **Leader, needle, cambial, and root growth of certain conifers and their interrelations.** Bot. Gaz. 96: 73-92, illus.
Near Keene, N. H., 97 percent of the leader elongation of pitch pine occurred between 15 May and 15 July. Needle elongation began about 15 May, reached a maximum in late June, and ceased in early September. The needles grew from a meristematic region at their base and did not elongate during the second year.

192. Little, S.
1941. **Calendar of seasonal aspects for New Jersey forest trees.** Pa. Forest Leaves 31(4): 1-2, 13-14, illus.
On the basis of 3 years' observations, dates are given for the times when staminate flowers become visible, leaf buds burst, leader growth begins, pistillate flowers are visible, pollen-shedding begins and ends, leaves and fruit are full grown, and seed dispersal begins and ends. Pitch pine, shortleaf pine, Atlantic white-cedar, and eight associated hardwoods are included. Effects of exposure, tree size, frost, and individual variation are discussed.

193. Little, S.
1959. **Silvical characteristics of pitch pine (*Pinus rigida*).** USDA Forest Serv. NE Forest Exp. Sta. Sta. Paper 119. 22 pp., illus. Upper Darby, Pa.

Describes the range; habitat conditions (climate, soils, physiographic, and biotic relations—including use by deer, rabbits, birds, mice, and squirrels; the associated trees, shrubs, fungi, and insects); seeding habits, including flowering, fruiting, seed production, and dissemination; vegetative reproduction; seedling establishment and growth; root development; growth and yield; reaction to competition; damaging agents and their effects; use for naval stores; and the hybrids and races of pitch pine.

194. Little, Silas, and Francois Mergen.
1966. **External and internal changes associated with basal-crook formation in pitch and shortleaf pines.** Forest Sci. 12: 268-275, illus.
Successive sketches show changes in basal form of 10 pitch pine and 22 shortleaf pine seedlings through their first 6 years or until the seedling died. Only one pitch pine did not form a basal crook. Many seedlings formed incipient crooks during the first summer; others a year or more later. Stem form continued to change for 2 to 10 years. Changes were explained on the basis of weak stems, usually upright apical growth, and formation of compression wood and eccentric growth rings. Sections showed heterogeneous alinement of wood fibers.

195. Little, S., and H. A. Somes.
1951. **Age, origin, and crown injuries affect growth of South Jersey pines.** USDA Forest Serv. NE. Forest Exp. Sta. Res. Note 8. 4 pp. Upper Darby, Pa.
Response of pitch and shortleaf pines after cutting oaks from an oak-pine stand varied. Overstory pines 6 to 13 inches d.b.h. doubled their rate of diameter growth. Old advance reproduction 5 to 16 feet tall also doubled their rates of diameter growth, but had little response in height growth because of flat tops. Seedlings established just before cutting had the best height growth after cutting.

196. Little, S., and H. A. Somes.
1956. **Buds enable pitch and shortleaf pines to recover from injury.** USDA Forest Serv. NE. Forest Exp. Sta. Sta. Paper 81. 14 pp., illus. Upper Darby, Pa.
Pitch pines sheared in August developed needle-fascicle buds and subsequent shoots both on current-year and previous-year growth (last when all of current-year growth was removed). The length of time pitch pines take to form well-developed basal crooks, and their importance in protecting basal buds and permitting sprouting after fires, are also described. Pitch pines sprouted at the base up to about 80 years of age, and the ages of boles at points where living buds were found also ran up to about 80 years. Pitch pine sprouts to far greater age than shortleaf, and consequently its sprouts vary much more in form and rate of growth.

197. Little, S., and H. A. Somes.
1964. **Root systems of direct-seeded and variously planted**

loblolly, shortleaf, and pitch pines. USDA Forest Serv. Res. Paper NE-26. NE. Forest Exp. Sta. 13 pp., illus. Upper Darby, Pa.

Root systems were developed normally only on plants from direct seeding. Amount of distortion of root systems varied with planting method, but seedlings in all planting methods had intertwined roots. Root systems of 1-0 stock recovered more from planting distortions than did 2-0 stock.

198. McIntyre, A. C.
1932. **Seeding habit of pitch pine.** Pa. Forest Leaves 23: 109-111.

A detailed description of serotinous cones in relation to portion of crown in which they grew on one tree. Cones from the middle portion of the crown produced the greatest number of viable seed. The lower third of sampled cones produced no seed, and the upper third of the cones yielded less than the middle.

199. McQuilkin, William Everett.
1935. **Root development of pitch pine, with some comparative observations on shortleaf pine.** J. Agr. Res. 51: 983-1016, illus.

Describes root systems at different stages from seedlings to mature trees on the basis of specimens excavated in southern New Jersey. Extensive root growth was found below the water table in saturated soils. On heavier soils, root development is less extensive than in the Coastal Plain. Shortleaf pine develops a stronger taproot and fewer supporting roots than pitch pine.

200. Moore, E. B.
1936. **Seedling-sprout growth of shortleaf and pitch pine in New Jersey.** J. Forestry 34: 879-882.

Seedling sprouts from natural reproduction of pitch pine and from shortleaf pines 2 years after planting 2-0 stock showed good survival and growth. More sprouts of pitch pine than of shortleaf pine reached heights of 5 to 9 feet in a 4-year period.

201. Namkoong, Gene.
1960. **Female flowers on 1-year-old pitch pine.** Forest Sci. 6: 163, illus.

Four flowers were found on three out of 20 potted seedlings of an intraspecific hybrid 12 months from seed.

202. Pak, T. S.
1966. **A study on growth in a young pitch pine stand originated from the sprouts and plantation.** Seoul Nat. Univ. Forests Bull. 3: 21-29, illus. Korea.

Sprouts from 17-year-old stumps outgrew planted seedlings in height for 4 years, and also in diameter, but differences were small. Growth of sprouts and of planted seedlings tend to become equal in both height and diameter.

203. Perry, George S.
1931. **Pine needles and oak leaves.** Pa. Forest Leaves 23: 22-23.

An acre of pitch pine forest in Pennsylvania had about 63 million needles weighing less than 2½ tons in a green condition during the winter. This is much less foliage than is borne by red or white pines.

204. Pomeroy, Kenneth B., and Lorna C. Littlecott.
1967. **The social register—85 new champs.** Amer. Forests 73(9): 28-33, illus.

The largest reported pitch pine, found near Hiddenite, N. C., was 9 feet 11 inches in circumference, 88 feet tall, and had a 50-foot spread in 1967.

205. Potzger, J. E.
1937. **Vegetative reproduction in conifers.** Amer. Midland Natur. 18: 1001-1004, illus.

Pitch pine is listed among species capable of vegetative reproduction.

206. Righter, F. I.
1939. **Early flower production among the pines.** J. Forestry 37: 935-938, illus.

The minimum age at which staminate or ovulate flowers are borne on pitch pines at the Institute of Forest Genetics in California is given as 4 years.

207. Stone, Earl L., Jr., and Margaret H. Stone.
1943. **Dormant buds in certain species of *Pinus*.** Amer. J. Bot. 30: 346-351, illus.

Stem sprouts of pitch pine arise from small buds at intermediate nodes of multinodal stems, as well as from small lateral buds at winter nodes—buds that remain dormant for a few years. These buds usually become small short branches bearing isolated or few fascicles, but are capable of forming long branches after injury to the tree. Such short shoots bear lateral buds that often remain dormant for a long time.

208. Stone, E. L., Jr., and M. H. Stone.
1954. **Root collar sprouts in pine.** J. Forestry 52: 487-491, illus.

In pitch pine small buds occur in the axils of primary needles above the cotyledons, and none of the buds or sprouts examined were adventitious. Basal buds like those of the upper stem often branch abundantly.

209. Zon, Raphael, and Henry S. Graves.
1911. **Light in relation to tree growth.** USDA Forest Serv. Bull. 92. 59 pp., illus.

Pitch pine is ranked as intermediate in tolerance of shade among eastern tree species.

Atmospheric and Biotic Relations (including fire)

210. Alderman, O. A.
1958. **Ohio trees. Pitch pine, *Pinus rigida* Miller.** Ohio Conserv. Bull. Feb.: 24, illus.
Briefly describes the range, appearance, and wood quality of pitch pine, and its relation to fire. This pine is used to some extent to reforest land in eastern Ohio.

211. Brown, James H., Jr.
1959. **Effect of fire on Rhode Island woodlands.** R. I. Agr. 5(4): 3, illus.
Briefly mentions that pitch pine is favored by or dependent upon fire for its existence.

212. Brown, James H., Jr.
1960. **The role of fire in altering the species composition of forests in Rhode Island.** Ecol. 41: 310-316, illus.
Pitch pine occurs abundantly on burns in several localities on extremely droughty soils.

213. Buell, Murray F., and John E. Cantlon.
1953. **Effects of prescribed burning on ground cover in the New Jersey Pine Region.** Ecol. 34: 520-528, illus.
In prescribed burning to favor pitch and shortleaf pines, the shrub cover is greatly reduced—especially *Gaylussacia.* Subsequent cutting of trees results in an increase in cover for shrub, herb, and moss layers; but the increase is greatest on areas most frequently burned. However, cutting caused a decrease in cover by *G. baccata.*

214. Burnham, C. F, M. J. Ferree, and F. E. Cunningham.
1947. **The scrub oak forests of the Anthracite Region.** USDA Forest Serv. NE. Forest Exp. Sta. Sta. Paper 4. 9 pp., illus. Upper Darby, Pa.
As a result of repeated fires, about 231,500 acres of the Anthracite Region of Pennsylvania have scrub oak forests in which the usual vegetation is chiefly blueberries, scrub oaks, and scattered pitch pines. With fire protection, scrub oak is replaced, most frequently by sassafras, red maple, chestnut oak, and red oak.

215. Clarke, W. S.
1946. **Effect of low temperatures on the vegetation of the barrens in central Pennsylvania.** Ecol. 27(2): 188-189.
In the barrens of Centre County, the higher land originally had an oak-chestnut forest; the lower ground bore mostly conifers, including pitch pine. Though scrub oaks were common on both sites after lumbering and fires, large oaks now prevail on the high ground. In the valley pitch pine is common, but scrub oaks predominate. Low temperatures every year in winter or spring are suggested to explain the absence of large oaks in the valley.

216. Fernow, B. E.
1895. **A coppice of pine.** Gard. and Forest 8: 472-473.
Briefly describes vegetation of the New Jersey Pine Barrens, including that in Plains growth (which covers about 15,000 acres), and also discusses the sprouting of pitch pine. Because a road bounded one portion of the Plains, repeated fires may be the cause of stunted growth there.

217. Hepting, George H.
1966. **Air pollution impacts to some important species of pine.** J. Air Pollut. Contr. Assoc. 16(2): 63-65.
Smoke from a manufacturing plant's trash burner severely injured large pitch mines in the surrounding wooded basin.

218. Little, S.
1946. **The effects of forest fires on the stand history of New Jersey's Pine Region.** USDA Forest Serv. NE. Forest Exp. Sta. Forest Manage. Paper 2. 43 pp., illus.
Original stands were probably composed mostly of large pines, and as a result of Indian fires had little undergrowth. Varying damage from different types of fires in oak-pine (pitch and shortleaf), in pitch pine-scrub oak, and in lowland pitch pine stands is described, as is the effect of past fires on present composition. Pre-settlement fires were of low intensity and usually permitted the development of good-quality stands. More recent fires have been less frequent, but have greatly damaged forest composition and quality.

219. Little, Silas.
1952. **Effects of forest fires on upland sites in the Pine Region of southern New Jersey.** N. J. Coll. Agr. Ext. Serv. Leafl. 100. 8 pp., illus.
Pine stands that develop on cleared land are replaced by hardwoods, chiefly oaks, because the latter are more shade-tolerant and can become established in thick litter. Differences in fire damage to pitch and shortleaf pines and to oaks are described, as is the role of wild fires in shaping present stand composition and quality — from Plains to oak-pine stands. The role of light frequent fires in the original forest and in present-day management is mentioned.

220. Lutz, Harold J.
1934. **Ecological relations in the pitch pine plains of southern New Jersey.** Yale Univ. School Forestry Bull. 38. 80 pp., illus.
In the Pine Barren region are Plains areas of dense low growth of pitch pine and bear oak, where stems are less than 11 feet tall. This bulletin contains data on plant composition, age, and height; on evaporation and surface soil temperatures; on soil analyses; and on fire history at 16 Plains and 18 other Pine Barren stations. The detailed study refuted hypotheses attributing Plains growth to geological, climatic, or soil differences. Repeated killing fires are the cause for present composition, predominance of sprouts, and young age of existing stems.

221. McCormick, Jack, and Murray F. Buell.
1968. **The Plains: pigmy forests of the New Jersey Pine Barrens, a review and annotated bibliography.** N. J. Acad. Sci. Bull. 13(1): 20-34, illus.
A review of knowledge about composition, location and extent, and cause of the Plains vegetation, and a new definition to distinguish it from other Pine Barren vegetation.

222. Moul, Edwin T., and Murray F. Buell.
1955. **Moss cover and rainfall interception in frequently burned sites in the New Jersey Pine Barrens.** Torrey Bot. Club Bull. 82: 155-162.
Periodic prescribed fires to favor pine (pitch and shortleaf) stands also favor the development of a bryophyte-lichen layer. This may cover 33 percent or more of the ground. Three species formed 98 percent of the moss cover.

223. Perry, George S.
1931. **Pitch pine as a rain-maker.** Pa. Forest Leaves 23(3): 43-45.
Condensation of moisture on pitch pine needles during a foggy period of 1 or 2 days in December was estimated to have added 15,320 gallons of water per acre to the soil of a pine forest, or possibly 5,100 gallons per acre to streamflow, in the vicinity of Mont Alto, Pennsylvania. In contrast, no condensation was observed on the associated bear and chestnut oaks.

224. Pinchot, Gifford.
1900. **The Plains.** N. J. State Geol. Annu. Rep. 1899: 124-130, illus.
Describes briefly the vegetation, mentioning that pitch pine stems on much of the Plains are only 2 to 4 feet tall, but sometimes reach 6 to 14 feet and rarely up to 25 feet in height. Relatively young sprout growth predominates, but there are some seedlings. Stumps that cease to sprout have main roots 40 to 100 years old. Origin of the Plains stands is attributed to fire, and exposure and poor soil are given as the reason for the prostrate form of most stems.

225. Wood, O. M.
1937. **The interception of precipitation in an oak-pine forest.** Ecol. 18: 251-254.
In the New Jersey Pine Barrens, rain gages were installed under a chestnut oak, under a pitch pine, under a white oak partly overtopped by a pitch pine, and under a blackgum overtopped by a chestnut oak and a pitch pine. Over a 17-month period the catch under trees was 85 to 91 percent of that in the open, but the proportion varied with type, intensity, and duration of precipitation.

226. Woodwell, G. M., and A. L. Rebuck.
1967. **Effects of chronic gamma radiation on the structure and diversity of an oak-pine forest.** Ecol. Monogr. 37: 53-69, illus.
An oak-pine forest in central Long Island has been irradiated

chronically with gamma radiation during 4 years, and four new vegetation zones were created: one where all indigenous higher plants have been killed; a zone where *Carex pensylvanica* was the principal survivor; a shrub zone where *Carex* and ericaceous shrubs survived; and an oak forest where pines have been killed (and finally the zone where the oak-pine forest is intact). Large pitch pines were more susceptible than small ones, because their crowns were more exposed.

Edaphic and Geological Relations

227. Allard, H. A.
1946. **Shale barren associations on Massanutten Mountain, Virginia.** Castanea 11: 72-124, illus.
On the barrens pitch pine grows with Virginia and table-mountain pines and chestnut oaks. Pitch and Virginia pines are the dominant invaders of old pastures.

228. Andresen, John W.
1959. **A study of pseudo-nanism in *Pinus rigida* Mill.** Ecol. Monogr. 29: 309-332, illus.
Data from this study show that the primary cause of dwarf pitch pine sprouts (Plains growth) in parts of the New Jersey Pine Barrens is repeated fires, not toxic amounts of soluble aluminum in the soil. From observations after cutting trees of different ages, sprouts of the younger trees had the best vigor and form. Soluble aluminum did not depress growth of pitch pine, which is classed in this study as an aluminum accumulator.

229. Bernard, John M.
1963. **Forest floor moisture capacity of the New Jersey Pine Barrens.** Ecol. 44: 574-576, illus.
Litter cover varied from 86 to 100 percent in the 12 communities studied, all of which were composed of mixtures of pitch and shortleaf pines with various oaks. Litter depths ranged from 0.5 to 0.9 inches, and the forest floor can hold about 0.5 inch of water.

230. Blair, A. W., and A. L. Prince.
1925. **The chemical composition of the soils of the Chatsworth area in New Jersey.** N. J. Agr. Exp. Sta. Bull. 414. 15 pp., illus.
Lakewood soils were among the least productive surveyed, and Leon soils also were called unproductive. Most of these two series are covered by forests of pitch pine. This report gives percentages of nitrogen, phosphoric acid, potash, lime, and magnesia, and the pH of individual samples by soil series.

231. Blankinship, J. W.
1903. **The plant-formations of eastern Massachusetts.** Rhodora 5: 124-137.
Pitch pine occurs in the Hilltop-Barren Formation (high points of

slate or granite or cliffs) and in the Sand-Plain Forest Formation. Other species in these formations are listed.

232. Bray, William L.
1921. **History of forest development on an undrained sand plain in the Adirondacks.** N. Y. State Coll. Forestry Tech. Pub. 13. 47 pp., illus.
Pitch pine is the dominant species of the Hudson-Mohawk, Saranac, and Black River sand plains, following destruction of an apparently edaphic climax of white pine.

233. Bray, William L.
1930. **The development of the vegetation of New York State.** N. Y. State Coll. Forestry Tech. Pub. 29. 189 pp., illus.
Pitch pine is mentioned as occurring in the Plattsburg sand barrens, Hudson-Mohawk pine barrens, Long Island pine barrens, and on summits of the Shawungunk Mountains — presumably edaphic conditions providing suitable sites for pitch pine and associated pine barren flora.

234. Brierly, William B.
1938. **The relation of *Pinus rigida* to physiographic features and soil types in central Massachusetts.** Rhodora 40: 72-73.
In Worcester County pitch pine occurs almost exclusively on sandy and gravelly soils of the Merrimac and Hinckley series, soils developed from stratified glacial deposits.

235. Broadfoot, W. M., and W. H. Pierre.
1939. **Forest soil studies: I. Relation of rate of decomposition of tree leaves to their acid-base balance and other chemical properties.** Soil Sci. 48: 329-348, illus.
The pH, and content of nitrogen, calcium, ash, and water-soluble organic matter are given for two samples of West Virginia pitch pine litter. The litter of this species was among the slowest to decompose.

236. Buell, Murray F., Arthur N. Langford, Donald W. Davidson, and Lewis F. Ohmann.
1966. **The upland forest continuum in northern New Jersey.** Ecol. 47: 416-432, illus.
Pitch pine is the most characteristic pioneer species of dry exposed ridge tops. Its presence as a dominant depends on fire.

237. Cantlon, John.
1951. **A preliminary investigation of the influence of prescribed burning on soil water supplies in South Jersey.** Annu. Conv. Amer. Cranberry Growers' Assoc. Proc. 82: 18-26, illus. (Reprinted with corrections).
In pitch-shortleaf pine and oak stands of the New Jersey Pine Barrens, throughfall of precipitation was measured for 4 months (6 July to 15 November) under pines, oaks, and trees plus shrubs. Soil moisture was sampled twice weekly from 15 June to 15 August at 20- and 70-cm. levels in annually burned and unburned oak-pine

stands. Throughfall under pine was less than under oak, but only slightly less than under oak plus shrubs. Effects on soil moisture from prescribed burning were inconclusive.

238. Colvin, Walter S., and Walter S. Eisenmenger.
1943. **Relationships of natural vegetation to the water-holding capacity of the soils of New England.** Soil Sci. 55: 433-446, illus.

On light soils with low water-holding capacity in both A and B horizons, characteristic plants include pitch pine, black oak, scrub oak, broomsedge, sweetfern, certain legumes, and other herbs.

239. Frothingham, E. H.
1924. **Forest research.** J. Forestry 22: 343-352.

In the southern Appalachians, pitch pine is one of the species found on ridges and dry, usually southerly slopes.

240. Garstka, Walter Urban.
1932. **The calcium content of Connecticut forest litter.** J. Forestry 30: 396-405, illus.

Pitch pine is described as a physiographic climax. On the basis of three or four samples of the 12 types studied, pitch pine litter had a very low ash content and the lowest calcium content (0.35 percent of litter weight).

241. Hawley, R. C., E. I. Terry, and K. W. Woodward.
1922. **Forest region and type classification for New England.** J. Forestry 30: 122-129.

The pitch pine type is of minor commercial importance, and occurs in central and southern New England on the poorest and driest sandy soils.

242. Hobbs, Clinton H.
1940. **Symptoms of mineral deficiency in pine.** Amer. J. Bot. 27, Supp. 10: 16.

In nutrient sand cultures lacking singly each of the major elements, deficiency symptoms for nitrogen, phosphorus, and potassium developed within 5 weeks; those for magnesium not until 3 months after germination. No deficiency symptoms for iron, boron, and manganese were observed in this 6-month study of pitch and red pines.

243. Hollick, Arthur.
1899. **The relation between forestry and geology in New Jersey.** Amer. Natur. 33: 1-14, illus.

In the coniferous zone (Pine Barrens), pitch pine predominates, often almost exclusively over extensive areas. The northern border of this zone is reported as coterminous with the northern border of Tertiary gravels, sands, and sandy clays. The tension zone has many more hardwoods and includes nearly all Cretaceous and Tertiary deposits of plastic clays, clay-marls, and marls.

244. Hollick, Arthur.
1900. **The relation between forestry and geology in New Jersey.** N. J. State Geol. Annu. Rep. 1899: 173-201, illus.
The northern edge of the coniferous zone in southern New Jersey coincides with the northern border of the Tertiary sands and gravels. Pitch pine is exceedingly abundant in the coniferous zone, less abundant in the tension zone, and forms only scattered groves or individuals in the deciduous zone. Pitch pine is better able to compete with other species on the poor soils of the coniferous zone than on richer soils, even though best growth of pitch pine is on the latter sites.

245. Hope, John G.
1943. **An investigation of the litter fauna of two types of pine forest.** Wagner Free Inst. Sci. Bull. 18: 1-7.
In one pitch pine stand of the New Jersey Pine Barrens, 138,112 animals per square meter were found in the litter and humus layers. Mites (Acarina) formed about 63 percent of the fauna, springtails (Collembola) about 37 percent. Ants, beetles, bugs, bristleworms, Diptera flies, centipedes, snails, etc., were also present.

246. Illick, Joseph S.
1921. **Replacement of the chestnut.** J. Forestry 19: 105-114.
Pitch pine was one of the chestnut associates on dry hillside sites, and with a little care it can be favored in considerable quantity to form new stands replacing chestnut on such sites. Where natural reproduction is insufficient, planting of pitch pine or other pines is recommended.

247. Joffe, J. S., and C. W. Watson.
1933. **Soil profile studies: V. Mature podzols.** Soil Sci. 35: 313-329, illus.
Descriptions and analysis of two podzol profiles of Lakewood soils in the New Jersey Pine Barrens, both from areas where pitch pine predominates. The authors suggest that the high amount of aluminum in one soil is a contributing factor to its unproductivity for pitch pine.

248. Kelley, Arthur Pierson.
1927. **Dune formation by Pine Barren plants.** Bot. Gaz. 83: 89-93, illus.
Suggests that secondary hills in the New Jersey Pine Barrens were formed by sand-binding plants, especially pitch pines with bushy basal whorls of branches.

249. Lounsbury, Clarence, F. B. Howe, R. E. Zautner, W. J. Moran, and P. D. Beers.
1933. **Soil survey of Suffolk and Nassau Counties, New York.** USDA Bur. Chem. and Soils Series 1928, 28: 1-46, illus.
A few pitch pines grow along the north shore of Long Island, but pitch pine is the dominant tree growth on many of the sandier soils (as Sassafras sandy loam) of the central and southern sections.

250. Lowry, Gerald L.
1960. **Conifer growth is best on acid spoils.** Ohio Farm and Home Res. 45: 44, illus.
Pitch pine grows well on sandy spoils and those with a loose shaly surface if soil acidity is between pH 3.5 and 5.8.

251. Lunt, Herbert A.
1948. **The forest soils of Connecticut.** Conn. Agr. Exp. Sta. Bull. 523. 93 pp., illus. New Haven, Conn.
Contains data on weights of forest floors under different forest types, results of analyses for physical and chemical properties, descriptions of typical profiles, and effects of agriculture and fire. Pitch pine is occasionally mentioned, as in summarizing Garstka's (*1932*) data on the F layers of forest floors.

252. Lutz, H. J.
1934. **Concerning a geological explanation of the origin and present distribution of the New Jersey pine barren vegetation.** Ecol. 15: 399-406, illus.
Refutes hypothesis developed by Hollick, Harshberger, and Taylor that the Pine Barrens were coextensive with geological formation and the vegetation was due to isolation on a Pensauken Island. Shows that Pine Barren vegetation occurs on several formations, and island hypothesis is no longer accepted.

253. McIntyre, Arthur C., and J. W. White.
1930. **The growth of certain conifers as influenced by different fertilizer treatments.** J. Amer. Soc. Agron. 33: 558-567.
On a Hagerstown silt loam in Pennsylvania, the three fertilizers that produced the most organic matter in 2-year-old pitch pine seedlings were in descending order: 400 lbs./acre of dried blood, 400 lbs./acre of ammonium sulfate, and a combination of 800 lbs. superphosphate and 200 lbs. of muriate of potash. Some of the other fertilizer treatments produced lighter seedlings than the checks.

254. McIntyre, A. C., and J. W. White.
1932. **Fertilizing coniferous seedlings.** J. Amer. Soc. Agron. 24: 72-73.
Dried blood fertilizer at 400 pounds per acre produced larger and heavier pitch pine seedlings than other mineral fertilizers during a 4-year period.

255. Maull, Theodore Ward.
1963. **Seed germination and establishment of *Pinus rigida* Miller (an autecological study).** Diss. Abstr. 23: 3607-3608.
In the Barrens of central Pennsylvania there is abundant seed production by pitch pine, but a paucity of natural reproduction. This study dealt with (1) factors affecting the germination of pitch pine seeds (temperature, relative humidity, period of imbibition necessary, drying after soaking, light, pH, soil moisture) and (2) soil-moisture conditions under different covers in the Barrens. Scarcity of pitch pine seedlings in the Barrens is attributed to unfavorable soil and air temperatures and unfavorable soil moisture.

256. Melin, Elias.
1930. **Biological decomposition of some types of litter from North American forests.** Ecol. 11: 72-101, illus.

Fairly active early decomposition of pitch pine litter in spite of low N content may be due to high content of water-soluble substances, chiefly sugars. After 4 months 30 percent of the organic matter had decomposed, including 87 percent of the water-soluble substances, 16 percent of the water-insoluble substances, and 43 percent of the hemicelluloses and celluloses.

257. Plice, Max J.
1934. **Acidity, antacid buffering, and nutrient content of forest litter in relation to humus and soil.** Cornell Univ. Agr. Exp. Sta. Mem. 166. 32 pp., illus.

Pitch pine litter from an area in Pennsylvania and one in New York was relatively low in CaO content (0.8 or 0.5 percent) and in mineral base content, and lowest in nitrogen content (0.6 percent) of 26 species studied. Pitch pine litter was placed in a group having low bases and buffer but strong acidity.

258. Radford, Albert E.
1948. **The vascular flora of the olivine deposits of North Carolina and Georgia.** Elisha Mitchell Sci. Soc. J. 64: 45-106, illus.

Describes plants found in "pine-andropogon" and "pine-oak" communities, both of which frequently include pitch pine among the dominants. The "pine-andropogon" community is xerophytic, occurring on southern slopes.

259. Raup, Hugh M.
1938. **Botanical studies in the Black Rock Forest.** Black Rock Forest Bull. 7. 161 pp., illus.

A scrub oak-pitch pine association occupies nearly every hilltop above 1,200-foot elevation in Black Rock Forest, Orange County, N. Y.— especially on southerly and westerly exposures. Associated species are mentioned.

260. Richards, B. N., and G. K. Voigt.
1965. **Nitrogen accretion in coniferous forest ecosystems. *In* Forest-soil relationships in North America.** Second North Amer. Forest Soils Conf. (Oreg. State Univ. Press): 105-116.

Soil beneath 12 pitch pines 5 to 9 years old contained a higher percentage of total N than soil uninfluenced by such trees. Yet soil N reserves were inadequate to account for all the N found in trees. The fixation of atmospheric N in association with *Pinus* is suggested.

261. Taylor, Norman.
1912. **On the origin and present distribution of the Pine Barrens of New Jersey.** Torreya 12: 229-242, illus.

Present composition of the Pine Barren vegetation is ascribed to the isolation of a remnant of more extensive distribution of pine barrens on a Miocene island. (Author's geological explanation of

the origin and present distribution of the New Jersey Pine Barrens was later refuted.)

262. Tedrow, J. C. F.
1952. **Soil conditions in the Pine Barrens of New Jersey.** Bartonia 26: 28-35, illus.
These soils are formed of extremely sandy materials, with some gravel, and are usually true podzols. The Pine Barrens are due primarily to the character of geologic materials, but there is no good correlation with geologic formations. Amount of soluble aluminum is reported higher in the Plains than in the Barrens, and was considered sufficient to have a serious toxic effect on vegetation. (See Andresen 1959).

263. Voigt, G. K.
1966. **Phosphorus uptake in young pitch pine (*Pinus rigida* Mill.).** Soil Sci. Soc. Amer. Proc. 30: 403-406, illus.
Average annual P requirements of pitch pine were approximated by acid-extracting agents, but water-soluble P in the root-surface zone was less than annual uptake. P uptake was apparently reduced by increasing Ca concentration, and increased with increased root surface.

264. Voigt, G. K., B. N. Richards, and E. C. Mannion.
1964. **Nutrient utilization by young pitch pine.** Soil Sci. Soc. Amer. Proc. 28: 707-709, illus.
Ten pitch pines 5 to 9 years old were excavated from an abandoned gravel pit in southern New Jersey. Annual uptake of K was approximately equal to exchangeable K content of root-surface sorption zone; similar uptake of Ca was about one-third of exchangeable Ca in the same zone. Less than 10 percent of the total soil volume occupied by roots was utilized in absorption of Ca and K.

265. Wherry, Edgar T.
1922. **Soil acidity preferences of some eastern conifers.** J. Forestry 20: 488-496.
Pitch pine is listed among conifers preferring acid habitats, is especially characteristic of acid New Jersey Pine Barrens, and less commonly grows on clayey or sandy soils that have neutral reactions at moderate depths.

266. Wherry, Edgar T.
1932. **Ecological studies of serpentine-barren plants. I. Ash composition.** Pa. Acad. Sci. Proc. 6: 32-38.
The ash of pitch pine growing near Atsion, Burlington County, N. J., and of pitch pine from serpentine barrens near Nottingham, Chester County, Pa., showed that the latter contained markedly less total ash and potash, but much more magnesium oxide.

267. Williams, Clarence R.
1929. **The pine barren "island" of New Jersey.** Amer. Bot. 35: 49-55.
Attributes the dominance of pine barren vegetation in the New

Jersey Pine Barrens to the area's being an island in early glacial times. (See Lutz, 252.)

268. Wood, O. M.
1933. **Litter cover and soil surface temperatures, oak-pine type.** USDA Forest Serv. Allegheny Forest Exp. Sta. Tech. Note 3. 1 p.
Litter cover reduced high surface soil temperatures under an oak-pine (pitch?) stand in southern New Jersey. Decreasing moisture content of surface soil increased its temperature.

269. Woodwell, G. M., and T. G. Marples.
1968. **The influence of chronic gamma irradiation on production and decay of litter and humus in an oak-pine forest.** Ecol. 49: 456-465, illus.
Gives the amount of organic matter in litter and humus of unaffected forest, annual input of litter, rates of decay in litter and humus, and effects of irradiation. Sensitivity of pitch pine as measured by litter fall is complicated by (1) usual persistence of leaves through second summer and (2) litter from currently dying trees. Exposure causing 50-percent reduction in pitch pine leaf fall declined from 29 r/day in 1962-63 to possibly 4 r/day in 1965-66. Some indications that, under continued exposure, damage to oaks and pines becomes similar after several years.

Plant Sociology

270. Allard, H. A., and E. C. Leonard.
1943. **The vegetation and floristics of Bull Run Mountain, Virginia.** Castanea 8: 1-64, illus.
Pitch pine occurs frequently, often in pastures, with the more common Virginia pine — usually on dry, sandy slopes and ridges or on burned sites.

271. Archard, Howell O., and Murray F. Buell.
1954. **Life-form spectra of four New Jersey pitch pine communities.** Torrey Bot. Club Bull. 81: 169-175.
Compares one pine-dominated community and one oak-dominated community in the Lebanon State Forest, in the Pine Region of southern New Jersey, with two similar communities in High Point State Park in northwestern New Jersey. Seed plants predominate in each of the pitch pine communities, but there are more hemicryptophytes and cryptophytes (the more protected life forms) in the High Point area, which has the more severe climate. In both sections the oak stand had less open space in the tree canopy, but more in the shrub layer, than the pine stand.

272. Beckwith, Charles S., and Jessie G. Fiske.
1925. **Weeds of cranberry bogs.** N. J. Agr. Exp. Sta. Circ. 171. 23 pp., illus.
Pitch pine covered 3 percent of a neglected cranberry bog at an unnamed locality in southern New Jersey, about as much as that

covered by gray birch, red maple, Atlantic white-cedar, or black-gum — the other tree species mentioned.

273. Braun, E. Lucy.
1935. **The vegetation of Pine Mountain, Kentucky: an analysis of the influence of soils and slope exposure as determined by geological structure.** Amer. Midland Natur. 16: 517-565, illus.
Pitch pine is a dominant species in pine and chestnut oak-pine types and occurs in some other types, all on southeast slopes. Pitch pine occurs in mixed stands on low ridges and on some sandstone soils; but as the soil becomes increasingly shallow, pitch and shortleaf or Virginia pines predominate. Associated species in the various conditions are listed. Pine and pine-oak communities are considered subclimax or physiographic climaxes.

274. Bromley, Stanley W.
1935. **The original forest types of southern New England.** Ecol. Monogr. 5: 61-89, illus.
Pitch pine originally dominated forests on the lighter, sandy soils of Cape Cod; oak prevailed on the better soils; oak-pitch pine in the tension zone. Pitch pine stands also prevailed on light sandy soils elsewhere in different parts of Massachusetts, Connecticut, and Rhode Island. Such stands were favored by frequent fires; and in the absence of fire, white pine and hemlock tended to supplant pitch pine in the northern portions, oaks to replace pitch pine in southern and southeastern sections.

275. Brown, Babette I.
1948. **A study of the distribution of epiphytic plants in New York.** Amer. Midland Natur. 39: 457-497, illus.
Ten lichens and two mosses were found as epiphytes on pitch pine.

276. Buell, Murray F., and John E. Cantlon.
1950. **A study of two communities of the New Jersey Pine Barrens and a comparison of methods.** Ecol. 31: 567-586, illus.
The place of pitch pine and associated trees and shrubs in the succession in two upland stands is discussed. The two communities, tending to be in the oak-pine and pine-scrub oak types, represent two stages of succession, and present composition is probably the result of differential disturbance due to fire.

277. Cain, Stanley A.
1931. **Ecological studies of the vegetation of the Great Smoky Mountains of North Carolina and Tennessee. I. Soil reaction and plant distribution.** Bot. Gaz. 91: 22-41, illus.
Pitch pine is one of the associated species in heath communities dominated by shortleaf and table-mountain pines. These communities occur on southern exposures of the lower ridges at an elevation of about 3,400 feet.

278. Chrysler, Mintin Asbury.
1905. **Reforestation at Woods Hole, Massachusetts. A study in succession.** Rhodora 7: 121-129, illus.

Describes the planting of pitch pine and other species at Woods Hole, as well as the direct seeding of pitch pine and some other conifers. Oaks are replacing pines, and along the coast pitch pines and Scotch pines are stunted, probably from wind-carried salt.

279. Conard, Henry S.
1935. **The plant associations of Central Long Island (New York).** Amer. Midland Natur. 16: 433-516, illus.
Pitch pine is the dominant species in a "Pinetum rigidæ" association, but is also found in some other Pine Barren associations and on Fire Island. Because of cuttings and fires, scrub oak has replaced former stands of pitch pine. Species associated with pitch pine are listed.

280. Davis, John H., Jr.
1930. **Vegetation of the Black Mountains of North Carolina: an ecological study.** Elisha Mitchell Sci. Soc. J. 45: 291-318, illus.
Pitch pine is a dominant member of the xeric slope and ridge association. Pines often occur in pure stands. Associated species are listed.

281. Day, Gordon M.
1953. **The Indian as an ecological factor in the northeastern forest.** Ecol. 34: 329-346.
From a comprehensive review of literature, Day concluded that in the Northeast Indians created sizeable clearings for villages and fields, and frequently moved to new sites. In many sections Indians also set fires to improve traveling, drive game, and for other reasons. Fires and the clearing and abandonment of fields modified composition and density of forests. Pitch pine land in New England may have been burned for over 1,000 years.

282. Donahue, William H.
1954. **Some plant communities in the Anthracite Region of northeastern Pennsylvania.** Amer. Midland Natur. 51: 203-231, illus.
In the scrub oak community occasional pitch pines jut above rest of vegetation, but play only a minor role in total cover (1.6 percent of overstory). Associated species are listed, and density and frequency of all plants given.

283. Eyre, F. H., W. A. Dayton, D. Den Uyl, R. C. Hawley, and P. R. Wheeler.
1954. **Forest cover types of North America (exclusive of Mexico).** 67 pp., illus. Soc. Amer. Foresters, Washington, D.C.
The pitch pine type occupies infertile ridges, flats and slopes, or coastal sands on dry to poorly drained sites. The type is considered temporary (resulting from fire) and succeeded by hardwoods. Pitch pine is listed as an associate in 12 other types: red pine, white pine, scarlet oak, bear oak, chestnut oak, white pine-chestnut oak, shortleaf pine, shortleaf pine-oak, shortleaf pine-Virginia pine, Virginia pine-southern red oak, Virginia pine, and Atlantic white-cedar.

284. Graham, H. W., and L. K. Henry.
1933. **Plant succession at the borders of a kettle-hole lake.** Torrey Bot. Club Bull. 60: 301-315, illus.

Lake levels near Wading River, Long Island, New York, fluctuate appreciably with precipitation, and consequently shore plant succession is periodically arrested or initiated. Pitch pine invades the higher zones, but is killed by rising water levels after 7 or 14 years.

285. Grandtner, Miroslav M.
1961. **Note sur le pinetum rigidae du Quebec.** Natur. Canad. 88: 39-44, illus.

Describes pitch pine stands on four different types of sites near Saint-Chrysostôme, Quebec. The appearance, composition, and value of these stands vary. Pitch pine fruits abundantly, is easily reproduced, and grows rapidly; but on only one of the sites does it become economically valuable.

286. Harper, Roland M.
1918. **A sketch of the forest geography of New Jersey.** Geog. Soc. Phila. Bull. 16(4): 107-125, illus.

The author mentions the occurrence of pitch pine on Kittatinny Mountain, in the Pine Barrens, in the Cohansey Region, on Cape May peninsula, and in the coastal dunes. Pitch pine is called the most abundant species, although it is less widely distributed than some hardwoods.

287. Harshberger, John W.
1916. **The vegetation of the New Jersey Pine-Barrens.** 329 pp., illus. Christopher Sower Co., Philadelphia.

The Pine-Barrens vegetation is described from phytogeographic and ecological aspects, including different associations in which pitch pine occurs, both inland and along the coast. Plains growth was attributed to impervious subsoil, strong winds, and protozoa destructive of bacteria (see Lutz, 220). Flowering and fruiting periods are given for different plants, as well as class of root system and detailed descriptions of leaf structure.

288. Hawley, R. C., E. I. Terry, and K. W. Woodward.
1922. **Revision of a report on a forest region and type classification for New England.** J. Forestry 20: 795-798.

The pitch pine forest type occurs in the white pine, Connecticut hardwoods, and Cape Cod regions. In the Cape Cod region the type may have a high percentage of scrub oak.

289. Henry, LeRoy K.
1930. **Ecological observations upon the flora of Wading River, Long Island, New York.** Pa. Acad. Sci. Proc. 4: 60-65.

Pitch pine barrens are confined to outwash plains, where soils are sands or coarse sandy loams. Pitch pine is the dominant species. Associated species are mentioned.

290. Henry, LeRoy K.
1932. **Ecological notes upon the flora of an old lake basin.** Pa. Acad. Sci. Proc. 6: 119-120.

In a kettle-hole basin near Wading River, Long Island, pitch pine grows on sloping sides and on higher tufts of sphagum moss in the central part. Associated species are mentioned.

291. Hotchkiss, Neil, and Robert E. Stewart.
1947. **Vegetation of the Patuxent Research Refuge, Maryland.** Amer. Midland Natur. 38: 1-75, illus.
Pitch pine forms nearly pure stands on old fields of poorly drained sandy sites and on well-drained terrace or upland sites, or sometimes occurs as an associate of sweetgum on the moister soils and of Virginia pine on the drier soils. On terraces pine stands later become pine-beech forests that yield to a beech-white oak mixture, while on upland sites the pine stands change to pine-oak and then to upland oak forests.

292. Howe, Clifton Durant.
1910. **The reforestation of sand plains in Vermont.** Bot. Gaz. 49: 126-148, illus.
Pitch pine probably occurred in small scattered areas in the original stands, but became predominant after the first cutting. White pine, however, is replacing it on cut-over areas and in abandoned fields. Succession in both types of areas is described.

293. Jennings, O. E.
1926. **Classification of the plant societies of central and western Pennsylvania.** Pa. Acad. Sci. Proc. 1: 23-55, illus.
Pinus rigida is predominant in the pitch pine association, which occurs on dry ridge tops, and in the pine barrens (pitch pine-scrub oak association) in Centre and Huntingdon Counties. The species is a minor component of some other associations.

294. Korstian, C. F.
1924. **Natural regeneration of southern white cedar.** Ecol. 5: 188-191, illus.
Pitch pine is an associate of Atlantic white-cedar in the Northeast, as far south as New Jersey.

295. Korstian, C. F., and Paul W. Stickel.
1927. **The natural replacement of blight-killed chestnut.** U. S. Dep. Agr. Misc. Circ. 100. 15 pp., illus.
In Pennsylvania and New Jersey, pitch pine is among desirable but less common species replacing chestnut. In New England it seldom is associated with chestnut.

296. Lewis, I. F.
1924. **The flora of Penikese, fifty years after.** Rhodora 26: 181-195, illus.
Penikese, a small island 12 miles south of New Bedford, Mass., reportedly once had forest vegetation — pitch pine, red maple, hickory, birch, and associated species. Cutting of the original timber was followed by grazing of sheep, which eliminated these tree species. Sheep were removed in 1910, but pitch pine and most other tree species are still absent.

297. Little, Silas, Jr.
1950. **Ecology and silviculture of whitecedar and associated hardwoods in southern New Jersey.** Yale Univ. School Forestry Bull. 56. 103 pp., illus.

Pitch pine is one of the species that invade abandoned cranberry bogs, but is less tolerant than Atlantic white-cedar and hence is usually taller. In dry, usually sandy swamps, fires have favored pitch pine over white-cedar.

298. Little, S.
1951. **Observations on the minor vegetation of the Pine Barren swamps in southern New Jersey.** Torrey Bot. Club Bull. 78: 153-160.

Lists and discussions of the nonarborescent plants found on plots in 16 stands. Occurrence of 124 species or varieties of shrubs, vines, herbs, ferns, liverworts, mosses, and lichens is listed by type of stand, size of overstory trees, and past use of area. Pitch pine is mentioned as occurring in some stands of mixed composition — along with Atlantic white-cedar and swamp hardwoods.

299. Little, S., and E. B. Moore.
1949. **The ecological role of prescribed burns in the pine-oak forests of southern New Jersey.** Ecol. 30: 223-233, illus.

On upland sites forest succession is from pitch or shortleaf pine stands on old-field sites to a hardwood forest dominated by low-value oaks. The effect of wildfires on stand composition is briefly described, and data are given to show the effect of prescribed winter fires on pine and hardwood reproduction. The prescribed fires favor herbaceous plants over shrubs, and certain types of cutting increase the effectiveness of prescribed burns on stand composition.

300. Littlefield, E. W.
1952. **The pitch pine is dead — long live the white pine!** N. Y. State Conserv. 7(2): 24-25, illus.

In New York pitch pine is common on Long Island, on sandy plains between Albany and Lake George, in an area south of Plattsburg, and in the Oneida Lake Section. White pines frequently become established under pitch pine stands either naturally or through planting. The author recommends conversion to white pine by planting where needed and by release of natural or planted seedlings.

301. McCormick, Jack.
1955. **A vegetation inventory of two watersheds in the New Jersey Pine Barrens.** Diss. Abstr. 15: 1707-1708.

Quantitative description of vegetation on two areas in Lebanon State Forest, Burlington and Ocean Counties. Basal area, density, and cover measurements are given for all tree species, including pitch pine, which is predominant.

302. McIntyre, Arthur C.
1932. **The scrub oak type in Pennsylvania.** Pa. Forest Leaves 23: 74-77.

In Pennsylvania the scrub oak type covers over 2 million acres.

The cause of this type, its place in succession, its composition and conversion are described. Pitch pine is mentioned as one of the most desirable associates.

303. Moore, Barrington.
1917. **Some factors influencing the reproduction of red spruce, balsam fir, and white pine.** J. Forestry 15: 827-853, illus.
The pitch-pine association on Mt. Desert Island, Maine, is usually pure pitch pine, but frequently contains red pine or red and white pines. Other associated species are mentioned. The type occupies rocky, dry sites and granite ledges above the sea. Pitch pines usually reach only 15 to 20 feet in height and 6 to 10 inches d.b.h., and are of no commercial value. Most stands are composed of even-aged groups and on better sites form a pioneer type.

304. Moore, Barrington, and Norman Taylor.
1927. **Vegetation of Mount Desert Island, Maine, and its environment.** Brooklyn Bot. Gard. Mem. 3: 1-151, illus.
Stands composed of 80 percent or more of pitch pine, with associated red pine, white pine, red oak, red spruce, balsam fir, and red maple, grow on rocky, barren southfacing or level sites. Associated species of herbs and shrubs are listed, and soil and weather data from a pitch pine stand are presented. Evaporation and soil temperatures were higher than in any other forest type. The pitch pine type may be a physiographic climax, although usually early successional.

305. Nicholas, Herbert M.
1925. **What trees are replacing our chestnut.** Pa. Forest Leaves 20: 44-45.
Pitch pine is common in the new growth replacing chestnut, especially on ridges and slopes, but also in the valleys of Michaux State Forest, Pa.

306. Nichols, George E.
1914. **The vegetation of Connecticut. III. Plant societies on uplands.** Torreya 14: 167-194, illus.
On Connecticut sand plains the first tree species to appear are red cedar, gray birch, and pitch pine, either alone or in mixture. Oak and hickory succeed pitch pine, although in one stand near Farmington succession is being retarded by fire.

307. Niering, William A.
1953. **The past and present vegetation of High Point State Park, New Jersey.** Ecol. Monogr. 23: 127-148, illus.
Pitch pine is common in two communities: the pine-scrub (bear) oak on very thin soil with rocky outcrops, and the pine-oak found on some hilltops. On most sites the former is relatively stable because of rocky outcrops and frequent fires, but in the pine-oak community oaks are replacing pitch pines.

308. Ogden, J. Gordon, III.
1961. **Forest history of Martha's Vineyard, Massachusetts.**

I. Modern and pre-Colonial forests. Amer. Midland Natur. 66: 417-430, illus.

Pitch pine forms pure stands on old fields, but these are replaced by oaks. The original forests probably contained same species found today, but the trees were larger.

309. Olmstead, Charles E.
1937. **Vegetation of certain sand plains of Connecticut.** Bot. Gaz. 99: 209-300, illus.

On coarse sandy terraces in southern Connecticut there are three subseres leading to a xerophytic oak edaphic climax. Forests of pitch pine and associated oaks are mainly successional stages following the *Andropogon-Cladonia* association.

310. Olmstead, Charles E.
1956. **The North Haven sand plains.** Conn. Arboretum Bull. 9: 15-18, illus.

Old fields occupied by broomsedge have been invaded by pitch pine, which forms forests or savanna-like stands. Seed trees are 85 to 100 years old.

311. Parker, Dorothy.
1945. **Plant succession at Long Pond, Long Island, New York.** Butler Univ. Bot. Stud. 7: 74-88, illus.

Pitch pine is the dominant species of the Pinetum and is invading earlier seral stages. Species of associated trees, shrubs, and herbs are mentioned.

312. Reiners, W. A.
1967. **Relationships between vegetational strata in the pine barrens of central Long Island, New York.** Torrey Bot. Club Bull. 94: 87-99, illus.

In 9 of 15 stands studied, pitch pine was dominant in terms of basal area, and it was also present in 5 of the other stands. Scrub oak (*Quercus ilicifolia*) had the highest (although variable) cover in pine-dominated stands. Pine domination is favored by succession from mineral soil and is maintained by repeated burning.

313. Roberts, Edith Adelaide, and Helen Wilkinson Reynolds.
1938. **The role of plant life in the history of Dutchess County.** 44 pp., illus. Lansing-Broas Printing Co., Inc., Poughkeepsie, N. Y.

The pine association, including pitch, white, and red pines, replaces gray birch on old fields and is succeeded by the oak-hickory association. Pitch pine reaches 80 feet in height and 2 to 3 feet in diameter. Associated species of the pine association are listed. Maps show locations of pine stands and old pitch pines in this New York county.

314. Sampson, Homer C.
1927. **The primary plant associations of Ohio.** Ohio J. Sci. 27: 301-309.

Pitch pine is mentioned as occurring in southeastern Ohio in a "cliff association."

315. Saunders, C. F.
1900. **New Jersey Pine Barrens in July.** Plant World 3: 1-4, illus.

The author describes vegetation seen on an 1899 trip — pitch pines 2 to 3 feet tall in the East Plains, associated bear and blackjack oaks, mountain-laurel, bearberry, arbutus, pyxie-moss, sand-myrtle, crowberry, hudsonia, and others.

316. Shreve, Forrest, M. A. Chrysler, Frederick H. Blodgett, and F. W. Besley.
1910. **The plant life of Maryland.** Md. Weather Serv. Spec. Pub. 533 pp., illus.

The authors describe the vegetation in different sections of Maryland. Pitch pine is mentioned as occurring in various places, especially on sandy soils. However, it is rare on the Eastern Shore and also on the Western Shore except on sandy soils. Pitch pine occurs frequently in the Midland and Mountain Zones, but usually with Virginia pine or hardwoods. Associated plants are listed.

317. Society of American Foresters, Committee of the Southern Appalachian Section.
1926. **A forest type classification for the southern Appalachian Mountains and the adjacent plateau and Coastal Plain regions.** J. Forestry 24: 673-684.

The pitch pine-mountain pine type occurs in pure stands of one or both species, but usually with black, scarlet, and chestnut oaks and other hardwoods. It occupies dry flats, slopes, and ridges from 2,000 to 5,000 feet elevation in the Appalachian and Cumberland Mountains.

318. Stephenson, S. N.
1965. **Vegetation change in the Pine Barrens of New Jersey.** Torrey Bot. Club Bull. 92: 102-114, illus.

Results of a resurvey of 104 permanent sample units in Lebanon State Forest. Between 1954 and 1962 basal area increased, mostly in the early successional communities—little or no change occurred in older stands. Total number of stems decreased among tree species, as did the shrub cover—possibly because of drought. Pitch pine was the major component of basal area in two types.

319. Stern, William L., and Murray F. Buell.
1951. **Life-form spectra of New Jersey Pine Barrens forest and Minnesota jack pine forest.** Torrey Bot. Club Bull. 78: 61-65.

When a pitch pine-shortleaf pine stand in southern New Jersey is compared to a Minnesota jack pine stand, the latter has more protected life-forms, apparently because of a more severe climate.

320. Weiss, Harry B., and Erdman West.
1924. **Insects and plants of a dry woods in the Pine Barrens of New Jersey.** Ecol. 5: 241-253, illus.

The authors studied a 10-acre wooded area near Lakehurst, in which pitch pine predominated, and a 4-acre open area nearby.

Associated plants are described, as are the insects found under various conditions in both areas.

321. Whittaker, R. H.
1956. **Vegetation of the Great Smoky Mountains.** Ecol. Monogr. 26: 1-80, illus.
Pitch pine occurs from lowest elevations to about 4,500 feet, but the type is usually found on open south and southwest slopes and on some ridges between 2,200 and 3,200 feet. Associated tree and other plant species are mentioned. Pine stands are considered an edaphic climax favored by fire.

321a. Whittaker, R. H., and G. M. Woodwell.
1969. **Structure, production and diversity of the oak-pine forest at Brookhaven, New York.** J. Ecol. 57: 155-174, illus.
The Brookhaven forest is composed of small oaks and pitch pine with an open canopy, of 88-percent tree coverage and leaf area ratio of 3.4, admitting 13 percent of incident sunlight so vaccinaceous shrubs form well-developed stratum (78-percent coverage). Data are given for (1) biomass above ground and above-and-below ground, (2) net annual production, and (3) efficiency of net and gross production. The limited number of species mentioned permits observations on niche differentiation among trees, shrubs, and herbs.

322. Williams, Ruby M., and H. J. Oosting.
1944. **The vegetation of Pilot Mountain, North Carolina: a community analysis.** Torrey Bot. Club Bull. 71: 23-45, illus.
Although Pilot Mountain is in the Piedmont, most of the vegetation is similar to that of the southern Appalachians, probably because of the sandy soil and elevation. Pitch pine occurs in all communities, but with chestnut oak dominates the stands on the western half of the mountain and on the higher southern slopes. The chestnut oak-pitch pine community is considered preclimax to the oak-hickory association and is favored by the thin rocky soil.

323. Woods, Frank W., and Royal E. Shanks.
1957. **Replacement of chestnut in the Great Smoky Mountains of Tennessee and North Carolina.** J. Forestry 55: 847.
Pitch pine formed 2 percent of 5,046 replacements in 2,569 openings in 79 stands investigated.

324. Zube, Ervin H., and Carl A. Carlozzi (editors).
1967(?). **Selected resources of the Island of Nantucket: an inventory and interpretation.** Univ. Mass. Coop. Ext. Serv. Pub. 4. 135 pp., illus.
The Island was generally wooded when the first colonists arrived, but then 90 percent of it was cleared. Pitch pine has been planted, reaches 60 feet in height, but suffers from wind exposure, especially on the edges of the stands. Natural reproduction of pitch pine invades the heath, and pitch pine is present in the oak scrub type.

SILVICULTURE & MANAGEMENT

General

325. Baker, Willis M.
1925. **Forestry for profit.** N. J. Dep. Conserv. and Develop. 88 pp., illus.
A general description of New Jersey forests, forestry problems, and State activities in forestry; and a discussion of the silviculture and management of common forest types. For pitch and shortleaf pines, thinnings are recommended at 25 to 30 years, clearcuttings or seed-tree cuttings at 40 to 60 years, and release from hardwood sprouts. The need for favorable seedbeds, the growth of pine sprouts, yields, and logging and planting techniques are described. Planting of pitch pine is recommended only for poor dry soils. Properties and uses of pitch pine wood are also described, and volume tables are given.

326. Baker, Willis M.
1936. **Comments on timber stand improvement in the Central States.** USDA Forest Serv. Cent. States Forest Exp. Sta. Sta. Note 30. 6 pp.
Shortleaf, Virginia, and pitch pines are associates of upland oaks on dry sites in unglaciated sections. Many present dry-site oak stands should be converted to pine by cutting at the time of a pine seed crop or, if natural reproduction cannot be obtained, by planting.

327. Belyea, Harold Cahill.
1922. **A suggestion for forest regions and forest types as a basis of management in New York State.** J. Forestry 20: 854-868, illus.
The pitch pine type occurs on Long Island and on dry soils of the Mohawk and Hudson Sand Plains. Replacement of this species with white, red, or Scotch pines is recommended.

328. Bentley, John, Jr.
1905. **Pitch pine in Pike County, Pennsylvania.** Forestry Quart. 3: 1-17, illus.
A discussion of distribution and growth of pitch pine on different sites and in different stand types. Cone crops, seed distribution, and effects of fires are described. Volume tables are given in cubic feet, board feet, and cords.

329. Cantlon, John E., and Murray F. Buell.
1952. **Controlled burning — its broader ecological aspects.** Bartonia 26: 48-52.
Possible effects of controlled burning on water supplies, shrubs, insects, deer, and other wildlife in the New Jersey Pine Region are discussed.

330. Cranmer, Carl B.
1952. **Future of the Pine Barrens.** Bartonia 26: 53-60.
Quotes early descriptions of forests in the New Jersey Pine Region; and describes the industrial use, fires, recreation, protection from wildfires, probable land use, possible timber yields, and benefits from prescribed burning. Recommends formulation of a land-use policy.

331. Dana, Samuel T.
1930. **Timber growing and logging practice in the Northeast.** U. S. Dep. Agr. Tech. Bull. 166. 112 pp., illus.
Briefly describes forests in the pine-and-oak region of Cape Cod, Long Island, and southern New Jersey, and suggests methods of harvest cutting, slash disposal, cleaning, and thinning. Recommends favoring shortleaf pine over pitch pine. The latter is mentioned as common on poor sites in the oak type.

332. Gifford, John.
1900. **The forestal conditions and silvicultural prospects of the Coastal Plain of New Jersey, with remarks in reference to other regions and kindred subjects.** N. J. State Geol. Annu. Rep. 1899: 235-318, illus.
Describes forests of the New Jersey Coastal Plain, including Plains growth (its area and the reasons for it), other Pine Barren types, effects of fires, dune forests and dune stabilization, industrial use of Pine Barren forests, and fire protection. Discusses possible role of various cutting systems and techniques to use in direct seeding. Recommends favoring shortleaf over pitch pine.

333. Illick, Joseph S., and John E. Aughanbaugh.
1930. **Pitch pine in Pennsylvania.** Pa. Dep. Forests and Waters Res. Bull. 2. 108 pp., illus.
A comprehensive bulletin: it includes common names, identifying and silvical characteristics (including growth habits, intolerance of shade, seed production, sprouting, and fire resistance), range and distribution, form and maximum size, common associates, silviculture and utilization of pitch pine, and damage by snow, ice, deer, insects, and diseases. Nursery practices, extent and success of plantings, growth of stands and yield are described; and recommendations are made for shelterwood cuttings or clearcuttings and for release from competing hardwoods. Volume tables and yield tables by age and site class are included, as are descriptions of properties and uses of pitch pine wood.

334. Little, S.
1952. **Silvicultural objectives and methods on upland sites in the New Jersey Pine Region.** Bartonia 26: 44-47.
Composition of present stands and factors affecting it and succession are described. Present annual growth of pine-scrub oak stands is about 1/10 cord per acre, of oak-pine stands about 1/4 cord, and the potential in seedling-pine stands about 1 cord. Discusses role of planting, site preparation with machinery or prescribed winter fires, need for release of pine reproduction, and desirable amount of area in one age class.

335. Moore, E. B.
1939. **Forest management in New Jersey.** N. J. Dep. Conserv. and Develop. 55 pp., illus.

Describes physiographic provinces of New Jersey, their forests and land uses, conservation problems and forestry program, forest management, and silviculture. Includes description of Plains stands and discusses the cause of such growth, original and current stand conditions in the Pine Region, planting of pitch pine and other species to increase proportion of conifers, and their release. Data given show how an increasing proportion of pine increases the yield of oak-pine stands.

336. Moore, E. B.
1940. **Forest and wildlife management in the South Jersey Pine Barrens.** J. Forestry 38: 27-30, illus.

Briefly describes the Pine Barrens, relative yields of oak and pine stands, and conversion to pine through cutting oak and planting pine. Wildlife-management measures include preparation of 0.5- to 2-acre clearings connected by cleared 25-foot lanes, both of which are sown to native herbaceous plants. Between outer lanes and roads are prescribe-burned firebreaks, and interior stands are thinned to favor pine over oak.

337. Toumey, James W., and Clarence F. Korstian.
1942. **Seeding and planting in the practice of forestry.** Ed. 3, 520 pp., illus. John Wiley and Sons, Inc., New York.

Mentions early plantings of pitch pine, and presents data on the opening of cones, number of seeds per pound, yield of seed per bushel of cones, seed purity and viability, seed stratification, germinating period in seed testing, recommended seedling densities and depth of soil coverings in nursuries. Discusses use of pitch pine in stabilizing New England dunes.

Seed Collection, Storage, and Treatment

338. Barton, Lela V.
1930. **Hastening the germination of some coniferous seeds.** Amer. J. Bot. 17: 88-115, illus.

In the seed lot tested, germination of seeds stratified for 1 month at 5°C. was 87 percent after 12 days and 95 percent after 18 days; germination of untreated seeds was only 3 percent after 12 days and 33 percent after 50 days. Germination was also increased by stratification for 1 to 3 months at 0° or 10°C.

339. Blaydes, David F.
1967. **Studies on the germination of seed of *Pinus rigida.*** W. Va. Acad. Sci. Proc. 38: 68.

In several tests both white and red light greatly stimulated germination over that in dark controls, whereas far-red light greatly reduced it.

340. Haasis, Ferdinand W.
1928. **Germinative energy of lots of coniferous-tree seed, as related to incubation temperature and to duration of incubation.** Plant Physiol. 3: 365-412, illus.

For one lot of pitch pine seed, optimal temperature for the shortest incubation period (6 to 7 hours) was 46° C.; optimum for 4 to 14 days was 23 to 33°. In five lots tested, one lot had a double optimum for germination; but two other lots weakly indicated a double optimum and in two others no evidence of this appeared. Temperatures tested varied from 8° to 57° C.

341. Heit, C. E.
1958. **The effect of light and temperature on germination of certain hard pines and suggested methods for laboratory testing.** Assoc. Offic. Seed Anal. Proc. 48: 111-117, illus.

For testing pitch pine seed, the author recommends blotters as a substrate, temperatures of 20 to 30° C., and use of artificial light if needed during an 8-hour high-temperature period. First count should be made at 7 to 10 days, final count at 14 days.

342. Heit, C. E.
1961. **Shorter germination test durations for tree seeds.** Int. Seed Testing Assoc. Proc. 26(3): 428-436.

For pitch pine the author recommends placing seeds on top of blotters at 20 to 30° C., alternating temperature with artificial light during 8-hour high-temperature period, and germination period of 6 to 10 days. Prechilling is unnecessary.

343. Heit, C. E.
1967. **Propagation from seed. Part 10: Storage method for conifer seeds.** Amer. Nurseryman 126(8): 14-15, 38, 40, 42-44, 46, 48, 50, 52, 54, illus.

Store pine seeds at moisture contents of 5 to 8 percent under sealed refrigeration (34 to 38° F.). Pitch pine seed will keep for 1 or 2 years without cold storage if moisture content is less than 10 percent.

344. Heit, C. E.
1968. **Thirty-five years' testing of tree and shrub seed.** J. Forestry 66: 632-634.

Pitch pine seed requires only artificial light for rapid and complete germination within 7 to 12 days in laboratory tests.

345. Heit, C. E., and E. J. Eliason.
1940. **Coniferous tree seed testing and factors affecting germination and seed quality.** N. Y. State Agr. Exp. Sta. Tech. Bull. 255. 45 pp., illus. Geneva, N. Y.

Methods of seed testing and results with different species are described. In 10 lots of pitch pine seed, 79 percent of the seeds germinated, and 9 percent were empty. Most lots germinated rapidly. Germination of only one lot benefited from prechilling.

346. Perry, George S., and C. A. Coover.
1933. **Seed source and quality.** J. Forestry 31: 19-25.
Larger cones of pitch pine yielded heavier and more viable seeds. Cone size varied among trees, but was rather uniform for a tree. Early-opening cones tended to be larger, but had fewer viable seeds than other cones. Differences were small.

347. Pettis, C. R.
1909. **How to grow and plant conifers in the Northeastern States.** U. S. Dep. Agr., Forest Serv. Bull. 76. 36 pp., illus.
Besides describing general procedures for seed collection and extraction, for nursing and planting practices, and for seeding, the author mentions that pitch pine cones may be collected during September and October and that seeds are easily extracted, with large yields. Average number of seeds is 50,000, and usual germination is 65 to 85 percent.

348. Rules Committee, Association of Official Seed Analysts.
1965. **Rules for testing seeds.** Assoc. Offic. Seed Anal. Proc. 54 (2):1-112.
A sample for germination purposes shall consist of at least 600 seeds. Gives 20 grams as minimum weight for purity analysis of pitch pine seed, number of seeds per gram or ounce, and methods of testing germination of pitch pine seed (following Heit 1958).

349. Toumey, James W., and Clark L. Stevens.
1928. **The testing of coniferous tree seeds at the School of Forestry, Yale University, 1909-1926.** Yale Univ. School Forestry Bull. 21. 46 pp., illus.
On the basis of 11 samples, pitch pine seeds varied between 35,552 to 71,616 per pound, germinated at the rate of 49 to 93 percent and in some samples as high as 49 percent within 15 days, and in commercial lots were about 99 percent pure. Either spring or fall sowing gave successful germination in nurseries.

350. U. S. Forest Service.
1948. **Woody-plant seed manual.** U. S. Dep. Agr. Misc. Pub. 654. 416 pp., illus.
For many species of pine, including pitch pine, this manual lists time of flowering, cone ripening, and seed dispersal; seed-bearing age; frequency of seed crops; number of closed cones per bushel; yield of seed per bushel of cones; number of seeds per pound; purity and soundness of seed; recommended storage and stratification methods for seed; and conditions to use in germination tests. Briefly describes nursery practices, and important sources of nursery injuries and their control.

Nursery Practice (including vegetative propagation)

351. Auten, John T.
1945. **Response of shortleaf and pitch pines to soil amendments and fertilizers in newly established nurseries in the Central States.** J. Agr. Res. 70: 405-426, illus.

Peat used to correct alkalinity beneficially affected height and density of seedlings. Phosphoric acid, superphosphate, and iron phosphate increased height growth, root length, and root weight. Seedling density varied inversely with quantity of phosphorus but was increased by potassium sulfate. Potassium did not stimulate height growth, and nitrogen applied at seeding time lowered seedling density.

352. Choi, S. K.
1966. **Studies on the plus tree grafting (conifer).** Korean Min. Agr. Forestry Office Rural Develop. Res. Rep. 9(2): 97-108, illus.

Grafting experiments included pitch pine and four other species. The author studied effect of compatibility between stock and scion, length of storage period for scion material, type and status of scion, date of grafting, and bagging upon grafting success in field and greenhouse.

353. Heit, C.E.
1967. **Propagation from seed. Part 9: Fall sowing of conifer seeds.** Amer. Nurseryman 126(6): 10-11, 56, 60, 62, 64-69, illus.

Pitch pine seeds may be slightly dormant, and their germination will benefit from fall sowing.

354. Hyun, S. K.
1967. **Physiological differences among trees with respect to rooting.** Int. Union Forestry Res. Organ. 14th Cong. 3: 168-190, illus.

Though pitch pine is relatively difficult to root, differences among tested trees showed high survival and good rootability of cuttings from some trees, low survival and rootability from others. High C/N ratio, low nitrogen level, and relative amounts of root-promoting substances, such as indoleacetic acid, are associated with rootability of pitch pine cuttings.

355. Johnson, Albert G.
1947. **Some effects of "2,4-D," on pines.** J. Forestry 45: 288-289.

Application of 2,4-D in a nursery caused some mortality and damage to pitch pine, but more among current-year seedlings than among those in their second season.

356. Mergen, François.
1954. **Heteroplastic micrografting of slash pine.** USDA Forest Serv. SE. Forest Exp. Sta., Sta. Paper 47. 17 pp., illus. Asheville, N. C.

A slash pine (*Pinus elliottii*) scion 1.5 months old was grafted onto a 4-month-old pitch pine and a year later was 5.6 inches tall.

357. Retan, George A.
1918. **Nursery practice in Pennsylvania.** J. Forestry 16: 761-769.

Describes nursery practices then in use. Application of acid soil decreased damping-off and increased survival of pitch pine seedlings from 62 percent in check beds to 92 percent in treated beds.

358. Santamour, Frank S., Jr.
1965. **Rooting of pitch pine stump sprouts.** Tree Planters' Notes 70: 7-8.
Near Laurel, Md., a stump of a 29-year-old tree produced 108 sprouts 4 to 12 inches long at end of first (1961) growing season. Of sprouts collected in September, 66 percent of those treated with Hormodin No. 3 rooted, but none of the controls. None of the sprouts collected the following January rooted.

359. Yim, Kyong Bin.
1962. **Physiological studies on rooting of pitch pine *(Pinus rigida* Mill.) cuttings.** Korean Inst. Forest Genet. Res. Rep. 2: 22-56, illus.
Rooting success varied with crown position, age of parent tree, season of collection, rooting medium, length of cutting, presence or absence of flower primordia, and treatment with synthetic plant hormones.

Seeding and Planting

360. Adams, W. R., and G. L. Chapman.
1942. **Competition in some coniferous plantations.** Vt. Agr. Exp. Sta. Bull. 489. 26 pp., illus.
Results 28 years after planting 5 species of pine in the Champlain Valley sand plain at spacings of 2 to 8 feet. Pitch pine grew more slowly than jack, red, white, or Scotch pine. Pitch pines at 28 years had mean heights of only 17 to 19 feet. Diameter and height of pitch pines increased with increased spacing, while the number of living trees and basal area per acre declined (from 8,603 trees per acre and 196.7 square feet in the 2-foot spacing).

361. Allen, John C.
1950. **Pine planting tests in the Copper Basin.** J. Tenn. Acad. Sci. 25: 199-216, illus.
In the 23,000-acre man-caused desert of the Tennessee Copper Basin, soil erosion, exposure to climatic extremes, and occasional injurious concentrations of sulfur dioxide present severe difficulties in erosion-control plantings. Of the four native pines, pitch pine has had the slowest height growth during the first 3 to 7 years—0.6 foot per year; loblolly pine has had the most—1.2 feet. However, pitch pine has had the best survival, and one excavated tree per species showed that pitch pine had the most extensive root development. Mixed plantings of loblolly and pitch pines are recommended.

362. Altpeter, L. Stanford.
1941. **Reforestation of sandblows in northern Vermont.** J. Forestry 39: 705-709, illus.
Wind erosion may be severe on cleared lands where soils are

water-deposited sands of glacial origin. Stabilization measures are described. Excellent survival and satisfactory growth of planted pitch pines and other species are mentioned, but no data are given.

363. Boyce, Stephen G., and Robert W. Merz.
1959. **Tree species recommended for strip-mine plantations in western Kentucky.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Paper 160. 12 pp., illus.
Of the pines planted on moderately acid to acid areas, loblolly and pitch pines had the best form. At 10 years pitch pines were shorter than loblolly pines, but slightly taller than Virginia or shortleaf pines. However, the latter two had suffered more tip-moth damage.

364. Boyce, Stephen G., and David J. Neebe.
1959. **Trees for planting on strip-mined land in Illinois.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Paper 164. 33 pp., illus.
Survival of pitch pines was considered satisfactory on all sites except poorly drained ones, but the trees were so crooked and limby that pitch pine was rated the least desirable of the pines. Pitch pines were damaged by tip moths and ice.

365. Bramble, William C., and Maurice K. Goddard.
1942. **Effect of animal coaction and seedbed condition on regeneration of pitch pine in the barrens of central Pennsylvania.** Ecol. 23: 330-335, illus.
The study included aspen, scrub oak, and grass communities and five seedbed treatments of seed spots. In aspen and scrub oak, unfavorable seedbeds—plus destruction of seed by birds or small mammals—prevented pitch pine establishment. In the grass community, covering the seeds with soil or sod, but without protection from birds or mammals, gave successful germination, although only low survival.

366. Bramble, William C., Henry H. Chisman, and Glenn H. Deitschman.
1948. **Research on reforestation of spoil banks in Pennsylvania.** Pa. State Coll. Forest School Res. Paper 10. 6 pp.
Pitch pine was found on acid shale and sandstone banks with pH 3.5 to 4.2. Growth was fairly good; on one bank trees were 36 feet tall and nearly 6 inches d.b.h. after 22 years. Poor survival of recent plantings was attributed to poor planting stock.

367. Bramble, W. C., and H. N. Cope.
1947. **Reforestation with certain trees succeeds on droughty, shallow soils.** Pa. Agr. Exp. Sta. Bull. 480, Suppl. 2: 1-2, illus.
In the Stone Valley Experimental Forest in Huntingdon County, several species were tried for reforesting abandoned fields. Deer browsing was more severe on the planted pitch pines than on other species and caused high mortality and stunting.

368. Brouse, E. F.
1930. **Planted forest trees grow and how.** Pa. Forest Leaves 22: 179-181.

On the basis of plantation studies, pitch pine outgrew other species at 10 years, and at 15 years was second to Scotch pine. Average heights of pitch pine in 25 Pennsylvania plantations were 3.4 feet at 5 years, 8.2 at 10 years, and 13.2 feet at 15 years.

369. Brown, James H., Jr., and Walter P. Gould.
1963. **Direct seeding of conifers in Rhode Island.** Tree Planters' Notes 61: 1-4.
On bulldozed strips, pitch pine seed treated with Arasan-75 and endrin was sown in the fall and spring at the rate of 2 pounds per acre (along with white pine and hemlock seed). After two growing seasons the fall-sown area had 9,428 pitch pine seedlings per acre; the spring-sown area had 6,000. Pitch pine seedlings outgrew white pine seedlings, some of the former being three to four times as tall as the white pine.

370. Brown, James H., Jr., and Walter P. Gould.
1965. **Direct seeding native conifers in Rhode Island.** Univ. Mass. Exp. Sta. Bull., Direct seeding in the Northeast—A symposium, Proc.: 73-75.
After five growing seasons in the study described above (*Brown and Gould 1963*), the fall-sown area had 9,430 pitch pines per acre; the spring-sown areas had 6,000. Seedlings from fall sowing were 31 inches tall, those from spring sowing 27 inches tall. Both lots were much taller than white pine seedlings (10 and 9 inches respectively).

371. Brown, R. M.
1928. **Survival and growth of trees planted in Rock Creek Arboretum, Washington, D. C.** J. Forestry 26: 94-104.
Planted pitch pines survived at the rate of 81 to 100 percent and over about a 9-year period had a mean annual height growth of 1.0 to 1.9 feet.

372. Buttrick, P. L.
1920. **American trees for forest planting in France.** J. Forestry 18: 815-822.
Pitch pine is suggested for dune stabilization in northern France, a section where maritime pine is not hardy.

373. Chapman, A. G.
1937. **An ecological basis for reforestation of submarginal lands in the central hardwood region.** Ecol. 18: 93-105, illus.
The range of pitch pine in southern Ohio and Kentucky is limited to residual sandstone soils and cherty mantle. The author recommends yellow pines for poorer, drier slopes. In northern states of the region, planted pitch pines are usually 1-1 transplants; farther south 1-0 seedlings are planted.

374. Chapman, A. G., and R. D. Lane.
1951. **Effects of some cover types on interplanted forest tree species.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Paper 125. 15 pp., illus.

Planted pitch pines or other pines can serve in preparing sites for later interplanted hardwoods, but form a less desirable nurse crop than black locust. Within 13 years all pitch pines planted in mixture with black locust were overtopped and had died.

375. Clark, F. Bryan.
1954. **Forest planting on strip-mined land in Kansas, Missouri, and Oklahoma.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Paper 141. 33 pp., illus.
After 6 years, pitch pines planted as 1-0 stock on 12 sites had 0 to 78-percent survival and mean heights of 2.5 to 5.8 feet. Survival and growth were best on north and east slopes, least in bottoms. Amount of cover influenced first-year survival.

376. Committee on Site Classification, Northeastern Forest Soils Conference.
1961. **Planting sites in the Northeast.** USDA Forest Serv. NE. Forest Exp. Sta., Sta. Paper 157. 24 pp., illus. Upper Darby, Pa.
The committee described sites in broad terms, and recommended species for forest plantings on these sites in different areas of the Northeast. Pitch pine was recommended for some sections, usually on the more adverse sites (droughty to very poorly drained).

377. Curlin, James W.
1962. **Planted pitch pine responds to fertilization.** Tree Planters' Notes 55: 3-4.
In the Copper Basin of Tennessee, planted pitch pines survived far better (95 percent) than loblolly, shortleaf, or Virginia pines. Survival was not affected by fertilizer treatments, but over a 7-year period height growth was favored by single fertilizer treatments. Nitrogen increased early growth; phosphorus and potassium appeared to be largely responsible for long-term increase in height growth.

378. Davis, Grant, and Rex E. Melton.
1962. **Plantations on strip-mine banks can yield timber products.** Pa. State Forest School Res. Paper 29. 2 pp.
On strip-mine banks in Pennsylvania's bituminous coal region, plantations of pitch pine after 25 years contained larger trees and more volume than those of jack or table-mountain pine, but smaller trees and less volume than those of red, white, or Scotch pine.

379. Davis, Grant, and Rex. E. Melton.
1963. **Trees for graded strip-mine spoils.** Pa. State Forest School Res. Paper 32. 4 pp.
Performance of 15 species was rated on graded spoil banks of Pennsylvania's bituminous region. Plantations of pitch pine were classed as good in survival and height growth on the spoils of three coal seams, satisfactory on those of four other seams.

380. Deitschman, Glenn H., and Richard D. Lane.
1952. **Forest planting possibilities on Indiana coal-stripped lands.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Paper 131. 57 pp., illus.

Pitch pine is one of the species recommended for acid or calcareous sands in the Illinoian Glaciated Region. Data are for 4- or 5-year survival and height growth in experimental plantings that included pitch pine.

381. Diebold, C. H.
1940. **Strip planting for flood control.** J. Forestry 38: 810-812, illus.
Use of pitch pine is recommended in plantings for flood control in Pennsylvania. Pitch pine crowns close almost as soon as those of Scotch pine, and 2 to 4 years sooner than those of red or white pine. Pitch pine also develops a deeper humus layer (1½ to 2 inches deep after 15 years). Suggests arrangement of pitch pine and other species for flood control and timber production.

382. Emerson, George B.
1850. **A report on the trees and shrubs growing naturally in the forests of Massachusetts.** 547 pp. Charles C. Little and James Brown, Boston.
Pitch pine is commonly 40 to 50 feet tall and 1 to 2 feet in diameter at the base, but some trees reach heights of 100 feet or more and diameters of 4 or 5 feet. Its wood has been used in ship-building; for floors, water wheels, pumps, sills and framing of buildings, railroad ties, nail casks, and fuel. On old fields natural reproduction grows at the rate of an inch in diameter in 3 or 4 years for the first 25 years and then 1 inch in 5 or 6 years. Seedlings reach heights of 3 to 4 inches in the first year, are up to 2 feet tall in 3 years, and then may grow 2 or 3 feet a year on favorable sites. Pitch pine is resistant to salt spray and is recommended for dune plantings.

383. Finn, Raymond F.
1958. **Ten years of strip-mine forestation research in Ohio.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Paper 153. 38 pp., illus.
Pitch pine had better survival and growth when planted on silty-shale ungraded banks with pH 3.0 to 5.0 than on spoils of calcareous clay or limestone with a pH of 7.0.

384. Gibbs, J. A.
1948. **Growth of tree plantings for erosion control in the southeastern region.** Iowa State Coll. J. Sci. 22: 371-386, illus.
Pitch pine was one of the species planted for erosion control in the Southeast (Virginia and Kentucky southward). Though it and Virginia pine proved to be rugged on eroded sites in the northern part, both are recommended only in mixture with shortleaf or white pine.

385. Goldring, W.
1887. **Trees and shrubs. The American pitch pine *(Pinus rigida).*** Gard. 31: 128, illus.
A brief description of the natural range of pitch pine and its distinguishing characteristics. The species is recommended for orna-

mental plantings on severe sites in England. Early plantings made as much as 130 years ago are mentioned.

386. Grisez, Ted J.
1968. **Growth and development of older plantations in northwestern Pennsylvania.** USDA Forest Serv. Res. Paper NE-104. 40 pp., illus. NE. Forest Exp. Sta., Upper Darby, Pa.
A follow-up on Hetzel's study, it includes data on three pitch pine plantations 40 to 45 years old. The author recommends other species and not pitch pine.

387. Hart, George E., and William R. Byrnes.
1959. **Performance of trees planted on coal-stripped lands in the bituminous region of Pennsylvania.** Pa. State Forest School Res. Paper 28. 2 pp.
Pitch pine was rated as intermediate in site requirements, and is adapted to all sites except those with extreme slopes or with severe wind exposure. Pitch pines 10 years after planting had a survival of 36 percent and were 8.2 feet tall. Pitch pine was not recommended where pine sawflies are common.

388. Hart, George, and William R. Byrnes.
1960. **Trees for strip-mined lands.** USDA Forest Serv. NE. Forest Exp. Sta., Sta. Paper 136. 36 pp., illus. Upper Darby, Pa.
For planting on strip-mined lands of Pennsylvania's bituminous region, pitch pine was rated only as fair. This conclusion was based on 10-year survival and height and diameter growth. In several plantings pitch pines were stunted, possibly because of severe winds or partly because of seed origins.

389. Hetzel, J. E.
1941. **Forest plantations in northwestern Pennsylvania.** USDA Forest Serv. Allegheny Forest Exp. Sta. Occas. Paper 3. 6 pp., illus.
Data on survival, height, and diameter of four plantations 19 to 24 years from seed. Pitch pine was rated about medium among conifers in growth and form, but on medium sites was dropped to seventh place (just ahead of white pine) in relative performance of conifers.

390. Illick, J. S.
1919. **Preliminary report of some forest experiments in Pennsylvania.** J. Forestry 17: 297-311, illus.
About 1.5 million pitch pines had been planted on State lands in Pennsylvania. For converting low-value stands, the author recommended planting 600 to 1,000 2-0 seedlings per acre under existing growth, and beginning release cuttings 2 or 3 years after planting.

391. Keller, John W.
1925. **Free distribution of forest trees in Pennsylvania.** J. Forestry 23: 896-904.
In a survey of plantations established between 1915 and 1922, 89 percent of 71,800 planted pitch pines were still alive. Where pitch

pines older than 2 years were used, survival rate was lower.

392. Leach, Walter.
1935. **Fall planting of conifers.** Pa. Forest Leaves 25: 75, 79.
Planting in October and November may be successful on Pennsylvania sites not subject to frost heaving: in one test pitch pines had 82 to 85 percent survival 1 year after fall planting.

393. Limstrom, G. A.
1960. **Forestation of strip-mined land in the Central States.** U. S. Dep. Agr. Agr. Handb. 166. 74 pp., illus.
Conditions suited to pitch pine are described, but pitch pine is not recommended for large-scale planting.

394. Limstrom, G. A., and G. H. Deitschman.
1951. **Reclaiming Illinois strip coal lands by forest planting.** Univ. Ill. Agr. Exp. Sta. Bull. 547: 201-250, illus.
In Saline and St. Clair Counties, survival of 8-year-old plantings of pitch pine ranged from 49 to 98 percent and height growth averaged 1.5 feet per year. Second-year survival of plantings in several counties varied from 3 to 84 percent. Counties and conditions where pitch pine is one of the recommended species for planting are given.

395. Little, S.
1965. **Direct seeding in southern New Jersey and the Pennsylvania Poconos.** Univ. Mass. Exp. Sta. Bull., Direct Seeding in the Northeast—A Symposium, Proc.: 64-68.
Describes procedures necessary for direct-seeding pitch pine successfully on moderately to excessively drained soils of southern New Jersey. Drought severely limited success in 10 percent of the years on all upland sites, and more often on the driest sites.

396. Little, S., C. B. Cranmer, and H. A. Somes.
1958. **Direct seeding of pitch pine in southern New Jersey.** USDA Forest Serv. NE. Forest Exp. Sta., Sta. Paper 111. 14 pp., illus. Upper Darby, Pa.
Tests included seed spots and broadcast sowing, disking and prescribed burning for seedbed preparation, brush-hogging to reduce competition and cover broadcast-sown seed, on different well or imperfectly drained soils. Results showed that for adequate amounts of pine reproduction, these conditions need to be met: (1) sufficient sound seed, sown preferably in January or February; (2) a favorable seedbed; (3) light cover of soil or debris over seed; (4) sufficient protection from rodents and birds; and (5) favorable weather for at least two growing seasons.

397. Ludwig, Walter D.
1923. **Reforestation by coal companies in southwestern Pennsylvania.** J. Forestry 21: 492-496.
To meet the needs of coal companies and to make brush lands and abandoned farm lands productive, planting of pitch pine or other conifers is recommended.

398. Ludwig, Walter D.
1924. **Reforestation progress and costs in southwestern Pennsylvania.** J. Forestry 22: 184-189.
Pitch pines planted in 1916 as 2-0 stock had current annual height growth of 1.6 feet, average annual growth of 0.85 feet. Those 4 years old when planted in 1920 had growth values of 1.6 and 0.6 feet, respectively. Values based on 66 and 47 trees.

399. McConkey, Thomas W.
1964. **Direct seeding of pine and spruce in southwestern Maine.** USDA Forest Serv. Res. Paper NE-24. 13 pp., illus. NE. Forest Exp. Sta., Upper Darby, Pa.
Effects of seedbed preparation and shade on germination and first-year establishment of five coniferous species were studied. Pitch pine germination and establishment were best on scalped, shaded spots sown in the spring, although the difference between spring and fall sowing was small. Pitch pine seemed to have less exacting moisture requirements than red or white pines.

400. McConkey, T. W.
1965. **Intolerant species and direct seeding.** Univ. Mass. Exp. Sta. Bull., Direct Seeding in the Northeast—A Symposium, Proc.: 97-98.
Direct seeding is usually more successful with intolerant species than with tolerant species, because the former have early and rapid germination of seed, the growth habit (as in pitch pine) may protect seedlings from heat injury, and these intolerant species are better adapted to sites commonly selected for direct seeding.

401. McLintock, Thomas F.
1940. **Effects of ground preparation on survival and growth of planted pine and black locust.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Note 23. 4 pp.
In Hocking County, Ohio, and in southern Illinois, plowing or furrowing before planting old-field sites increased the height growth of pitch pines, but by 0.6 foot or less during a 3- or 5-year period.

402. McLintock, Thomas F.
1942. **Stratification as a means of improving results of direct seeding of pines.** J. Forestry 40: 724-728.
Stratification of seed improved both germination and catch in direct seeding pitch pine. Effects were much more pronounced on northern slopes than on southern slopes.

403. McNamara, E. F., and Irvin C. Reigner.
1955. **Root competition slows growth of plantings on unprepared sites in scrub oak.** USDA Forest Serv. NE. Forest Exp. Sta. Forest Res. Note 54. 3 pp. Upper Darby, Pa.
In scrub oak on the Delaware-Lehigh Experimental Forest in Pennsylvania, pitch pines planted in 4-foot-wide bulldozed furrows were 4.2 feet tall, those in ammate-treated strips were 3.8

feet, and those in openings of unprepared sites were 2.4 feet tall after 5 years.

404. McQuilkin, W. E., Irvin C. Reigner, and Eugene McNamara. 1953. **Scrub oak conversion studies. *In* Forest and Water Research Project, Delaware-Lehigh Experimental Forest.** Pa. Dep. Forests and Waters Rep. 2: 1-7, illus.

The 1948 plantings of pitch pine did poorly because of poor stock. For 1950 plantings made in furrows 3 to 4 feet wide, pitch pine survival was 90 percent in 1952, and pitch pines were growing nearly as fast as jack pines. A desirable density of natural reproduction was obtained where bulldozers exposed mineral soil within 100 feet of seed trees.

405. McQuilkin, W. E., E. F. McNamara, and Irvin C. Reigner. 1955. **Scrub oak conversion studies. *In* Forest and Water Research Project, Delaware-Lehigh Experimental Forest.** Pa. Dep. Forests and Waters Rep. 3: 1-9, illus.

In the Poconos, planted pitch pines have been loosened by high winds. Pitch pines have grown better on prepared sites than when interplanted: on furrowed sites mean height was 4 feet after 5 years. Additional trials of direct seeding were failures. Excessive deer browsing has prevented adequate survival and growth of natural reproduction obtained by scarification near seed sources.

406. McQuilkin, W. E., and E. F. McNamara. 1961. **Scrub oak conversion. *In* Forest and Water Research Project, Delaware-Lehigh Experimental Forest.** Pa. Dep. Forests and Waters, Rep. 4: 1-16, illus.

Pitch pine has outgrown red pine in conversion studies started in 1948, but is rated in second-order preference because it is considered less desirable for timber production. Some pitch pines have been severely browsed by deer, and a few were not windfirm. After 8 years pitch pines had a mean height of 6.3 feet. Factors affecting success of direct seeding on Pocono sites are discussed.

407. McQuilkin, William E., and Eugene F. McNamara. 1967. **Tree planting in scrub oak areas after site preparation with heavy equipment.** USDA Forest Serv. Res. Paper NE-60. 26 pp., illus. NE. Forest Exp. Sta., Upper Darby, Pa.

Describes techniques possible on stony sites where sufficient soil is exposed to permit planting. None of the pitch pines planted on the Dilldown Unit (Delaware-Lehigh Forest) on the Pocono (Pa.) Plateau is developing in good form, so until genetic strains of good form are available, extensive planting of this species is not recommended.

408. Meek, Chas. R. 1929. **Forest tree seedlings for reforestation or for distribution?** J. Forestry 27: 943-948.

Based on a survey of 961 plantations on private land in Pennsylvania, recommendations are made to improve the selection of species and sites, the planting practices, and the care of plantations.

Ten percent of the stock recommended for production is pitch pine. Survival of the 595,996 pitch pines planted in areas included in the survey was 41 percent.

409. Meekins, E. H., H. J. Deion, and C. Tiffany.
1965. **Effect of site preparation on direct seeding conifers in the brush oak type in Rhode Island.** Univ. Mass. Exp. Sta. Bull., *Direct Seeding in the Northeast—A Symposium*, Proc: 71-73.

In a 1951 burn that was stocked with bear oak, red and white oak, red maple, and pitch pine, these 1964 site-preparation measures were tried: disking in late April and May, controlled burning on 21 May, and a mistblower treatment with Tordon 101 in part of the disked area on 21 May. Treated seeds of pitch pine, larch, and white pine were sown on 22 May. In August stocking was unsatisfactory, possibly because of the drought.

410. Minckler, Leon S.
1948. **Planted pines on claypan soils of southern Illinois.** USDA Forest Serv. Cent. States Forest Exp. Sta., Sta. Note 44. 2 pp., illus.

Eight years after planting 1-1 stock, pitch pines were 14 feet tall with 90-percent survival; those planted as 1-0 stock were 11 feet tall with 70-percent survival. Shortleaf pine is recommended over pitch and Virginia pines because the latter two have excessive branching and crook.

411. Minckler, Leon S.
1955. **Observations on open-grown, non-native conifers in southern Illinois.** Amer. Midland Natur. 54: 460-465, illus.

The one measured pitch pine was 22 inches d.b.h. and 78 years old.

412. Minckler, Leon S., and Arthur G. Chapman.
1954. **Direct seeding of pines in the central hardwoods region.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Paper 140. 20 pp., illus.

Pitch pine was one of six pine species used in a series of experiments. Seeding in spots is not recommended, but suggested procedures are given both for this type of seeding and for seeding in furrows. When seeding in furrows in areas covered by broomsedge or poverty grass, three viable seeds of pitch pine should be sown per linear foot with a push-type mechanical seeder.

413. Minckler, Leon S., and Glenn H. Deitschman.
1953. **Success of planted pines varies with species and site.** USDA Forest Serv. Cent. States. Forest Exp. Sta., Sta. Note 76. 2 pp., illus.

On claypan soils of southern Illinois, planted pitch pines had good survival and fair growth, but after 13 years were 16 to 24 feet tall compared to 32 to 38 feet for loblolly pines and 22 to 26 feet for shortleaf pines. However, the pitch pines were slightly taller than Virginia pines.

414. Newby, A. E.
1968. **Giving nature a hand: NAS Lakehurst reclaims fire-damaged forest.** Navy Civ. Engin. 9(5): 19-20, illus.
Where wildfires had changed stand composition to slow-growing sprouts of pitch pine and scrub oaks, Marden brush-clearing drums were used to chop the existing growth and prepare the site for direct seeding. Plans are to treat 100 acres each spring, and to retreat 8 weeks later. Seeding with cyclone-type hand seeders in January after treatment is at the rate of 70,000 seeds per acre. Pitch pine seedlings reach 7 to 10 inches in height during the first summer.

415. Ostrom, C. E., and Miles J. Ferree.
1942. **Species and sizes of stock for planting in northwestern Pennsylvania.** USDA Forest Serv. Allegheny Forest Exp. Sta. Tech. Note 37. 1 p.
Because of ability to sprout after browsing, planted pitch pines had almost 60-percent survival.

416. Polivka, J. B., and O. A. Alderman.
1937. **The problem of selecting the desirable pine species for forest planting in Ohio.** J. Forestry 35: 832-835.
Pitch pine is considered the least desirable native pine for planting in Ohio, partly because of tip moth damage. White, jack, red, shortleaf, and Austrian pines are recommended ahead of pitch pine. On the basis of examining 295 pitch pines, the authors list the species of insects and leaf diseases and the number of trees damaged by them or by sapsuckers.

417. Rothrock, J. T.
1889. ***Pinus rigida* on the dunes at Cape Henlopen.** Pa. Forest Leaves 2: 83-85, illus.
Pitch pine provided naval stores in colonial days and its wood was used in shipbuilding, for fuel, and for charcoal. Although pitch pine grows on coastal dunes and stabilizes them, its forests can be buried under drifting sand. Advance of the dune at Cape Henlopen, Delaware, is described, and stabilization of the dune by planting pitch pine and other plants is recommended.

418. Sargent, C. S.
1891. **The northern pitch pine.** Gard. and Forest 4 (183): 397, 402, illus.
Pitch pine grows naturally on poor soils—sandy barrens and sour swamps—and is recommended for the barrens of Cape Cod and southern New Jersey where it is the most productive species. Seedlings can be easily raised by sowing seed in open ground. On good sites pitch pine reached diameters of 2 to 3 feet, and such trees were prized for timbers and flooring. As an ornamental, pitch pine might be planted to cover barren knolls.

419. Silviculture Committee, Allegheny Section, Society of American Foresters.
1961. **Tree planting in the Allegheny Section.** USDA Forest

Serv. NE. Forest Exp. Sta., Sta. Paper 158. 18 pp., illus. Upper Darby, Pa.

Describes practices used to establish forest plantations in physiographic regions of the five-state area. Pitch pine is planted in all states, usually as 2-0 stock. Diseases and insects to which planted pitch pines are susceptible are listed. Pitch pine is among the species recommended for planting on bituminous strippings of Pennsylvania and West Virginia.

420. Stevenson, Donald D., and R. A. Bartoo.
1940. **Coniferous forest plantings in central Pennsylvania.** Pa. State Coll. Agr. Exp. Sta. Bull. 394. 20 pp., illus.

Pitch pine is recommended for planting on poor, dry sites. Where planted with red, Scotch, and white pines in 1927, pitch pine surpassed other species in height growth. Average annual increment of pitch pine in pure plantings was 0.23 inches in diameter (b.h.) and 1.24 feet in height. A spacing of 6 by 6 feet is recommended for pitch pine even though diameter growth is greater at wider spacings.

421. Stone, E. L.
1968. **A check list for planting site appraisal.** Cornell Univ. Conserv. Circ. 6(4): 1-4.

Planting of pitch pine is recommended only for sandy or droughty soils, and pitch pine is only one of three or four pine species suggested for these. Indications of sandy or droughty soils are described.

422. Storey, Herbert C.
1951. **Forest and water research project, Delaware-Lehigh Experimental Forest.** Pa. Dep. Forests and Waters. 44 pp., illus.

Studies in converting scrub oak areas of the Poconos to commercial forests are described. Pitch pine was one of the species used in planting and direct-seeding trials, and methods and results are described. Site preparation to favor the establishment of natural reproduction of pitch pine was also tested.

423. Tillotson, C. R.
1921. **Some instances of sand dune planting.** J. Forestry 19: 139-140.

One method for stabilizing dunes near Provincetown, Mass., is to cover land with brush cut from native pitch pine stands and, after this had rotted, plant pitch pine wildlings.

424. U. S. Soil Conservation Service.
1950. **Forestry handbook for the upper Mississippi Region (Ed. 5).** U. S. Dep. Agr., Agr. Handb. 13. 101 pp., illus.

Pitch pine has a medium growth rate and is recommended for planting on heavy and light acid soils and on ridges or southern and western slopes of stripped coal land. Common diseases include Atropellis canker and sweetfern rust.

425. Walters, Russell S.
1959. **Conversion planting on poor hardwood sites shows promise in Ohio.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Paper 168. 5 pp., illus.

Hardwoods were clearcut on a ridge-top site; and pitch, shortleaf, and white pines were planted. After 5 years 71 percent of the surviving pitch and shortleaf pines were free to grow even where not released. Early release favored survival and growth, but in the study area did not appear necessary.

426. Weston, G. C.
1957. **Exotic forest trees in New Zealand.** New Zeal. Forest Serv. Bull. 13. 104 pp., illus.

Pitch pine had been introduced by 1868, and subsequently small plantings had been made. The trees had grown up to 2 feet in height annually in early years and reached 70 feet in height and 15 inches d.b.h. at 47 years. However, planting of pitch pine is suggested only for further trials at high altitudes.

427. Wood, O. M.
1936. **Early survival of some pine interplantings in southern New Jersey.** J. Forestry 34: 873-878, illus.

In a 7-year-old stand of sprout oaks and pitch pine, the interplanting of seedlings of several pine species, including pitch pine, was tried. Drought, competition, and animal damage affected survival of the planted seedlings during the first 4 years.

Natural Regeneration (including harvest cutting, seedbed treatment, and release)

428. Burns, Paul Yoder.
1952. **Effect of fire on forest soils in the Pine Barren region of New Jersey.** Yale Univ. School Forestry Bull. 57. 50 pp., illus.

Effect of 0 to 11 or 15 prescribed burns was studied in two experimental areas with stands of mixed oaks and pitch and shortleaf pines. One was on Lakewood soil; the other on Evesboro soil. Amount, thickness, and N content of the forest floor were determined, as well as chemical properties of the A horizon and the physical properties of the surface mineral soil. Moderate burning treatments did not appreciably modify chemical and physical properties of the mineral soil. Annual burning for long periods had unfavorable effects on the forest floor, but benefited the mineral soil chemically.

429. Frothingham, E. H.
1943. **Some observations on cutover forests in the southern Appalachians.** J. Forestry 41: 496-504, illus.

Pitch pine is mentioned, but is grouped with other yellow pines in results of surveys. In the forest composition these pines were a

minor component, and formed a smaller proportion of the new stand than of the original.

430. Little, S.
1953. **Prescribed burning as a tool of forest management in the Northeastern States.** J. Forestry 51: 496-500.
In some forest types fire may have an ecological role. The author described differences among pitch, pond, loblolly, and shortleaf pines in sprouting, production of closed cones, size of seed, desirable seedbed, and seedling growth; and discussed effects of wild and prescribed fires on stand composition in New Jersey and Maryland pine sections, the advantages and disadvantages of prescribed burning, and effects on growth, site, and game.

431. Little, S.
1963. **Mistblower treatments in regenerating preferred species in the forests of New Jersey, eastern Maryland, and eastern Pennsylvania.** NE. Weed Contr. Conf. Proc. 17: 517-526.
For selective release of pitch pines from competing bear, blackjack, black, white, or chestnut oaks, the author recommended mistblower treatments in June, using 2 pounds acid equivalent of the isooctyl ester of 2,4,5-T in 2 quarts of fuel oil and 4 gallons of water. Formulations were suggested for use in preparing sites for natural regeneration in southern New Jersey or for direct seeding of desired species in converting Pocono pitch pine-scrub oak stands.

432. Little, S., and R. H. Fenton.
1964. **1963 results from injector treatments of New Jersey and Maryland hardwoods.** NE. Weed Contr. Conf. Proc. 18: 584-590.
For killing common hardwood associates by individual-stem treatments, the authors recommended complete, low frills, the use of either 2,4,5-T ester or amine, and the application of about 1.5 ml. of 20-, 40-, or 80-pound aehg. solutions to each injector cut. For high kills the first year use 80-pound aehg. solutions.

433. Little, S., J. P. Allen, and H. A. Somes.
1948. **More about the technique of prescribed burning.** USDA Forest Serv. NE. Forest Exp. Sta. 4 pp. Upper Darby, Pa.
For cheap and satisfactory burns under stands, burn only upland sites with fairly continuous fuel at times when firing with the wind gives proper fire intensity; set lines of fire about 1,000 feet apart. To prevent crown scorch (caused by temperatures of 145° F. for 2½ minutes), burn when air temperatures are less than 50°F.

434. Little, S., and E. B. Moore.
1945. **Controlled burning in South Jersey's oak-pine stands.** J. Forestry 43: 499-506, illus.
Effects of 0 to 3 or 5 prescribed burns on mortality and basal wounding of oaks and pitch and shortleaf pines and on establishment of pine reproduction. Effect on shrub height and cover and on forest floor is also described, and recommendations are given on

use of fire in seedbed preparation, on cleanings, and on type of harvest cutting. Cost of burning and effect on soils are also discussed.

435. Little, S., and E. B. Moore.
1950. **Effects of prescribed burns and shelterwood cutting on reproduction of shortleaf and pitch pine.** USDA Forest Serv. NE. Forest Exp. Sta., Sta. Paper 35. 11 pp. Upper Darby, Pa.
In two studies in oak-pine stands, the amount of shortleaf and pitch pine reproduction after harvest cutting increased with number of burns before cutting. Shelterwood cutting before burning also encouraged the establishment of pine seedlings, but is less important than burning. Recommended treatments for obtaining adequate and prompt regeneration are given; and losses because of logging damage or drought are described.

436. Little, S., and E. B. Moore.
1952. **Mechanical preparation of seedbeds for converting oak-pine stands to pine.** J. Forestry 50: 840-844, illus.
Different methods of slash disposal and two methods of scarification after seed-tree cuttings were tried. Results indicate that satisfactory reproduction of pitch and shortleaf pines is obtained only when fair or better seed crops occur within the next year. Because of the type of machinery used in this study, subsequent release from hardwood sprouts was necessary.

437. Little, S., and E. B. Moore.
1953. **Severe burning treatment tested on lowland pine sites.** USDA Forest Serv. NE. Forest Exp. Sta., Sta. Paper 64. 11 pp. Upper Darby, Pa.
In pitch pine stands on poorly drained Leon soils, a hot deep-burning fire in late summer or early fall and before or after a seed-tree cutting may eliminate much of the competing vegetation and favor pine reproduction. In the trials described, the first-year catch of pine seedlings on severe burns varied with site from 6,700 to 22,800 per acre—far more than occurred on light burns or unburned areas.

438. Little, S., H. A. Somes, and J. P. Allen.
1952. **Choosing suitable times for prescribed burning in southern New Jersey.** USDA Forest Serv. NE. Forest Exp. Sta., Sta. Paper 51. 7 pp. Upper Darby, Pa. (Also USDA Forest Serv. Fire Contr. Notes 14 (1): 21-25.)
Describes fire-danger ratings when satisfactory burns have been made in oak-pine (pitch and shortleaf) stands, in upland pine stands, and in pine-swamp (pitch pine) stands.

439. Little, S., and H. A. Somes.
1949. **Slash disposal in oak-pine stands of southern New Jersey.** USDA Forest Serv. NE. Forest Exp. Sta., Sta. Paper 31. 12 pp. Upper Darby, Pa.

Slash may form an appreciable hazard where there are dense shrubby understories and thick duff layers. Slash is often not greatly damaging to established reproduction of pitch and shortleaf pines and may protect it from deer browsing. If the seedbed is poor for additional pine reproduction, slash deteriorates it, but has little effect on favorable seedbeds prepared by periodic prescribed fires before harvest cutting.

440. Little, S., and H. A. Somes.
1952. **Poisoning hardwoods in southern New Jersey.** USDA Forest Serv. NE. Forest Exp. Sta. Res. Note 16. 4 pp. Upper Darby, Pa.
Results from using ammate in cups on standing trees of associated species, and from using ammate or a spray of 2,4-D and 2,4,5-T on stumps. To favor pine reproduction, the use of ammate crystals on the edges of freshly cut stumps is suggested wherever vigorous sprouting of oaks after cutting is expected.

441. Little, S., and H. A. Somes.
1961. **Prescribed burning in the pine regions of southern New Jersey and Eastern Shore Maryland—a summary of present knowledge.** USDA Forest Serv. NE. Forest Exp. Sta., Sta. Paper 151. 21 pp., illus. Upper Darby, Pa.
Describes differences between the two sections: the Eastern Shore where loblolly and pond pines are most common, and southern New Jersey where pitch and shortleaf pines predominate. Periodic light winter fires before harvest cutting favor the establishment of pitch and shortleaf pine reproduction (both advance and subsequent) in oak-pine stands and to a lesser extent in pitch pine-scrub oak stands. Such fires are usually not recommended for pitch pine-lowland stands where a hot, deep-burning fire in late summer or early fall seems more desirable for favoring establishment of pine reproduction.

442. Moore, E. B., *et al.*
1946. **Minimum forest practices recommended for the Allegheny Section territory.** J. Forestry 44: 597-599.
Recommended even-aged management, seedbed preparation, and thinning of immature stands in the yellow pine-hardwood type (including pitch and other pines).

443. Somes, H. A., and G. R. Moorhead.
1950. **Prescribed burning does not reduce yield from oak-pine stands of southern New Jersey.** USDA Forest Serv. NE. Forest Exp. Sta., Sta. Paper 36. 19 pp. Upper Darby, Pa.
Data on mortality, basal wounding, basal-area and diameter growth in oak-pine stands subjected to 0 to 10 prescribed winter fires. Mortality and open wounds on pitch and shortleaf pines were limited to stems 1 inch or less in diameter (b.h.). While oaks suffered far more wounding and mortality than pines, damage was

concentrated on small, overtopped stems so growth and yields were not affected.

444. Sowers, David W., *et al.*
1956. **Some factors affecting management of conifers and hardwoods in the Allegheny Region.** J. Forestry 54: 563-567.
For stands composed of shortleaf and pitch pines and oaks, recommended measures for pine management include seed-tree cuttings, seedbed preparation chiefly through prescribed burning, a cleaning at 5 to 8 years, thinnings at about 20 years, and a rotation age of about 40 years (pulpwood the chief product).

Stand Improvement

445. Little, S., and H. A. Somes.
1964. **Releasing pitch pine sprouts from old stools ineffective.** J. Forestry 62: 23-26, illus.
A summary of literature and knowledge about the cause of Plains vegetation, and results from reducing competition in present stands. Poisoning all sprout clumps except 400 selected pitch pine sprouts per acre doubled their diameter growth, but did not affect height growth in a 6-year period. Present sprout stands should be converted to seedling stands if trees of merchantable quality are to be grown.

446. McLintock, Thomas F.
1940. **Effect of intensity of pruning on sprout formation in young planted pitch pine.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Note 21. 3 pp.
When applied to 6-year-old planted pitch pines, removal of 1/4, 1/2, or 3/4 of the crown induced sprouting on pruned portions of stems. Sprouts on heavily pruned trees were 14 times as dense as on lightly pruned trees.

447. McLintock, Thomas F.
1940. **Growth response of planted pitch pine to differential pruning.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Note 15. 2 pp.
In a 1935 plantation in southern Illinois, first-year response to a 1939 pruning showed that light to heavy pruning did not affect height growth, light to moderate pruning did not appreciably affect diameter growth, and heavy pruning caused a heavy loss in diameter increment. However, this was less at 4.5 feet than at 1.5 feet above ground.

Tree Measurements (Including volume tables)

448. Anonymous.
1935. **Bark thickness.** J. Forestry 33: 624-626.
At breast height, thickness of pitch pine bark varied from 0.19 inch on trees 2 inches d.b.h. to 1.74 inches on 12-inch trees; at 1

foot above ground bark thickness varied from 0.41 inch to 1.99 inches. These thicknesses were similar to those of table-mountain pine, greater than those of Virginia pine, and far greater than those of associated hardwoods.

449. Bartoo, R. A., and R. J. Hutnik.
1962. **Board foot volume tables for timber tree species in Pennsylvania.** Pa. State Forest School Res. Paper 30. 35 pp.
Volume tables for pitch pine according to International and Scribner log rules.

450. Burnham, C. F., M. J. Ferree, and F. E. Cunningham.
1946. **Site class volume tables for merchantable timber in the Anthracite Region of Pennsylvania.** USDA Forest Serv. NE. Forest Exp. Sta. Forest Manag. Paper 3. 16 pp.
Volume tables per tree for pitch pine on class 2 and 3 sites. Merchantable volumes are given in board feet, cubic feet, and tons.

451. Cunningham, F. E., S. M. Filip, and M. J. Ferree.
1947. **Relation of tree-stump diameter to diameter breast high.** USDA Forest Serv. NE. Forest Exp. Sta., Sta. Note 1. 3 pp.
Shows diameter at 0.5 or 1.0 foot above ground for pitch pines 5 to 18 inches d.b.h.; gives reverse relationship.

452. Emmer, R. E.
1941. **Volume table for pitch pine *(Pinus rigida)*, Jackson and Hocking Counties, Ohio.** USDA Forest Serv. Cent. States Forest Exp. Sta. Tech. Note 43. 1 p.
Gross volume in board feet for stems 9 to 18 inches d.b.h. containing one, two, or three 12.3-foot logs.

453. Hampf, Frederick E.
1957. **Relationship of stump diameter to d.b.h. for pitch pine in the Northeast.** USDA Forest Serv. NE. Forest Exp. Sta. Forest Res. Note 65. 3 pp., illus. Upper Darby, Pa.
An equation was developed to show the relationship, and also a graph that permits estimation of diameter at breast height from stump diameter (i.b.) and stump height.

454. McClure, Joe P.
1968. **Predicting tree d.b.h. from stump measurements in the Southeast.** USDA Forest Serv. Res. Note SE-99. 4 pp. SE. Forest Exp. Sta., Ashville, N. C.
Equations for such predictions for pitch pine and 52 other tree species.

455. McCormack, James F.
1955. **An allowance for bark increment in computing tree diameter growth for southeastern species.** USDA Forest Serv. SE. Forest Exp. Sta., Sta. Paper 60. 6 pp., illus. Asheville, N. C.
Growth factors that permit conversion from radial growth inside bark to diameter growth outside bark are given for many southeastern species. That for pitch pine is 2.15; or for 1 inch of radial growth, the diameter increment o.b. is 2.15 inches.

Stand Growth and Development (Including yields)

456. Aughanbaugh, J. E.
1934. **Yield of the oak-chesnut-hard pine forest type in Pennsylvania.** J. Forestry 32: 80-89.
About half of Pennsylvania's forest land is in this type. On typical sites in central Pennsylvania, where the site index for oak at 50 years is 56 feet, pitch pine has a site index of 57 feet. Pitch pine stands produce about 50 percent more volume than stands of oak and associated species (up to 90 years of age).

457. Doolittle, Warren T.
1958. **Site index comparisons for several forest species in the southern Appalachians.** Soil Sci. Soc. Amer. Proc. 22: 455-458, illus.
Measurements taken in nine counties in western North Carolina and one county in northern Georgia showed that site indexes of pitch and shortleaf pines were (1) not significantly different; (2) less than those for Virginia pine, white pine, and scarlet, black, northern red, and chestnut oaks; (3) slightly greater than for yellow-poplar on poorest sites; and (4) slightly more than for white oak on good sites.

458. Ike, Albert F., Jr., and C. D. Huppuch.
1968. **Predicting tree height growth from soil and topographic site factors in the Georgia Blue Ridge Mountains.** Ga. Forest Res. Council Forest Res. Paper 54. 11 pp., illus.
Pitch pine was sampled on 23 plots with a range in site index from 46 to 77 feet. Factors included in the prediction equation for its site index are elevation, position on slope, and steepness of slope.

459. Leete, Bernard E.
1945. **How fast does second-growth timber grow?** Ohio Forest News 42: 35-38.
Describes 20-year changes in stand composition, basal area, and board-foot volume in the Shawnee State Forest, Scioto County, Ohio. As a result of fire protection, shortleaf and pitch pines formed a smaller proportion of the stand after 20 years, although they had a large net gain in volume. The 20-year growth of pines, oaks, and associated species was 1,339 board feet per acre.

460. Moore, E. B., and A. F. Waldron.
1940. **A comparison of the growth of oak and pine in southern New Jersey.** N. J. Dep. Conserv. and Develop. Div. Forests and Parks Tech. Note 10. 6 pp.
Growth of predominantly oak and predominantly pine stands on Sassafras and Lakewood sands are compared. Pine stands were predominantly shortleaf, with some pitch pines; and they grew twice or more as much volume as the oak stands. Data include basal-area, cubic-foot, and board-foot values for a 10-year period in unthinned stands and ones thinned at 30 years.

461. Pinchot, Gifford.
1900. **Effect of fire on forest production.** N. J. State Geol. Annu. Rep. 1899: 109-123, illus.

The original forest was mostly pitch and shortleaf pines; trees were 150 to 200 years old, mostly 15 to 20 inches d.b.h., and 65 to 70 feet tall (maximum of 30 inches and 90 feet). Stands had little undergrowth, and volumes ranged up to 10,000 board feet per acre. Second growth undamaged by fire produced up to 7,500 board feet per acre at 80 years in stands of shortleaf and pitch pine, but fire-damaged stands, many of pitch pine sprouts, yielded far less—0.5 to 7.5 cords per acre in 30 to 40 years.

462. Sargent, Charles S.
1888. **A New Jersey pine forest.** Gard. and Forest 1: 164, 166, illus.

Stems in a pure old-field stand of pitch pine near Lakewood averaged 50 feet in height and 10 inches in diameter at 50 years of age. Such stands are recommended for timber crops on similar soils in New Jersey and on Cape Cod, and direct seeding is suggested for establishing them where natural reproduction is absent.

FOREST DAMAGE & PROTECTION

Weather (including salt spray)

463. Boggess, W. R., and F. W. McMillan.
1954. **Cold weather and glaze damage to forest plantations in southern Illinois.** Univ. Ill. Agr. Exp. Sta. Bull. 574. 23 pp., illus.

Damage to pitch pine by heavy ice accumulation was considerable —about equal to that of shortleaf pine.

464. Boyce, Stephen G.
1954. **The salt spray community.** Ecol. Monogr. 24: 29-67, illus.

Studying the effects of salt spray on dune vegetation of North Carolina and Cape Cod, Massachusetts, shows that much of the damage is not due to wind, but to the deposition of chloride, especially on the seaward side. Pitch pine is considered intolerant to salt spray.

465. Curtis, James D.
1936. **Snow damage in plantations.** J. Forestry 34: 613-619, illus.

Pitch pine in plantations has been damaged by snow, but damage was limited to stems with one-sided crowns.

466. Fenton, Richard H.
1955. **Windthrow a hazard in Virginia pine strip cuttings.** USDA Forest Serv. NE. Forest Exp. Sta. Forest Res. Note 53. 3 pp. Upper Darby, Pa.

Hurricane Hazel in 1954 damaged about 3 percent of the pitch

pines in uncut 65-year-old stands of Virginia and pitch pines and hardwoods, but these were in strips 1 chain wide left after cutting strips 2 or 3 chains wide. More trees were broken off than were blown over, and losses among trees 9 inches d.b.h. and larger were more than among those 5 to 9 inches. Damage to Virginia pine was proportionally more than three times that to pitch pine.

467. Hemenway, Ansel F.
1926. **Late frost injury to some trees in central Kentucky.** Amer. J. Bot. 13(6): 364-367, illus.
After a late frost, woody tissues of several tree species were examined for damage. In pitch pine, injury occurred after one to three rows of cells had been formed; and injury resulted in bending or widening of rays, in a dark layer between rays, and in abnormal thickening of some tracheid cell walls. Injury to pitch pine was more severe than that to some other species.

468. Littlefield, E. W.
1942. ***Pinus thunbergii:* a successful exotic on the North Atlantic coast.** J. Forestry 40: 566-573, illus.
Pitch pines on Long Island have been severely attacked by tip moths, leaf miners, and pine scales; and where pitch pines were fully exposed to spray or submergence, trees were killed in the 1938 hurricane.

469. Moss, A. E.
1940. **Effect on trees of wind-driven salt water.** J. Forestry 38: 421-425, illus.
Salt-spray damage in Connecticut from the 1938 hurricane extended 45 miles inland on white pine, the most sensitive species. Pitch pine was among the more resistant tree species.

470. Pinkney, C. Coatsworth.
1944. **Tree valuation, a measure for property loss by hurricane.** Landscape Architect., Oct. 1944: 22-24.
Factors affecting tree values and the evaluation of tree losses in hurricanes are discussed. Felt's table of basic tree values by diameter classes is reproduced, and many species are classed into groups that range from no deduction to 60-percent deduction. Pitch pine was placed in the group of 40-percent deduction.

471. Wallace, Raymond H., and A. E. Moss.
1939. **Salt spray damage from recent New England hurricane.** Nat. Shade Tree Conf. Proc. 15: 112-119.
Describes damage from salt spray carried into Connecticut by the 1938 hurricane. Pitch pine is ranked with Austrian and red pine as resistant.

Fire

472. Banks, W. G., and S. Little.
1964. **The forest fires of April 1963 in New Jersey can point the way to better protection and management.** Soc. Amer. Foresters Proc. 1963: 140-144.

Severe burning conditions of 20 April 1963—conditions that apparently occur only about twice in 50 years—are described, as are the behavior of wildfires on that day, the suppression difficulties, and resulting damage. Measures to prevent similar disasters are suggested, including favoring of pines (pitch and shortleaf) over oaks, and frequent use of prescribed burns.

473. Byram, G. M., and R. M. Nelson.
1952. **Lethal temperatures and fire injury.** USDA Forest Serv. SE. Forest Exp. Sta. Res. Note 1. 2 pp., illus. Asheville, N.C.
Temperatures of 52 to 60°C. are lethal to needles, but the lethal temperature varies with duration of exposure. Susceptibility of pitch pine foliage is somewhat, but not markedly, less than that of loblolly, longleaf, and slash pines.

474. Cumming, James A.
1964. **Effectiveness of prescribed burning in reducing wildfire damage during periods of abnormally high fire danger.** J. Forestry 62: 535-537, illus.
Under extreme burning conditions of 20-21 April 1963, wildfires killed or severely damaged 79 percent of the pines (pitch and shortleaf) 1.6 inches d.b.h. and larger in areas not previously prescribe-burned, but only 17 percent in areas prescribe-burned within the previous 10 years. The wildfire died out in areas with little fuel from prescribed burning in 1962-63. Height of char on tree trunks and proportion of area burned varied with prescribe-burning history. Oaks were more susceptible than pines to fire killing.

475. Gaskill, Alfred.
1910. **How New Jersey is trying to improve her forests.** Amer. Forestry 16: 274-279, illus.
Briefly describes steps taken to improve fire protection of forests: use of local fire wardens in prevention and suppression; requirement of permits for outdoor fires in or near woodlands; and construction and maintenance of firebreaks at least 110 feet wide on each side of railroad tracks through wooded areas. Illustrations show some aspects of pitch pine forests and of fire effects in southern New Jersey.

476. Gustafson, R. O.
1944. **Cull as determined from basal wounds in Kentucky Highlands timber.** J. Forestry 42: 181-184.
In pitch and shortleaf pines there was no cull in the first 8-foot logs of unwounded trees, 5.7 percent cull volume in trees with open wounds (chiefly caused by fires). Proportion of cull in wounded trees of associated hardwood species was much higher, 13 to 34 percent of first-log volume.

477. Little, S.
1945. **Influence of fuel types on fire danger.** J. Forestry 43: 744-749.
In the New Jersey Pine Region fire danger varies with fuel type.

Effects of fuel type and site on wind velocities, drying of natural fuels, and fuel amounts are discussed. Types include oak-pine, (pitch) pine-scrub oak, and (pitch) pine swamps.

478. Little, S., J. P. Allen, and E. B. Moore.
1948. **Controlled burning as a dual-purpose tool of forest management in New Jersey's pine region.** J. Forestry 46: 810-819, illus.

In the pine region of New Jersey, where stands of pitch and shortleaf pines are desired, prescribed burning favors pines over oaks through seedbed preparation and selective killing of hardwoods. But in this section, where devastating wildfires have been common, prescribed burning is especially important in reducing fuels and aiding suppression. The applicable region and sites, methods of burning, costs, and arrangement of areas in practical management are described—as is one case history of controlling a wildfire through prior fuel reduction.

479. Moore, E. B., A. F. Waldron, W. J. Seidel, and S. Little.
1941. **Appraising forest fire damage in New Jersey.** USDA Forest Serv. Allegheny Forest Exp. Sta. Occas. Paper 4. 8 pp.

A technique for appraising wildfire damage is described, based on (1) segregating burned areas into type and age classes, (2) counts of tree numbers and estimates of average diameter (b.h.), and (3) tables on value per tree by species and d.b.h. class. Per-tree values for pitch and shortleaf pines varied from $0.001 for a 2-inch stem to $1.20 for an 18-inch tree.

480. Moore, E. B., A. F. Waldron, W. J. Seidel, and S. Little.
1942. **Forest fuel types of New Jersey.** N. J. Dep. Conserv. and Develop. and USDA Forest Serv. Allegheny Forest Exp. Sta. 59 pp., illus.

Classifies the forest fuel types of New Jersey and assigns relative ratings for spread of fires and resistance to control. Pitch pine is mentioned as occurring in various types, especially the pine-scrub oak and pine lowland. Fires in the latter type are the most difficult to control.

481. Moore, E. B., G. E. Smith, and S. Little.
1955. **Wildfire damage reduced on prescribe-burned areas in New Jersey.** J. Forestry 53: 339-341, illus.

A survey was made to determine relative damage done by a May wildfire in previously prescribe-burned areas as compared to untreated areas. In latter, 64 percent of the trees in oak-pine stands (including pitch pine) were killed or severely damaged, as compared to 17 percent in areas treated once in the previous 3 years. In another area where pitch pine predominated, mostly on lowland sites, prescribed burning during the previous winter prevented spread of a killing wildfire across a property line—except in the path of searing heat from the headfire, where the fire crowned through the pines for about 400 feet into a prescribe-

burned area. Prescribed burning both reduces damage and makes fire-control efforts more effective.

482. Nelson, Ralph M.
1952. **Observations on heat tolerance of southern pine needles.** USDA Forest Serv. SE. Forest Exp. Sta., Sta. Paper 14. 6 pp., illus. Asheville, N.C.

Pitch pine was one of the species tested by immersing fascicles in a water bath. Slight differences were found between species. Average lethal temperatures and times varied from 3 seconds at 64°C. to 11.3 minutes at 52°C.

483. Pinchot, Gifford.
1900. **The effects of fire.** N.J. State Geol. Annu. Rep. 1899: 100-108, illus.

Forest fires damage standing timber, destroy young growth and the forest floor, depreciate property values, encourage theft and discourage thrift, and cause general impoverishment in regions where they are common. Each of these effects is discussed. Varying effects of fires on pitch pine are described, and its sprouting in the crown is illustrated.

484. Starker, T. J.
1932. **Fire resistance of trees in northeast United States.** Forest Worker 8: 8-9.

From a questionnaire sent to leading foresters, fire resistance of 22 species was rated. Pitch pine was considered the most resistant.

485. Starker, T. J.
1934. **Fire resistance in the forest.** J. Forestry 32: 462-467.

Fire resistance of species in different parts of the United States is discussed. From a questionnaire answered by 41 foresters, pitch pine was rated as the most resistant species in the Northeast.

486. Stickel, P. W.
1952. **The nature of fire damage to northeastern forests.** *In* Important Tree Pests of the Northeast: 157-161, illus.

Damage from direct killing, basal wounding and delayed mortality, and insect or disease infection is described. Pitch pine is considered the most fire-resistant species, because its bark is relatively thick, is not deeply fissured, and is composed of much corklike tissue.

487. Wood, O. M.
1936. **First year losses after a fire may not represent total mortality.** USDA Forest Serv. Allegheny Forest Exp. Sta. Tech. Note 13. 2 pp.

Mortality of oaks and pines in New Jersey areas burned by 1930 wildfires increased between 1930 and 1932, especially among the pines. In 1930 more pitch pines than shortleaf pines were dead, whereas in 1932 pitch pine mortality was 43 percent compared to 64 percent for shortleaf pine and 54 to 100 percent for associated oak species.

Animals

488. Biswell, H. H., and M. D. Hoover.
1945. **Appalachian hardwood trees browsed by cattle.** J. Forestry 43: 675-676.
Pitch pine foliage was not browsed by cattle on the Coweeta Experimental Forest in North Carolina; but nearly all the foliage of some associated species, such as black locust, was consumed.

489. Bramble, W. C., and M. K. Goddard.
1953. **Seasonal browsing of woody plants by white-tailed deer in the Ridge and Valley section of central Pennsylvania.** J. Forestry 51: 815-819, illus.
A 5-year study was made of seasonal browse perferences in major forest communities of central Pennsylvania. Pitch pine was one of the species heavily browsed—mostly in winter. Little browsing of this species was done in the spring, and none in summer or fall.

490. Church, Thomas W., Jr.
1954. **Mice cause severe damage to Virginia pine reproduction.** USDA Forest Serv. NE. Forest Exp. Sta. Forest Res. Note 35. 2 pp., illus. Upper Darby, Pa.
In two stands on the Beltsville Experimental Forest in Maryland, meadow mice damaged about 60 percent of the Virginia pine reproduction, but only about 11 percent of the young pitch pines. Damaged pitch pines were 0.5 to 0.8 inch in diameter at 1 foot above ground.

491. Hazen, J. F., and O. M. Wood.
1935. **Animal damage in relation to size of planting stock.** USDA Forest Serv. Allegheny Forest Exp. Sta. Tech. Note 4. 2 pp.
Damage by animals, presumably rabbits, was much greater to interplanted pines (pitch and four other species) that were 0.1 to 0.3 foot tall than to stems 0.4 to 0.7 foot tall.

492. Johnson, E. A.
1952. **Effect of farm woodland grazing on watershed values in the southern Appalachian mountains.** J. Forestry 50: 109-113, illus.
Cattle grazed most heavily in cove-hardwood type, secondly on oak-hickory slopes, and hardly at all on pitch pine ridges where associated laurel, azalea, and buckberry occurred. Reduction in tree growth, changes in soil porosity, permeability, and infiltration, and in runoff and turbidity are discussed.

493. Little, Silas, Jr.
1937. **Deer damage to pine reproduction in southern New Jersey.** USDA Forest Serv. Allegheny Forest Exp. Sta. Tech. Note 19. 2 pp.
Damage decreases with increase in height; few seedlings over 3.5 feet tall were injured. Pitch and shortleaf pines were browsed much more than associated Virginia pines.

494. Little, S., G. R. Moorhead, and H. A. Somes.
1958. **Forestry and deer in the pine region of New Jersey.** USDA Forest Serv. NE. Forest Exp. Sta., Sta. Paper 109. 33 pp., illus. Upper Darby, Pa.

Present knowledge of food preferences and availability by seasons and sites, of deer effects on forest practices, and of forest-practice effects on deer are summarized. During the dormant season deer browse on small seedlings and sprouts of pitch and shortleaf pines. Although pines furnish more browse than associated oaks, most of the deer food comes from lowland sites, especially from Atlantic white-cedar.

495. Little, S., and H. A. Somes.
1951. **Deer browsing in New Jersey handicaps pine seedlings.** USDA Forest Serv. NE. Forest Exp. Sta. Res. Note 2: 3-4. Upper Darby, Pa.

Average height growth of pine reproduction in exclosures was twice as much as that of unprotected reproduction. Browsed seedlings gained in height only about a fifth as much as undamaged stems.

496. McQuilkin, W. E., and S. Little.
1952. **Deer repellent fails to protect pine seedlings.** USDA Forest Serv. NE. Forest Exp. Sta. Res. Note 15. 4 pp. Upper Darby, Pa.

Spraying natural reproduction of pitch and shortleaf pines with a repellent (zinc-dithiocarbamate-amine complex plus polyethylene polysulfide) cost $80 an acre for material and labor, but caused only a slight reduction in overwinter browsing by deer (72 percent of untreated stems 0.1 to 1.0 foot tall, 61 percent of those sprayed once).

497. Martin, Alexander C., Herbert S. Zim, and Arnold L. Nelson.
1951. **American wildlife and plants.** 550 pp., illus. McGraw-Hill Book Co., Inc., New York.

Pitch pine is mentioned as especially important to wildlife in the Northeast. Though many birds and rodents are listed as consumers of pine seeds, and several mammals as consumers of foliage, no differentiation is made among species of pine in such food consumption.

498. Mollenhauer, William, Jr.
1939. **Table mountain pine—squirrel food or timber tree?** J. Forestry 37: 420-421, illus.

Branches of table-mountain pine up to 1 inch in diameter are severed by red squirrels to drop the sessile and whorled cones. Similar clipping of branches was not observed on associated pitch, white, and Virginia pines.

499. Perry, Geo. S.
1922. **The special planting problems in Pennsylvania.** J. Forestry 20: 507-512.

Pitch pine is valuable wildlife food because it bears seed at an early age and almost annually; and less than 10 percent of the

cones open before January. Some cones remain closed until April or May, but most seeds are released in midwinter. Squirrels feed on unopened cones. Quail, grouse, and many smaller birds eat seeds falling on snow.

500. Smith, Clarence F., and Shaler E. Aldous.
1947. **The influence of mammals and birds in retarding artificial and natural reseeding of coniferous forests in the United States.** J. Forestry 45: 361-369.
Trees squirrels, chipmunks, white-footed mice, and a few species of birds are responsible for most seed losses. Pitch pine is not specifically mentioned.

501. Van Dersal, William R.
1938. **Native woody plants of the United States, their erosion-control and wildlife values.** U. S. Dep. Agr. Misc. Pub. 303. 362 pp., illus.
According to stomach analyses or observations, pitch pine seed or foliage has been consumed by white-tailed deer and by seven species of birds (including ruffed grouse), and is a preferred food of red squirrels.

Diseases

502. Anderson, Gerald W.
1963. **Sweetfern rust on hard pines.** U. S. Dep. Agr. Forest Pest Leafl. 79. 7 pp., illus.
Hosts, life history, symptoms, damage, and control of this fungus are described. Pitch pine is susceptible.

503. Arthur, Joseph Charles, and Frank Dunn Kern.
1914. **North American species of *Peridermium* on pine.** Mycologia 6: 109-138.
The authors describe 16 species of *Peridermium,* and give known hosts and range. Pitch pine is attacked by *P. delicatulum, P. acicolum, P. Rostrupi, P. Comptoniae,* and *P. cerebrum.*

504. Berry, Charles R., and George H. Hepting.
1959. **Pitch canker of southern pines.** U. S. Dep. Agr. Forest Pest Leafl. 35. 3 pp., illus.
Symptoms, damage, control, and hosts of this *Fusarium* fungus are described. It occurs to some extent on pitch pine.

505. Boyce, J. S.
1943. **Host relationships and distribution of conifer rusts in the United States and Canada.** Conn. Acad. Arts and Sci. Trans. 35: 329-482.
Leaves of *Pinus rigida* are the aecial hosts for the rusts *Coleosporium campanulae* (*Peridermium rostrupi*), *C. delicatulum* (*P. delicatulum*). *C. elephantopodis* (*P. elephantopodis*), *C. ipomoeae* (*P. ipomoeae*), *C. lacinariae* (*P. fragile*), *C. solidaginis* (*P. acicolum*), and *C. vernoniae* (*P. carneum*). Pronounced gall-like hypertrophy of pitch pine stems is produced by *Cronartium fusi-*

forme (*P. fusiforme*) and *C. quercuum* (*P. cerebrum*). *Cronartium comandrae* (*P. pyriforme*) and *C comptoniae* (*P. comptoniae*) also infest some stems, but cause little or no hypertrophy.

506. Boyce, J. S.
1952. **Needle cast disease of conifers (caused by *Bifusella, Hypoderma, Hypodermella, Lophodermium*).** *In* Important Tree Pests of the Northeast: 87-89, illus.

Symptoms, injury, life history, and control of needle-cast fungi are described. *Lophodermium pinastri,* the most common species, attacks pitch pine, but is not damaging. *Hypoderma lethale* is prevalent on pitch pine.

507. Campbell, W. A., and Otis L. Copeland, Jr.
1954. **Littleleaf disease of shortleaf and loblolly pines.** U. S. Dep. Agr. Circ. 940. 41 pp., illus.

Although littleleaf disease has been reported on pitch pine, no definite statement can be made about pitch pine's susceptibility, and the disease is not important on this species.

508. Carter, J. C.
1938. ***Coleosporium vernoniae* on *Pinus rigida* in Illinois.** Plant Disease Rptr. 22: 433.

Pitch pines in or planted near a state nursery in Union County, Ill., were lightly to heavily infected with the aecial stage of this fungus.

509. Dearness, John.
1926. **New and noteworthy fungi—IV.** Mycologia 18: 236-255.

In a discussion of 52 species of fungi—including descriptions of the fungus, its host and its known distribution—pitch pine foliage is mentioned as being attacked by *Pezizella minuta, Phacidium convexum, Hypoderma Hedgcockii,* and *H. lethale.*

510. Diller, Jesse D.
1943. **A canker of eastern pines associated with *Atropellis tingens.*** J. Forestry 41: 41-51, illus.

Symptoms, distribution, and damage caused by this canker are described. It usually attacks twigs or branches, and has been found on pitch pine in seven states. No control measures are considered necessary.

511. Doak, K. D.
1934. **Cortical parasitism of conifer-seedling roots in pure culture by mycorrhizal and nonmycorrhizal fungi.** Phytopathol. 24: 6-7.

A fungus resembling *Rhizoctonia silvestris* formed a mantle and network characteristic of ectotrophic mycorrhizae on pitch pine roots, and also infected the cortex of "mother" roots. *Armillaria mellea* infected cortices of "short" and "mother" roots.

512. Doak, K. D.
1934. **Fungi that produce ectotrophic mycorrhizae of conifers.** Phytopathol. 24: 7.
Boletus bicolor, Boletinus brevipes, B. pictis, and Russula lepida formed ectotrophic mycorrhizae with pitch pine roots in culture media.

513. Doak, K. D.
1955. **Pine root reaction in sterile culture to mycorrhizal and other fungi.** Amer. Midland Natur. 54: 443-451, illus.
Armillaria mellea on pitch pine produced rhizomorphs and an intracellular penetration resembling previously reported parasitic behavior. *Boletinus pictus* on pitch pine formed ectotrophic mycorrhizal mantles.

514. Dodge, B. O., and J. F. Adams.
1918. **Some observations on the development of *Peridermium cerebrum*.** Torrey Bot. Club. Mem. 17: 253-261, illus.
On pitch pine in New Jersey this fungus forms globular or fusiform swellings, mostly on trunks. Infections often consist of a number of closely associated swellings formed through a series of migrations by the fungus. Morphology of galls is discussed.

515. Fergus, Charles L., and Frank D. Kern.
1959. **A list of fungi found on trees in Pennsylvania.** Pa. State Univ. Agr. Exp. Sta. Bull. 646. 38 pp.
Lists species found on pitch pine and gives part of tree infected.

516. Hansbrough, J. R.
1952. **Sweetfern blister rust of pitch pines (caused by *Cronartium comptoniae*).** *In* Important Tree Pests of the Northeast: 103-106, illus.
Distribution, life history, damage, and control of this fungus are described. Pitch pine is susceptible to damaging infection.

517. Hatch, A. B., and K. D. Doak.
1933. **Mycorrhizal and other features of the root systems of *Pinus*.** J. Arnold Arboretum 14: 85-99, illus.
Different types of roots and their distinguishing characteristics are described. Included is a photograph of mantle structure and intercellular net of cortical cells in a mycorrhiza from pitch pine.

518. Hedgcock, George G.
1928. **A key to the known aecial forms of *Coleosporium* occurring in the United States and a list of the host species.** Mycologia 20: 97-100.
Pitch pine is host to *C. carneum, C. Elephantopodis, C. Ipomoeae, C. Campanulae, C. Laciniariae, C. Solidaginis, C. Terebinthinaceae,* and *C. delicatulum.*

519. Hedgcock, George G., and Paul V. Siggers.
1949. **A comparison of the pine-oak rusts.** U. S. Dep. Agr. Tech. Bull. 978. 30 pp.
This bulletin deals with host relationships and a morphological

comparison of five *Cronartium* species. Pitch pine appears to be about equally susceptible to infection by *C. cerebrum* and *C. fusiforme,* but is less susceptible than some of the pines studied.

520. Hepting, George H., and Marvin E. Fowler.
1962. **Tree diseases of eastern forests and farm woodlands.** U. S. Dep. Agr. Agr. Inform. Bull. 254. 48 pp., illus.
Sweetfern rust stunts, distorts, and may kill pitch pine. Control measures are described. *Atropellis* twig canker also attacks pitch pine.

521. Hepting, George H., and Elmer R. Roth.
1946. **Pitch canker, a new disease of some southern pines.** J. Forestry 44: 742-744, illus.
A *Fusarium* canker found mostly on Virginia pine and rarely on shortleaf and pitch pines is described. Based on studies in North and South Carolina.

522. Hepting, George H., Elmer R. Roth, and Bailey Sleeth.
1949. **Discolorations and decay from increment borings.** J. Forestry 47: 366-370, illus.
None of five pitch pines that were bored developed decay. Holes healed rapidly except where excessive pitch plugs occurred. The wood developed pitch-soaked band seven inches long.

523. Jackson, L. W. R.
1945. **Root defects and fungi associated with the littleleaf disease of southern pines.** Phytopathol. 35: 91-105, illus.
Root defects and fungi associated with littleleaf disease are described, as are results of inoculations on shortleaf pines. Disease is less common on pitch pine than on shortleaf.

524. Kelley, Arthur Pierson.
1930. **Mycorrhizal studies: I. Mycorrhiza of Mont Alto nursery stock.** J. Forestry 28: 34-41, illus.
The mycorrhiza on pitch pine roots is described, and is classed as ectendrotrophic.

525. McKenzie, Malcolm A.
1942. **Experimental autoecism and other biological studies on a gall-forming *Peridermium* on northern hard pines.** Phytopathol. 32: 785-798, illus.
Inoculations of Scotch, jack, and pitch pines were made with aeciospores of a gall-forming rust—presumably *Cronartium quercuum*—from jack and pitch pines. A few of the inoculated pitch pines developed no symptoms of infection, while in others mycelia, but no galls, were produced. In numerous cases bark became roughened, swollen, or discolored. On some pines (pitch ?) leaves were cast, and the leader or whole tree died. Usually cork layers were formed that cut off infected tissue.

526. Mielke, James L.
1961. **Comandra blister rust.** U. S. Dep. Agr. Forest Pest Leafl. 62. 7 pp., illus.

Symptoms, life history, damage, and range of this fungus are described. This rust may girdle and kill trees, but pitch pine is not highly susceptible.

527. Morris, C. L.
1953. **Chemical control of *Hypoderma lethale* on pitch pine.** Plant Disease Rptr. 37: 368-370.
Foliage damage by *Hypoderma lethale* was more serious in Pennsylvania than damage done by a needle-mining insect (*Exoteleia pinifoliella*) or by a rust fungus (*Coleosporium solidaginis*). Much of the damage by *H. lethale* was to needles in the lower part of crowns. Two fungicides tested gave almost complete control, so foliage was retained 8 months longer than on untreated trees.

528. Orton, C. R., and J. F. Adams.
1914. **Notes on *Peridermium* from Pennsylvania.** Phytopathol. 4: 23-26.
Cronartium comptoniae and *Peridermium acicolum* were found on pitch pines in central Pennsylvania.

529. Overholts, L. O.
1917. **An undescribed timber decay of pitch pine.** Mycologia 9: 261-270, illus.
Polyporus amorphus and *P. abietinus* were the principal wood-destroying fungi found in pitch pines that had died and fallen. Fungi and the decay caused by them are described.

530. Overholts, L. O.
1926. **Mycological notes for 1925.** Mycologia 18: 179-184, illus.
Crumenula pinicola, which rarely attacks the twigs of pitch pine in central Pennsylvania, produces cankers and kills infected twigs.

531. Overholts, L. O.
1941. **New species of Polyporaceae.** Mycologia 33: 90-102, illus.
Polyporus lineatus, found on a pitch pine log in Centre County, Pa., produced a brown carbonizing type of rot.

532. Powers, Harry R., Jr., and John S. Boyce, Jr.
1963. **Annosus root rot in eastern pines.** U. S. Dep. Agr. Forest Pest Leafl. 76. 7 pp., illus.
Distribution, hosts, symptoms, spread, damage, and control of *Fomes annosus* are described. This fungus kills pitch pine and other pines, especially in plantations.

533. Roth, Elmer R.
1952. **Roots of living *Pinus rigida* decayed by *Fomes annosus.*** Plant Disease Rptr. 36: 330, illus.
Two uprooted pitch pines near Asheville, N. C., had roots decayed by *Fomes annosus.*

534. Siggers, Paul V.
1955. **Control of the fusiform rust of southern pines.** J. Forestry 53: 442-446, illus.
Life history and distribution of *Cronartium fusiforme,* susceptibility of pines and oaks, canker development, practices affecting susceptibility of trees, and control in nurseries and natural stands are described. Loblolly and slash pines are the main hosts, although pitch pine is also attacked.

535. Slagg, Charles M., and Ernest Wright.
1943. ***Diplodia* blight in coniferous seedbeds.** Phytopathol. 33: 390-393.
Diplodia pinea attacked mature pitch pines on the campus of Kansas State College, and caused dieback by killing foliage of younger and then older needle clusters until the whole shoot on some trees was killed.

536. Spaulding, Perley.
1913. **Notes on *Cronartium comptoniae.*** Phytopathol. 3: 62.
Within one area 147 living pitch pines bore fruiting bodies of *Cronartium comptoniae,* and 8 infected trees had recently died. The fungus apparently causes an annual mortality of about 5 percent.

537. Spaulding, Perley.
1913. **Notes on *Cronartium comptoniae,* II.** Phytopathol. 3: 308-310.
Fruiting of *Cronartium comptoniae* on pitch pines has usually been on stems less than 4 inches in diameter. Thirteen percent of the infected trees, mostly less than 10 feet tall, died within 2 years in one observed area.

538. Spaulding, Perley.
1952. **Red ring root of conifers (caused by *Fomes (Trametes) pini*).** *In* Important Tree Pests of the Northeast: 135-138, illus.
Symptoms, life history, damage, and control of this fungus are described. Pitch pine is one of the conifers frequently attacked.

539. Spaulding, Perley.
1956. **Diseases of North American forest trees planted abroad, an annotated list.** U. S. Dep. Agr. Agr. Handb. 100. 144 pp.
Pinus rigida is known to have been planted in 16 countries in Europe, Asia, Africa, and Australia. *Armillaria mellea* (British Isles, Germany), *Cenangium abietis* (Germany, Poland), and *Lophodermium pinastri* (Denmark, Germany, Russia) have been reported to infest trees in foreign plantings.

540. Spaulding, Perley, and J. R. Hansbrough.
1932. ***Cronartium comptoniae,* the sweetfern blister rust of pitch pines.** U. S. Dep. Agr. Circ. 217. 21 pp., illus.
History of the disease, symptoms, species attacked, distribution, economic importance, life history, and control are described. The disease has been found on pitch pine in 10 states.

541. Stambaugh, William J.
1952. **A study of the needle cast diseases of conifers in Pennsylvania.** J. Forestry 50: 944.
All pitch pines examined in plantations and natural stands were infected with *Hypoderma lethale;* and heavy infections that caused defoliation and growth reduction occurred in 10 to 30 percent of the stands.

542. Underwood, Lucien M., and F. S. Earle.
1896. **Notes on the pine-inhabiting species of *Peridermium*.** Torrey Bot. Club Bull. 23: 400-405.
P. acicolum attacks pitch pine at least in Massachusetts and New Jersey. *P. cerebrum* has been found on pitch pines in those two states and New York.

543. Verrall, A. F.
1964. **Diseases of the hard pines.** *In* Diseases of Widely Planted Forest Trees. FAO/IUFRO Symp. on Internationally Dangerous Forest Diseases and Insects: 56-84.
A list of diseases attacking (1) seedlings, (2) foliage and cones, (3) roots, and (4) stems and branches (including heart rots, cankers, rusts, and mistletoes). Indicates where these diseases occur and on what species, including pitch pine.

544. Weir, James R.
1921. ***Thelephora terrestris, T. fimbriata,* and *T. caryophyllea* on forest tree seedlings.** Phytopathol. 11: 141-144.
Thelephora fimbriata was common on pitch pine seedlings in a Lycoming County (Pa.) nursery.

Insects

545. Aughanbaugh, John E.
1949. **Research—the *Matsucoccus* scale in pitch pine plantations.** Pa. Forests and Waters 1: 182, 186, illus.
Matsucoccus gallicolus Morr. has infested plantations in south-central Pennsylvania since 1931. Symptoms, damage, and data from a plantation in Huntingdon County are given.

546. Beal, James A., and Calvin L. Massey.
1945. **Bark beetles and ambrosia beetles *(Coleoptera: Scolytoidea)*: with special reference to species occurring in North Carolina.** Duke Univ. School Forestry Bull. 10. 178 pp., illus.
Bark and ambrosia beetles, their life histories, damage, and control are described. Ten species that attack pitch pine are listed.

547. Beal, James A., William Haliburton, and F. B. Knight.
1952. **Forest insects of the Southeast: with special reference to species occurring in the Piedmont Plateau of North Carolina.** Duke Univ. School Forestry Bull. 14. 168 pp., illus.
Insects, their damage, life histories, and control are described. Ten species are listed as attacking pitch pine.

548. Behre, C. Edward, and L. H. Reineke.
1943. **The opportunity for silvicultural control of gypsy moth in southeastern Maine.** J. Forestry 41: 811-815.
Pitch pine cover type includes stands dominantly or fully resistant to gypsy moth, whereas the bear oak type has 90 to 100 percent of its composition in favored food species.

549. Bess, Henry A., Stephen H. Spurr, and E. W. Littlefield.
1947. **Forest site conditions and the gypsy moth.** Harvard Forest Bull. 22. 56 pp., illus.
Describes varying populations and damage done by gypsy moths, and weather and forest conditions favoring high and low populations. The pitch pine cover type varies in susceptibility with site, stand composition, and condition. Scrub oak or tree oaks characteristic of dry sites dominate many susceptible stands.

550. Benjamin, Daniel M., J. Donovan Larson, and Arnold T. Drooz.
1955. **The European pine sawfly on the Henderson State Forest, Illinois, with notes on its biology and control** J. Forestry 53: 359-362, illus.
When eggs were laid on pitch pine, needles dried and fell off so that eggs failed to hatch.

551. Brown, R. C., and R. A. Sheals.
1944. **The present outlook on the gypsy moth problem.** J. Forestry 42: 393-407, illus.
Foliage of pitch pine and other pines is unfavorable food for larvae in early stages, but is highly favored by larger caterpillars. In the pine-oak region of Cape Cod, where pitch pine is common, outbreaks of gypsy moth have been frequent, because the hardwoods are mostly oaks. Methods and recommendations on control are discussed, as well as spread of the insect, susceptibility of different forest types, and weather effects.

552. Craighead, F. C.
1950. **Insect enemies of eastern forests.** U. S. Dep. Agr. Misc. Pub. 657. 679 pp., illus.
Important insects that attack eastern forests are described, as are general measures of controlling insect damage. A supplement provides an index to insects by host plants and lists more than 30 insects that attack pitch pine.

553. Eaton, C. B.
1955. **The Saratoga spittlebug.** U. S. Dep. Agr. Forest Pest Leafl. 3. 4 pp., illus.
Describes the insect (*Aphrophora saratogensis*), the damage it does, life cycle, and control. Although pitch pine is a host, severe damage is restricted to red and jack pines.

554. Eaton, C. B., and J. S. Yuill.
1960. **Gouty pitch midge.** U. S. Dep. Agr. Forest Pest Leafl. 46. 8 pp., illus.
Distribution, hosts, symptoms, life history, damage, and control

of this insect are described. Pitch pine is the principal host in eastern United States.

555. Felt, E. P., and S. W. Bromley.
1942. **The increasing importance of coleopterous borers in shade trees.** J. Econ. Entomol. 35: 169-171.
Pitch pines weakened by the 1938 hurricane have been attacked by *Dendroctonus terebrans, D. valens,* and *Ips pini,* but only the last has caused severe injury or death of the trees.

556. Felt, E. P., and S. W. Bromley.
1944. **The insect menace to shade trees in the Northeast.** J. Econ. Entomol. 37: 212-213.
Turpentine odor from newly painted buildings attracted *Dendroctonus terebrans* and *D. valens,* which infested nearby pitch pines.

557. Hall, Ralph C.
1935. **Cape Cod pitch pine: its resistance to gipsy moth defoliation and its advantages as a forest tree.** J. Forestry 33: 169-172, illus.
Gypsy moth damage to pitch pine foliage is relatively rare—far less than that to associated oaks, white or red pines, Norway spruce, or European larch. Pitch pine is well adapted to Cape conditions: it is resistant to fires and salt spray; it reproduces well; and in growth rate it compares favorably with associated species.

558. Henry, H. K., and E. W. Littlefield.
1952. **Pine spittle bug *(Aphrophora parallela).*** *In* Important Tree Pests of the Northeast: 66-69, illus.
The insect, its damage, and life history are described, along with recommended methods of control. The insect may be abundant on pitch pine, but causes extensive injury only to Scotch pine.

559. Hoffman, C. H., and R. F. Anderson.
1945. **Effect of southern pine beetle on timber losses and natural restocking.** J. Forestry 43: 436-439, illus.
In Bent Creek Experimental Forest, N. C., this beetle attacked and killed more than 75 percent of the pines 6 inches and larger in limited areas, especially in pure pine stands. Three-fourths of the pines in these groups were shortleaf pine, the remainder were mostly pitch pine. Openings created were restocked mostly by hardwoods.

560. Kowal, R. J.
1960. **Southern pine beetle.** U.S. Dep. Agr. Forest Pest Leafl. 49. 7 pp., illus.
Pitch pine is a preferred species of this insect. Distribution, hosts, evidence of attack, life history, identification, and control of the insect are discussed.

561. McCormick, Jack, and John W. Andresen.
1961. **Infestation of pitch and shortleaf pines by the red pine sawfly in southern New Jersey.** Amer. Mus. Novitates 2032. 6 pp., illus.

Sawflies caused light to heavy defoliation of pitch and shortleaf pines in southern New Jersey during 1956 and 1957. The damage had been attributed to *Neodiprion pratti paradoxicus, N. lecontei,* and *N. pini—rigidae;* but specimens collected and reared by the authors were identified as N. *nanulus nanulus.*

562. McCormick, Jack, and John W. Andresen.
1960. **Some effects of animals on the vegetation of the New Jersey Pine Barrens.** Torrey Bot. Club Bull. 87: 375-385.
Influences of insects (especially locusts, Nantucket pine moths, acorn weevils, and ants); of deer through deer beds, antler rubbing, and urination; and of small mammal excavations are discussed. Some data on the highly variable extent of pine moth damage are presented.

563. Miller, William E., and Ralph B. Neiswander.
1959. **The pitch pine tip moth, *Rhyacionia rigidana* (Fernald), and its occurrence in Ohio (Lepidoptera, Olethreutidae).** Ohio Agr. Exp. Sta. Res. Bull. 840. 23 pp., illus.
Taxonomy, distribution, hosts, seasonal history, damage, and control of pitch pine tip moth are described. Pitch pine is attacked, but not so frequently as red and shortleaf pines.

564. Nelson, Ralph M., and J. A. Beal.
1929. **Experiments with bluestain fungi in southern pines.** Phytopathol. 19: 1101-1106.
Tunnels of southern pine beetles seem insufficient to account for rapid death of attacked trees. From experiments with inoculation of bluestain fungi on pitch and shortleaf pines, wounding during inoculation and infection by fungi together may kill pines in a short time. The authors suggest that fungi are also important in killing beetle-attacked pines.

565. Northeastern Forest Experiment Station.
1956. **1955 annual report.** USDA Forest Serv. NE. Forest Exp. Sta. 118 pp., illus. Upper Darby, Pa.
Describes many of the important insects of the Northeast, their ranges, damage done, and control. Pitch pine is attacked by the pine looper, red-headed pine sawfly, pine spittle bug, and Nantucket pine tip moth.

566. Parr, T. J.
1939. ***Matsucoccus* sp., a scale insect injurious to certain pines in the Northeast (Hemiptera-Homoptera).** J. Econ. Entomol. 32: 624-630, illus.
M. gallicolus feeds chiefly on pitch pine, although it also attacks shortleaf, table-mountain, Virginia, and ponderosa pines in the Northeast. Damage, life history, distribution, and possible control of this insect are described. It attacks all ages of pitch pine from 3-year-old seedlings to mature trees, and is most destructive to stems 10 to 30 feet tall, especially those weakened by drought or other adverse conditions.

567. Ripley, Thomas H.
1962. **Tree and shrub response to recreation use.** USDA Forest Serv. SE. Forest Exp. Sta. Res. Note 171. 2 pp. Asheville, N.C.

Of five conifers, pitch pine is rated fourth most resistant to damage correlated with public use of camping and picnicking sites in the Cherokee, Nantahala, and Pisgah National Forests in North Carolina and Tennessee. Many associated hardwoods seemed more resistant to disease and insect attacks in recreational areas.

568. Ross, Herbert H.
1955. **The taxonomy and evolution of the sawfly genus *Neodiprion*.** Forest Sci. 1: 196-209, illus.

A key to the species is given, and critical species are described. Pitch pine is listed as a host for *N. pini-rigidae, N. sertifer,* and *N. pratti paradoxicus.*

569. Schaffner, J. V., Jr.
1943. **Sawflies injurious to conifers in the Northeastern States.** J. Forestry 41: 580-588, illus.

General habits, life cycles, damage done, and control of sawflies. A key for identification of Northeastern species is given, and the individual species are discussed. Damage to pitch pine by *Neodiprion dyari, N. lecontei,* and *N. pini-rigidae* is described.

570. Schaffner, J. V., Jr.
1952. **Pine sawflies (Tenthredinidae and Pamphiliidae).** *In* Important Tree Pests of the Northeast: 9-15, illus.

Includes descriptions of larvae and life histories of several sawflies and of the pine false webworm; and suggests control methods. Pitch pine is a host of *Neodiprion lecontei, N. pinetum, N. pini-rigidae,* and *N. dyari.*

571. Schaffner, J. V., Jr., and H. L. McIntyre.
1944. **The pine root-collar weevil.** J. Forestry 42: 269-275, illus.

Discusses characteristics, life history, habits, economic importance, and control of *Hylobius radicis.* Although pitch pine is attacked, no serious injury has usually resulted.

572. Wilson, Louis F., and Donald C. Schmiege.
1965. **Pine root collar weevil.** U. S. Dep. Agr. Forest Pest Leafl. 39. 7 pp., illus.

Damage is most severe in plantations, especially on poor sites and usually before crown closure. Hosts, life history, damage, and natural and artificial control of this insect (*Hylobius radicis*) are described. Pitch pine is one of the least susceptible hosts.

573. Betts, H. S.
1954. **The southern pines.** USDA Forest Serv. Amer. Woods Series. 13 pp., illus.
Pitch pine is one of the less important yellow pines, but the woods of several species are so similar that they are described together. Discusses the distribution of the four most important species, their volumes and uses, and wood properties of the whole group.

574. Brown, H. P., and A. J. Panshin.
1940. **Commercial timbers of the United States.** 554 pp., illus. McGraw-Hill Book Co., New York.
Pitch pine is grouped with other yellow or hard pines of eastern United States, and the wood anatomy and uses of this group are described (pp. 376-378).

575. Bull, Marcus.
1826. **Experiments to determine the comparative quantities of heat, evolved in the combustion of the principal varieties of wood and coal, used in the United States, for fuel; and, also, to determine the comparative quantities of heat lost by the ordinary apparatus, made use of for their combustion.** Franklin J. and Amer. Mech. Mag. 1: 257-293, illus.
Specific gravity of dry wood of pitch pine is 0.426; weight per cord, 1,904 pounds. A cord of dry wood yields 510 pounds or 33 bushels of charcoal.

576. Forest Products Laboratory, USDA Forest Service.
1955. **Wood handbook, basic information on wood as a material of construction with data for its use in design and specification.** U. S. Dep. Agr. Agr. Handb. 72. 528 pp., illus.
Heartwood of pitch pine is brownish red and resinous; sapwood is thick and light yellow. The medium heavy to heavy wood is used for lumber and fuel, weighs 34.9 pounds per cubic foot at 15-percent moisture content or 2,910 pounds per thousand board feet (2,130 pounds when dressed). The wood is rated as medium strong, medium stiff, medium hard, medium high in shock resistance, and medium small to medium large in shrinkage. Amounts of radial, tangential, and volumetric shrinkage are given for drying to 20-, 6-, and 0-percent moisture content.

577. Grabow, Rudolph H.
1923. **Suitability of various American woods for pulp and paper making.** J. Forestry 21: 462-474.
Structure and pulping qualities of pitch pine wood are similar to those of shortleaf, loblolly, longleaf, slash, and Virginia pines. Yields in the sulphate process are about 40 percent compared to 50 percent for spruces.

578. Hall, William L., and Hu Maxwell.
1911. **Uses of commercial woods of the United States: II. Pines.** USDA Forest Serv. Bull. 99. 96 pp.
Physical properties of the wood, supply, and early and contemporary uses of pitch pines are described. Uses have included production of tar, shoemaker's wax, fagots for light, water wheels, building timbers, fence rails, boats, bridge timbers, mine props, boxes and crates, flooring and interior finish, barrel headings, piling, pulp, and fuel.

579. Hardy, Eric.
1942. **Woods for dye vats and chemical storage.** Textile Recorder 60 (711): 35, 37.
Vats made of pitch pine are serviceable for many cold acids, but its wood contains too much resin for use with hot liquids.

580. Ifju, Geza.
1969. **Within-growth-ring variation in some physical properties of southern pine wood.** Wood Sci. 2:11-19, illus.
Describes results from testing one tree of each of six species, including pitch pine. Gives for pitch pine values of specific gravity, tensile strength, and modulus of elasticity for 13 to 82 replicates at 3 positions: rings 8-10, 18-20, 28-30—all at breast height.

581. Markwardt, L. J.
1930. **Comparative strength properties of woods grown in the United States.** U. S. Dep. Agr. Tech. Bull. 158. 38 pp., illus.
Gives comparative properties of clear wood by species (including pitch pine): specific gravity, weight per cubic foot, shrinkage (radial and tangential), bending strength, compressive strength, stiffness, hardness, and shock resistance.

582. Markwardt, L. J., and G. E. Heck.
1938. **Standard terms for describing wood.** J. Forestry 36:3-11.
Pitch pine wood is moderately heavy (specific gravity 0.45), has a moderately small shrinkage in drying (110), moderately strong bending strength (80) and compressive strength (76), a moderately weak composite bending and compressive strength (78), a moderately high shock resistance (96), and it is moderately stiff (146), and moderately hard (56). (Data about the same as in Markwardt 1930.)

583. Markwardt, L. J., and T. R. C. Wilson.
1935. **Strength and related properties of woods grown in the United States.** U. S. Dep. Agr. Tech. Bull. 479. 99 pp., illus.
For pitch pine and other species, this bulletin gives strength and related properties of wood samples: specific gravity, weight, shrinkage, static bending, impact bending, compression, hardness, shearing strength, cleavage, and tensile strength. Data for pitch pine are given separately for samples from Tennessee and Massachusetts.

584. Mathewson, J. S.
1930. **The air seasoning of wood.** U. S. Dep. Agr. Tech. Bull. 174. 56 pp., illus.
Shrinkage values, specific gravity, and weight per cubic foot for pitch pine and for other species.

585. Newlin, J. A., and Thomas R. C. Wilson.
1917. **Mechanical properties of woods grown in the United States.** U. S. Dep. Agr. Bull. 556. 47 pp., illus.
Results of tests made on pitch pine samples from Tennessee. (See also Markwardt and Wilson 1935).

586. Pomeroy, Kenneth B.
1952. **Modern trends in an ancient industry.** J. Forestry 50: 297-299, illus.
In 1715 a law was passed in Massachusetts to forbid the boxing of pitch pines on Cape Cod for turpentine.

587. Sargent, Charles S.
1884. **Report on the forests of North America (exclusive of Mexico).** U. S. Dep. Int. Census Office, 10th U. S. Census (1880), vol. 9: 1-612, illus.
Describes distribution, wood characteristics, and properties, and lists taxonomic references for pitch pine and other species.

588. Sim, Robert J., and Harry B. Weiss.
1955. **Charcoal-burning in New Jersey from early times to the present.** 62 pp., illus. N. J. Agr. Soc., Trenton.
Pitch pine was the principal wood used in charcoal production. Tar, resin, and pitch also were obtained. The open-pit method of charcoal burning is described, and some information on yields (about 30 bushels of charcoal per cord of wood) is given. In the days of bog-ore furnaces, stands were cut over at 20-year intervals for charcoal.

589. Wells, Sidney D., and John D. Rue.
1927. **The suitability of American woods for paper pulp.** U. S. Dep. Agr. Dep. Bull. 1485. 101 pp., illus.
The suitability of pitch pine and other species for pulp by sulfite, sulfate, and mechanical processes is discussed. Yields, bleach required, and uses of pulp are given. Pitch pine pulp by the sulfate process is suitable for kraft wrapping paper, fiber board, and book stock.

AUTHOR INDEX

Caution about Pesticides

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife — if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

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