

CHAPTER 1

REGION, SPECIES, AND CULTURE

In this chapter the biological and geographical boundaries are established for forest genetics research and tree breeding in the southern pine region, which consists of about 192 million acres in 13 of the southeastern states. There are 78.4 billion cubic feet of softwoods and 81.1 billion cubic feet of hardwoods in the area. The tree species and forest products are briefly described, also important features of soil and climate.

growth on a variety of soils, and the wood is valued for pulp and structural materials. It is planted in other countries. Only slash pine is planted in comparable numbers in southern pine reforestation work. Loblolly pine hybridizes in nature with longleaf pine to form Sonderegger pine (*Pinus* × *Sondereggeri*).

SPECIES

Loblolly Pine

With slightly over half of the total pine volume, loblolly pine is the most important softwood species in the southern pine region. It occurs throughout the entire South and Southeast, with the exception of the lower part of Florida, and extends from Delaware to Texas (fig. 1). The tree makes rapid

Longleaf Pine

Longleaf pine occurs generally in the Coastal Plain from Virginia to Florida and west to eastern Texas (fig. 2). It is conspicuous for its ability to grow on sandy soils, its delayed height growth in youth, and its ability to withstand fire. Also, it is unique among local pines in that its seed is big, soft, and has adnate wings. With slash pine it is the basis of the naval stores industry. It has been planted in

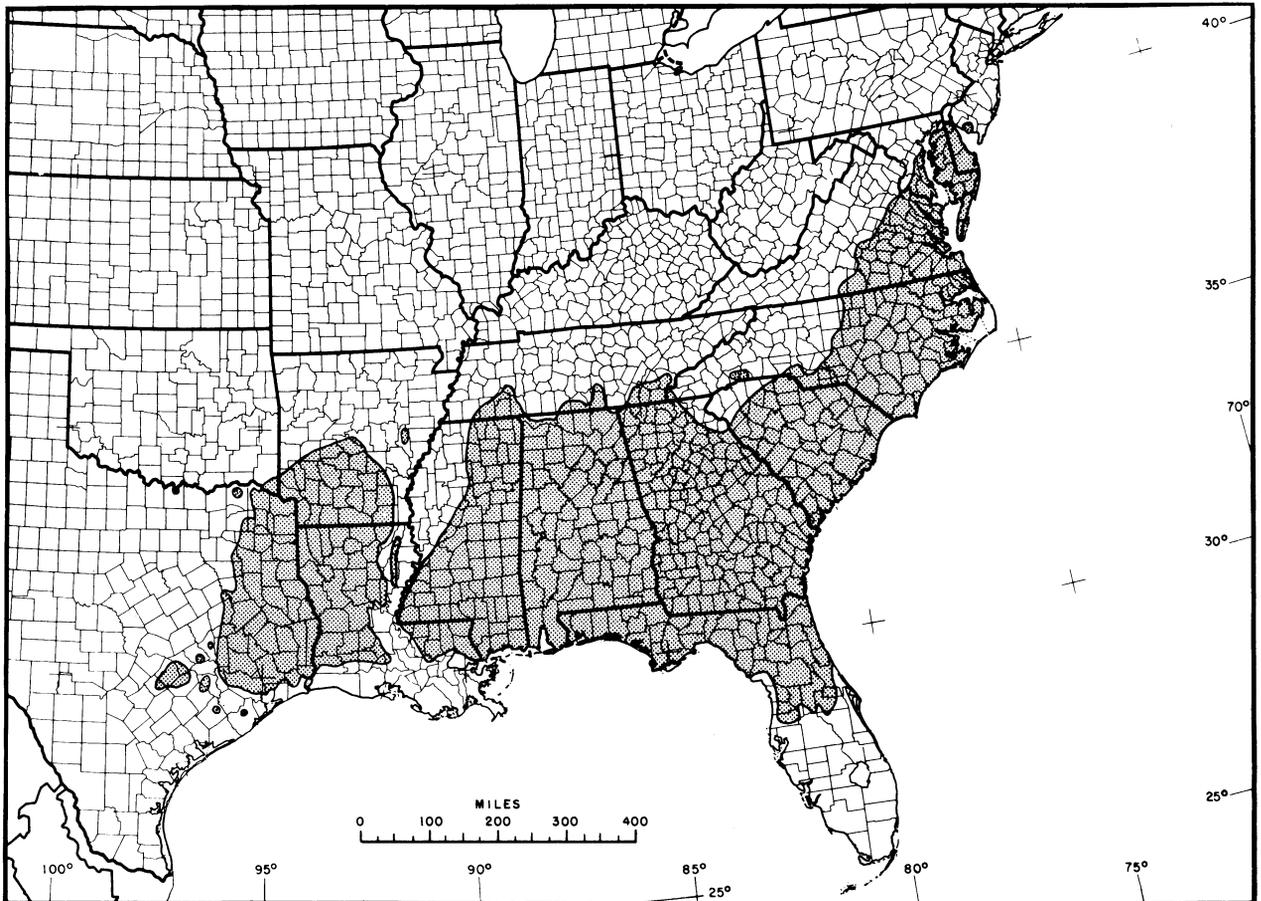


Figure 1.—Natural range for loblolly pine, *Pinus taeda*.

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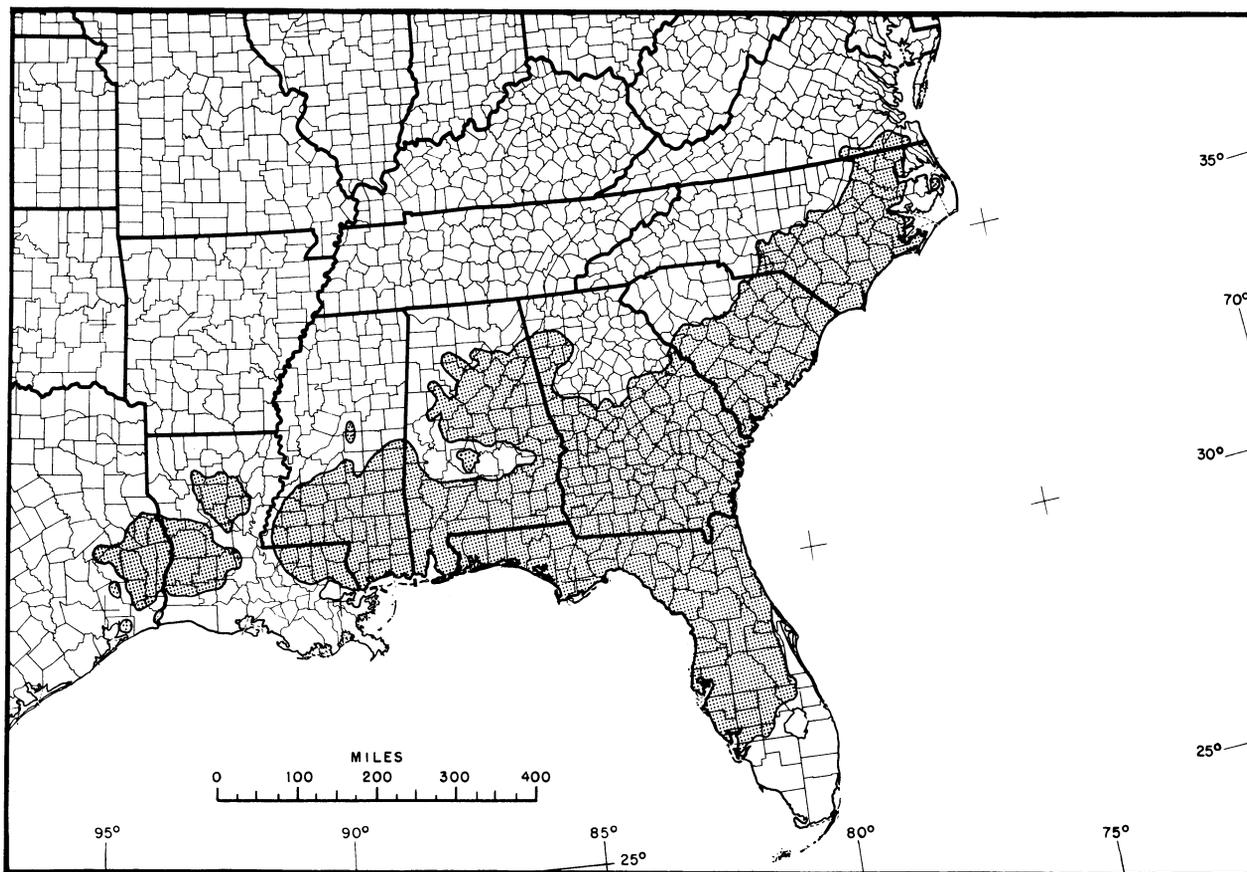


Figure 2.—Natural range for longleaf pine, *Pinus palustris*.

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foreign countries but is probably of minor importance. It is planted throughout its range, but in relatively small numbers.

Pitch Pine

Ranging from Maine and southern Ontario south to Georgia and west to Tennessee and Ohio, pitch pine has a more northerly range than any of the southeastern pines (fig. 3). It is not a commercially important species. It grows on poor, dry soils, and is resistant to fire. In the southern part of its range it grows only in the Piedmont and mountains, but farther north it is found near the coast. It is planted rarely, if at all, in the Southeast. An artificial hybrid with loblolly pine is important to forestry in Korea. In the United States, pitch pine hybridizes with certain other species.

Pond Pine

Largely restricted to the Coastal Plain from New Jersey to Florida and Alabama, but found in certain Piedmont locations, pond pine is used commercially

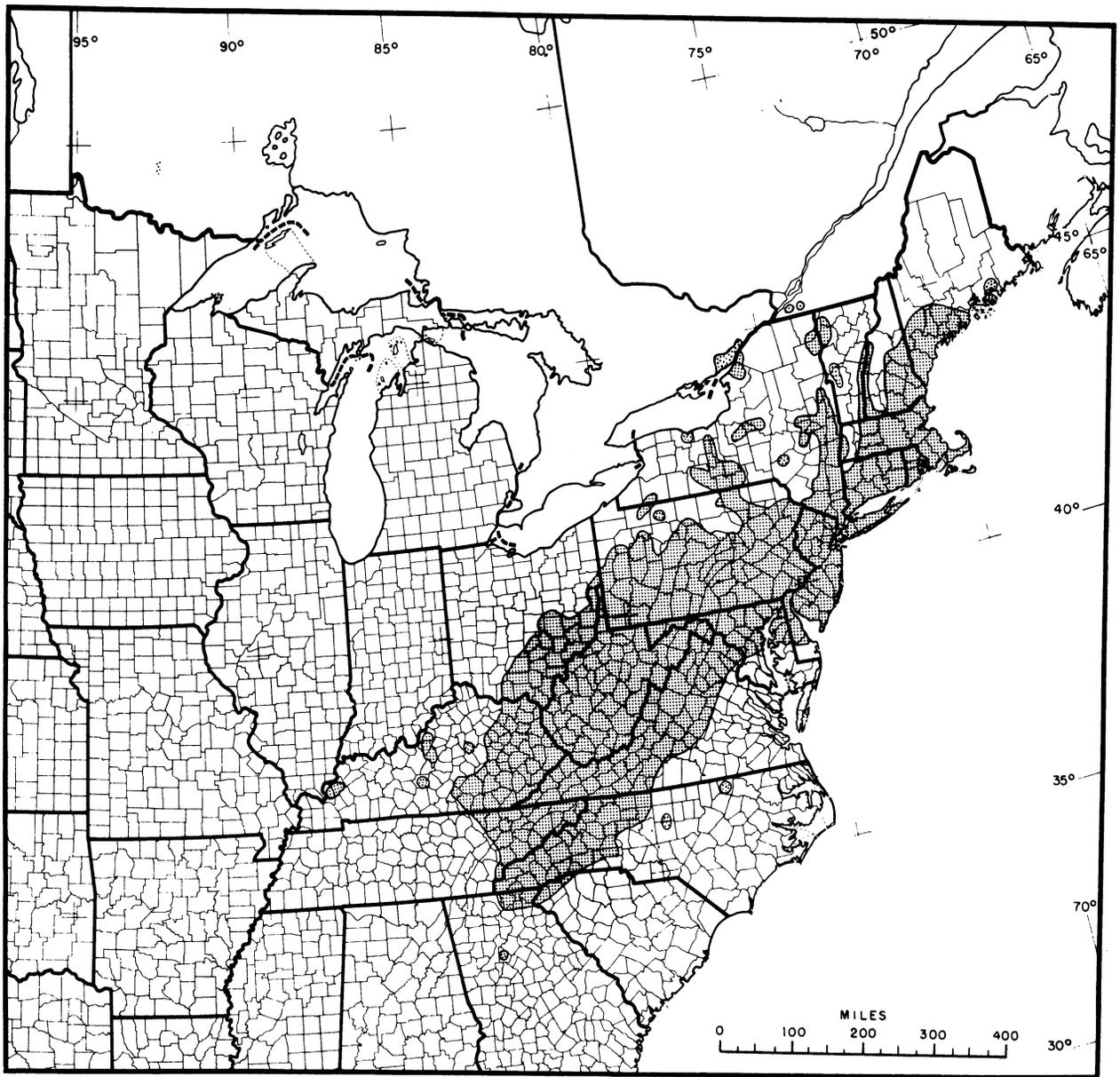
with associated species, but does not occur in large volume (fig. 4). It is a common species on very poorly drained soils and pocosins. Although it does not occur with pitch pine except where their ranges slightly overlap, it resembles the latter so much that at one time it was considered to be a serotinous form of pitch pine.

Sand Pine

This species has the most limited range of the southern pines, growing only in Florida and the southern tip of Alabama (fig. 5). Formerly not utilized, sand pine is now being cut for pulpwood and small saw logs. It forms fairly large areas of pure and often even-aged stands on deep, droughty sands. Typical sand pine, Ocala race, in central Florida has serotinous cones, but the Choctawhatchee race, with cones opening at maturity, is formally recognized in west Florida by taxonomists.

Shortleaf Pine

Ranging from New York to Texas, this species has the most extensive natural range of all the



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Figure 3.—Natural range for pitch pine, *Pinus rigida*.

southern pines, but it has only about 55 percent as much total volume as loblolly pine (fig. 6). It occurs more often on clay or heavy soils of the Piedmont and mountains than on the sandy soils of the Coastal Plain. The future of this important pulp and lumber species is clouded because of its initially slow growth rate and its susceptibility to littleleaf disease in some locations.

Slash Pine

Although it has the most restricted range of the four major species of pine in the South and Southeast, slash pine is planted in large numbers. It grows in the Coastal Plain from South Carolina to

Florida and west to eastern Louisiana (fig. 7). It is generally considered the most rapid growing of the local pines, but is second to loblolly in growth on some sites. The wood is valued for many uses. Slash pine produces higher yields of oleoresin than does longleaf pine—the other naval stores pine. It is quite widely planted in some foreign countries. A variety growing in south Florida has been named *Pinus elliottii* var. *densa* Little & Dorman.

Spruce Pine

Although spruce pine grows throughout the Coastal Plain from South Carolina to Florida and

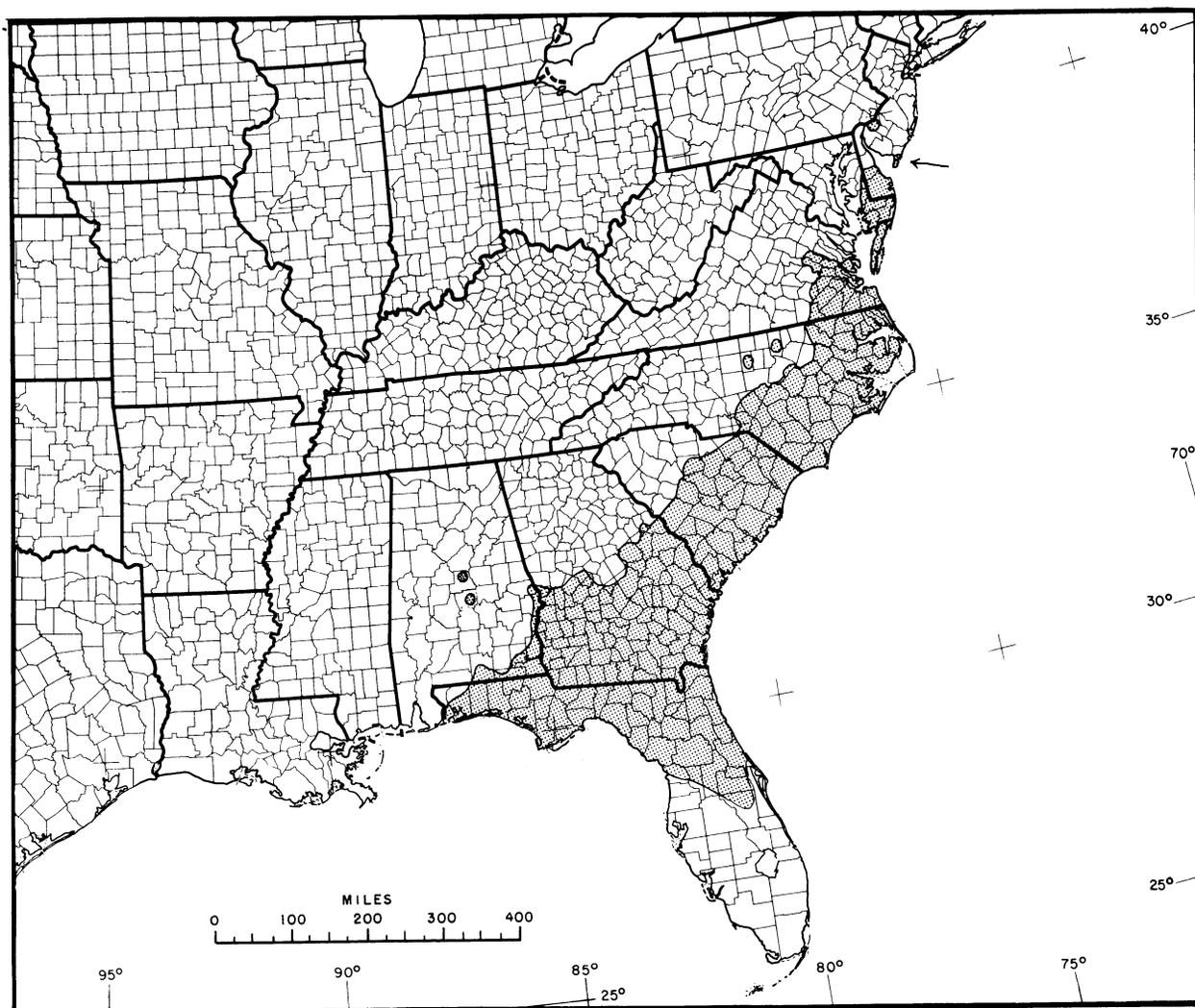


Figure 4.—Natural range for pond pine, *Pinus serotina*.

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Louisiana, it is very scattered (fig. 8). Spruce pine is associated with bottomland hardwoods, and Mohr (1897) states it is the most tolerant of all the pines in the South. It has been planted on a small scale in South Carolina.

Table-Mountain Pine

From Pennsylvania, the range of this species follows the Appalachian Mountains to northern Georgia, but there are scattered outlying areas with small wood volume (fig. 9). It may grow on soils of low fertility and is usually unsuited for many commercial uses because of poor form. It is rarely planted.

Virginia Pine

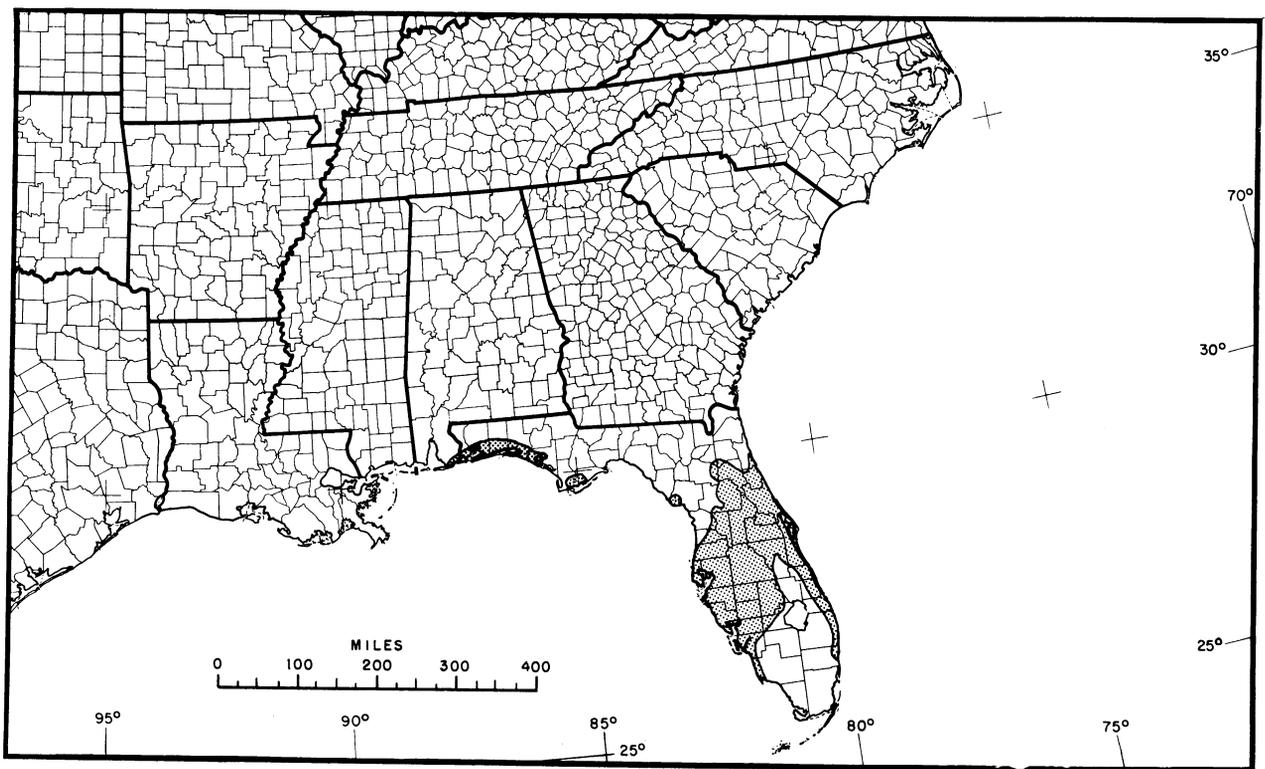
Virginia pine ranges from New York and Pennsylvania to Indiana, and south to Georgia and Mississippi, an area larger than that of any other

minor pine (fig. 10). It is found near the coast only in the northern part of its range. Tree form in this species is usually poor, although locally there are stands of good quality. It invades old fields in the Piedmont and Appalachian Mountains. It is becoming an important species for pulpwood in local areas.

As a group the southern pines are characterized by their rapid growth in early years, dense and strong wood, ability to reseed naturally in nearly pure stands, and utilization for a wide variety of products.

SIZE AND SHAPE OF GEOGRAPHIC RANGES

Slash, longleaf, loblolly, and shortleaf occurred in large volume in nearly pure stands over large areas



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Figure 5.—Natural range for sand pine, *Pinus clausa*.

in virgin forests and, as such, were of paramount importance to industry. Slash pine is the only species not native west of the Mississippi River. These four major species loom large in forest management operations, and as a consequence have received the lion's share of attention in research in regeneration, cultural practices, and utilization.

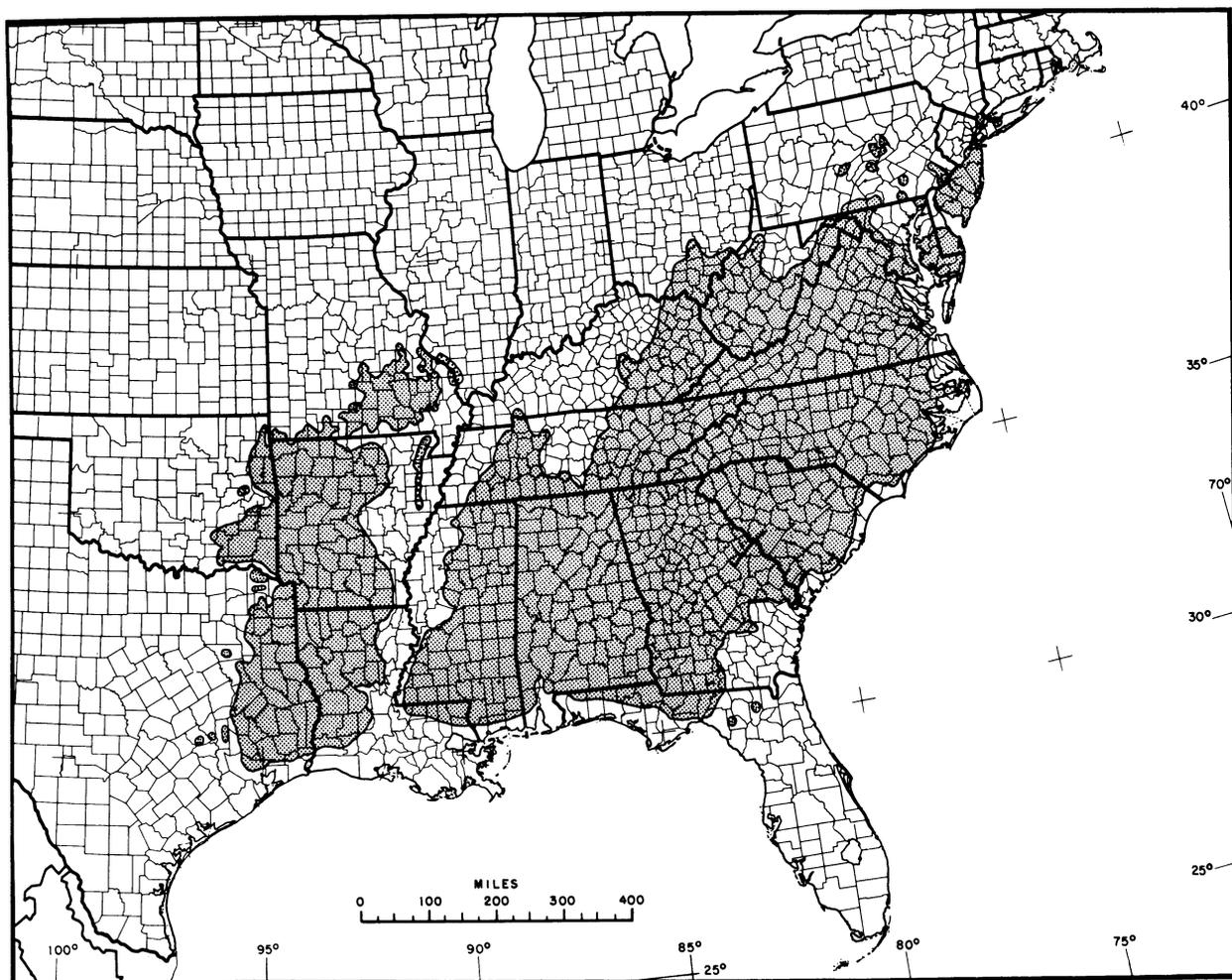
The minor species as a group are less important because of smaller geographic coverage. The combined effect of small volume and geographic range slowed industrial use and also research study. This is not to say these species are unimportant locally, as they may be the most valuable softwood available. Moreover, with increasing intensity of forest management to keep pace with expanding industrial use, the so-called minor species are becoming not so minor and are receiving the attention they deserve, an important factor being the rise in pulp and paper mills that utilize small trees of less desirable stem and crown form than lumber mills require.

Most of the minor southern pine species occur on rather special sites although they are not restricted to them. Sites may vary over the range of the species, particularly from north to south. Sand pine in Florida, in the largest block of pure stands, grows on very infertile, coarse and deep sand. In other areas it occurs in relatively small volume on typical flatwoods sites. Pond pine grows on very

wet sites, some of which are typical flatwoods swamps, while others are peat. Spruce pine is the only southern pine generally found on bottomland sites, although loblolly pine is found there occasionally, where it occurs in close association with hardwood species. Pitch pine in upland areas is found on steep slopes and ridges where soils are shallow, but it also occurs on sands and gravels as well as peat soils in swamps. Virginia pine grows well on a variety of soils but will establish itself in pure stands on dry and eroded fields abandoned for agriculture.

Geographic ranges of the four major pine species are very similar in shape. Difference in total area occupied by each is a result of difference in the extension northward and inland from the Atlantic and Gulf Coasts. A minor exception to this generality is that slash pine does not extend as far westward along the Gulf Coast as do shortleaf, loblolly, and longleaf pines. The natural ranges of all these species extend from the northernmost point along the Atlantic Coast, southward along the coast, and westward along the Gulf Coast.

The range patterns of the minor species are very different. Sand pine is so limited geographically in Florida that not much significance can be attached to its range. The ranges of all the other four species are somewhat long and narrow. That of spruce pine, however, is oriented east and west and ex-



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Figure 6.—Natural range for shortleaf pine, *Pinus echinata*.

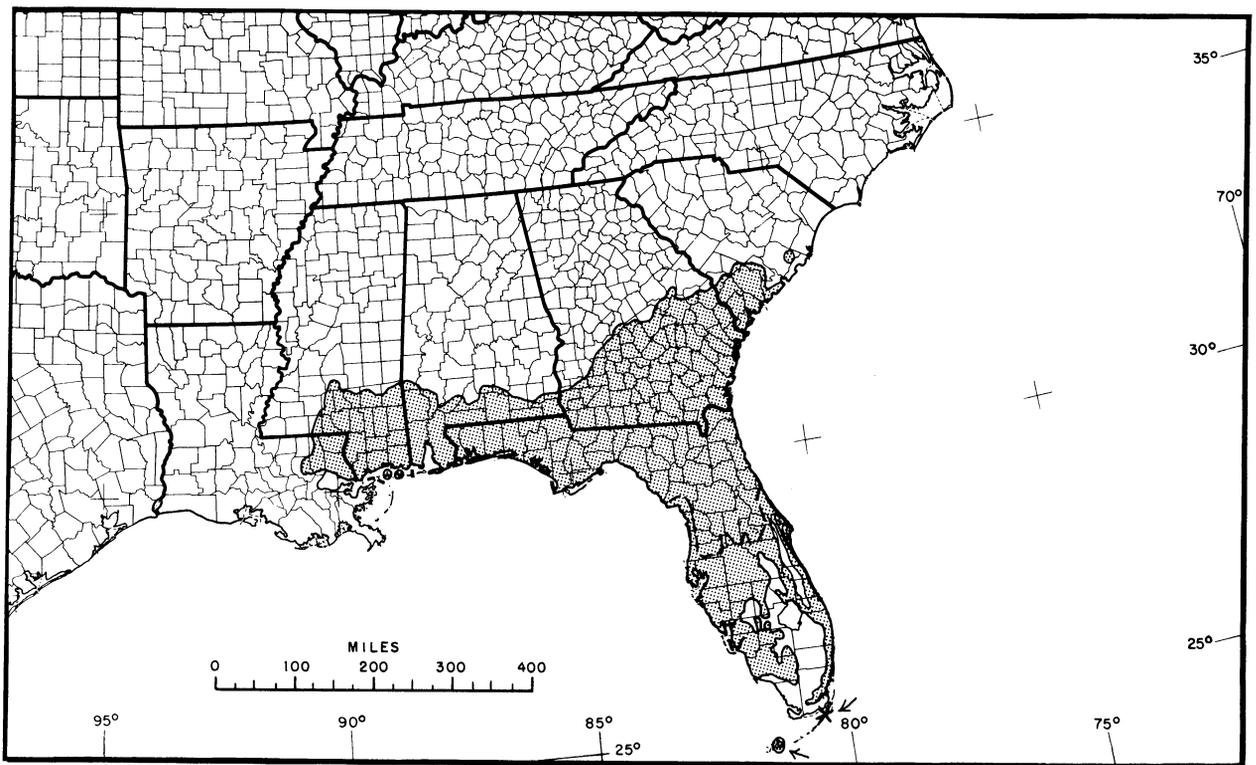
tends from the Georgia coast to the Mississippi River, while those of Virginia, pond, pitch, and Table-Mountain pines extend southwestward from their northernmost point parallel to the Atlantic Coast and the Appalachian Mountains. None of the minor pines is found west of the Mississippi River.

CLIMATE OF SOUTHERN PINE REGION

Climate was undoubtedly an important influence in developing the number and diversity of tree species, races, and clines in the southern pine region. Although the southern latitudes in the United States have long warm summers, relatively mild winters, and ample rainfall, there are important differences locally in these three factors that affect growth and other performance characteristics important in forestry. Climatographs positioned around the range map of loblolly pine illustrate some of the rather wide variation in temperature and rainfall (fig. 11).

In Florida, average monthly temperatures have a range of only about 20° F throughout the year, with a minimum of about 60° F and a maximum of 80° F. The range in rainfall per month is the widest in the region, with a minimum of slightly over 1 inch to a maximum of nearly 8 inches. Low monthly rainfall occurs in winter months when temperatures are low, and high rainfall rates are common in mid-summer when temperatures are high. In the northeastern part of the southern pine region such as Dover, Delaware, the variation in monthly rainfall is only about 3 inches but the temperature varies from a little over 30° F to highs of nearly 75° F. Rainfall is well distributed throughout the year. In Texas a different pattern appears: rainfall is highest during the winter and spring months, when temperatures are low, then decreases in summer and early fall, when temperatures are at the highest point for the year.

Elevation above sea level affects temperature and rainfall, which in turn, of course, affect growth.



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Figure 7.—Natural range for slash pine, *Pinus elliottii*.

Slash pine, with its range restricted to coastal areas on sandy soils of marine origin, grows over a very narrow elevational range. At the other extreme, shortleaf pine occurs from slightly above sea level to an altitude of 3,300 feet in the Appalachian Mountains.

A rapid and extreme change in temperature from mild levels to below freezing can occur in some areas of the region, and if this happens in early fall may severely damage pine needles. Also, storms with freezing rain or wet snow may seriously affect tree crown and stem form. This limits the choice of species suitable for planting. Both slash and loblolly pine will grow when planted in the Piedmont of Georgia, but quality or value of the trees can be extremely low in certain locations because of damage from ice and snow.

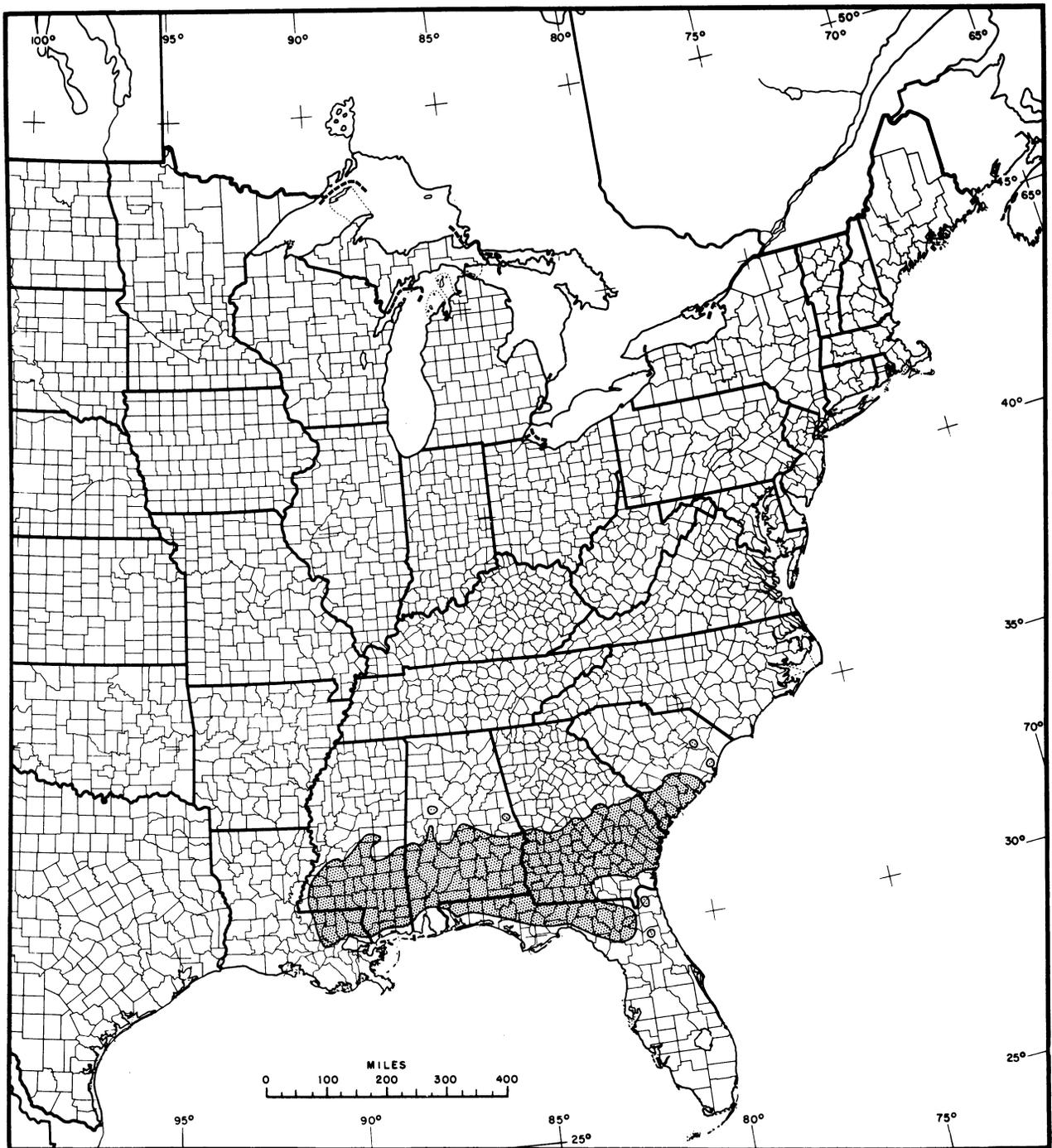
Ever since large-scale artificial reforestation began, silviculturists have had to give important consideration to the rather restricted soil and climatic requirements of southern pines. A knowledge of the requirements is a help in understanding why a highly valuable species like slash pine is not planted throughout an area with a range in climate such as found in the state of Georgia, but is highly esteemed in Africa, South America, and Australia, which lie in the southern hemisphere. Lack of consideration of soil and climatic requirements of various species explains, to some degree,

why much of the work in introducing pines from other regions has been unsuccessful in the South.

Flowering and seed production activities as well as growth periods and rates are closely attuned to climatic conditions. Slash pine, with the most restricted range of the major species, as well as the most southern, matures its flowers or strobili the earliest in the spring. At the same location, longleaf pine follows slash pine in blooming sequence and it has a more extensive natural range to the north and west. These are followed in turn by loblolly pine and shortleaf pine, each of which has larger geographic coverage in its natural range.

GROWTH AND STAND CHARACTERISTICS

Rapid growth of individual southern pine trees is sometimes made at the expense of high cubic-foot volume growth per acre. In other words, trees do best where light and sufficient growing space are available to permit development of good-sized but not necessarily huge crowns. The multinodal growth habit permits use of the long growing season typical of southern latitudes, although growth habits vary with latitude within the region. Southern yellow pines do not have the strongly uninodal growth characteristic typical of many pines, al-



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Figure 8.—Natural range for spruce pine, *Pinus glabra*.

though longleaf may be weakly uninodal.

An important factor in what might be called the rebirth of the southern pine industry which followed the period of readjustment after removal of the virgin forest is the ability of the southern pines to produce wood in large volume on lands unsuited to intensive agriculture. Thus, timber is replacing

annual crops as a result of land acquisition programs of forest industry. A few counties in the South are 90 percent forested. The deep sand and tight clay soils have a fairly low nutrient level but enable harvesting of forest products throughout the year.

Southern pines form extensive areas with pure

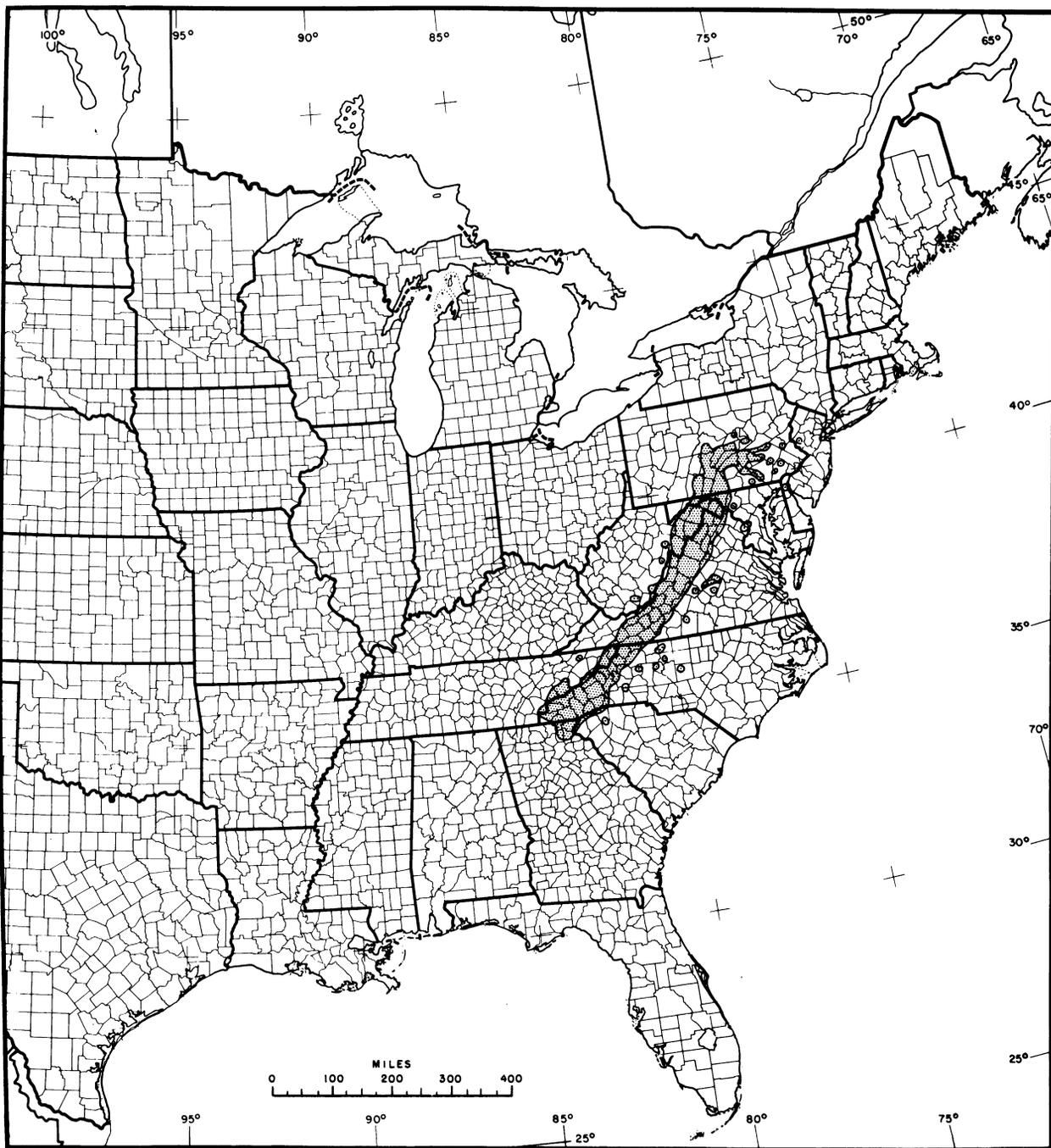


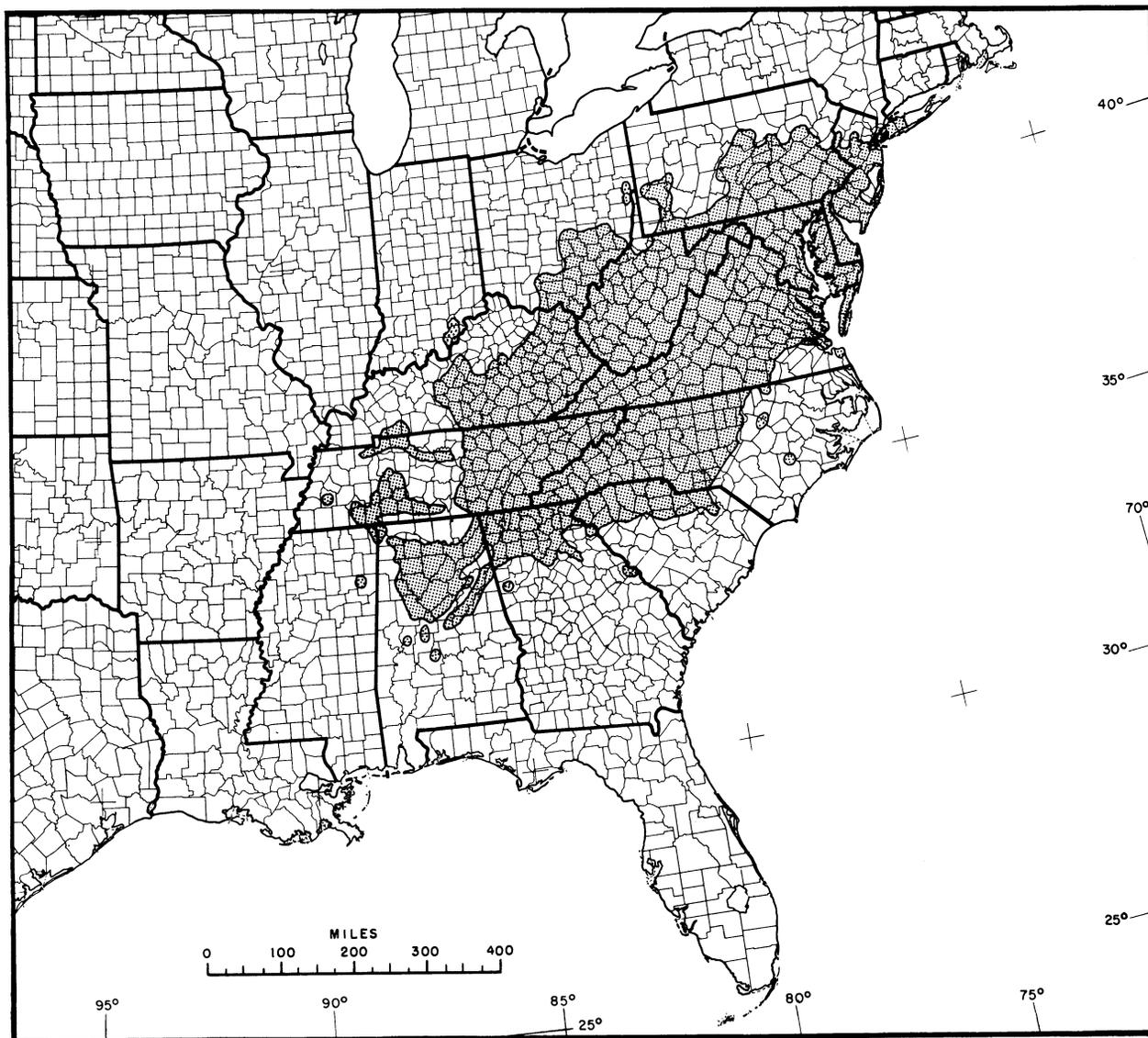
Figure 9.—Natural range for Table-Mountain pine, *Pinus pungens*.

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stands largely in the Atlantic Coastal Plain and along the Gulf of Mexico (fig. 12). Hardwoods of many species mixed with pines become more common inland. In the southern pine region, timber occupies about 60 percent of the total area, and 55 percent of the timber volume is pine.

OLEORESIN AND NAVAL STORES

The valuable naval stores products, turpentine and rosin, produced in the United States come from longleaf and slash pines. Rosin and sulphate turpentine come from steam distillation of wood and



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Figure 10.—Natural range for Virginia pine, *Pinus virginiana*.

stumps or as byproducts of the pulping industry. In the 1972–73 season production was about 1.6 million 520-pound drums of rosin in the United States, 43 percent from steam distillation of wood, 52 percent from pulpmill tall oil, and 5 percent from oleoresin. Turpentine production of 565,890 barrels (50 gallons each) was made up of 13 percent from steam distillation of wood, 82 percent from pulping, and 5 percent from oleoresin. Application of chemicals to cause pitch soaking in trees and increase yield of byproducts of pulping is being studied (Roberts 1973).

Naval stores products may be an important factor in breeding programs from the standpoint of both volume yield and chemical composition because differences among species and individual

trees contribute to variation in product quality. Oleoresin yield and chemical composition may also be factors in resistance to certain insect and disease pests.

Each major southern pine species produces turpentine that, chemically, is largely alpha- and beta-pinene. The species vary in proportion of various pinenes in the turpentine. The five minor species have α -pinene only, or both pinenes, and, in addition—an important difference—four of them have one other component each such as *l*-limonene, *l*- β -phellandrene or *l*-camphene in concentrations of nearly 10 percent or higher. Virginia pine does not have the minor components, but the turpentine is nearly all α -pinene instead of both pinenes as in the four major species. These comparisons are

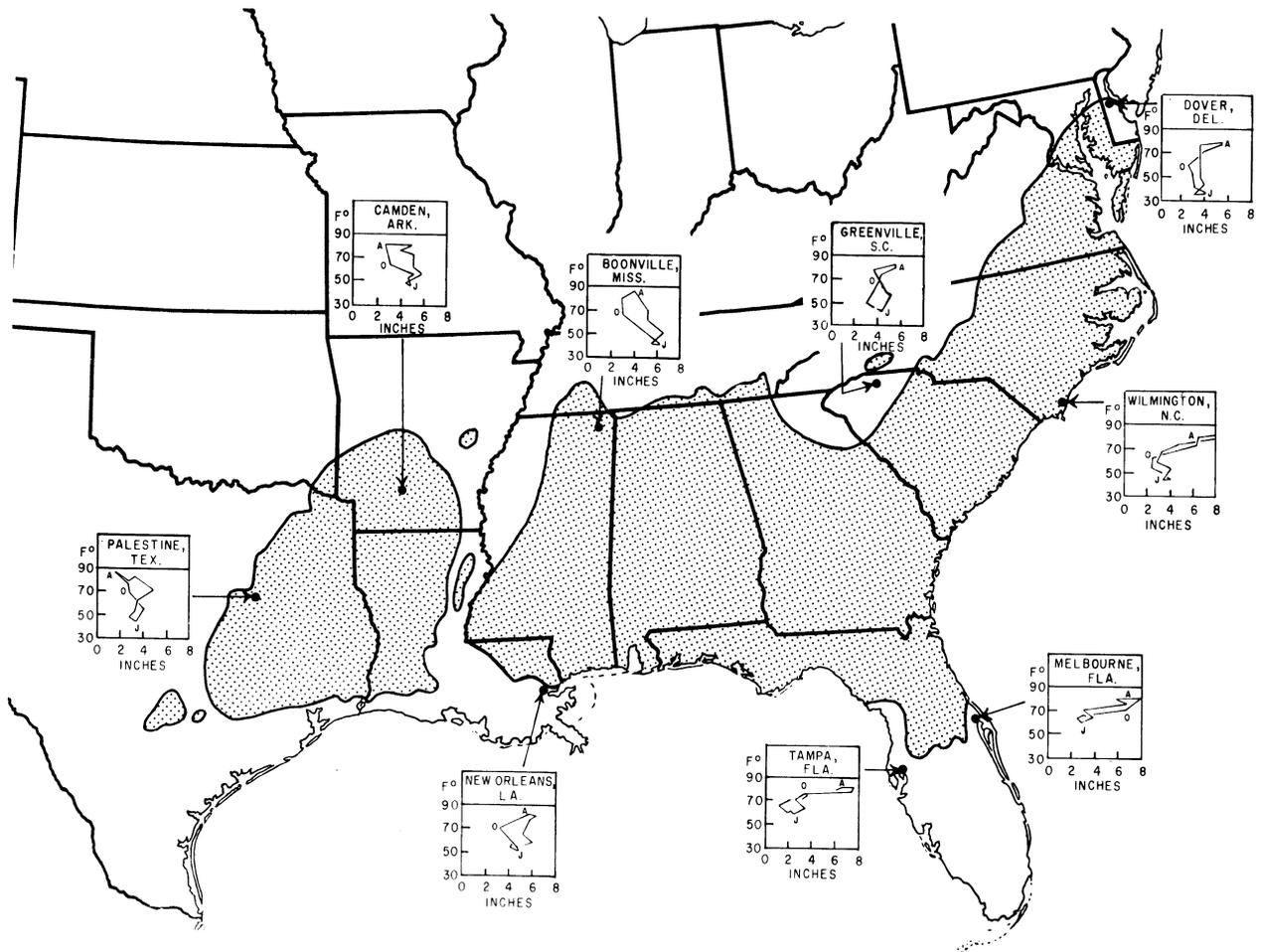


Figure 11.—Average monthly rainfall and temperature vary widely throughout the southern pine region. Also, the climatographs show that in certain areas such as central Florida, periods of high rainfall coincide with the seasons of high temperature, while in northern Mississippi high rainfall occurs when temperatures are low. Environmental differences such as these may contribute to the development of geographic races. (Wahlenberg and Ostrom 1956)

generalities. Recent work, using highly refined methods, is giving better estimates of the amount of major components and kind and amount of minor components.

SILVICS OF SOUTHERN PINE SPECIES

As we have seen, the southern pines occur over a large geographic area, but not all grow in the same areas. Inasmuch as a large area is involved, the climate, soils, and sites differ also. The species differ in growth capability, associated tree species, and disease and insect enemies; they vary also in response to damage from climatic factors. All these factors contribute to the size and complexity of forest genetics research programs, creative tree breeding to synthesize varieties, and silvicultural practices.

A substantial body of literature covers the differences among species. Excellent book-length monographs have been written about longleaf and loblolly pines by Wahlenberg (1946, 1960). Most of the southern pines were given separate treatment in the book *Silvics of Forest Trees of the United States* (Fowells 1965). Much information by species about the characteristics of cones, seed, seedlings, and planting requirements is given in *Planting the Southern Pines* (Wakeley 1954a). The literature of shortleaf pine is summarized according to subject in a bibliography by Haney (1962), and longleaf by Croker (1968).

The magnitude of different growth rates shown by southern pines is indicated in certain long-term studies. In Virginia plantations after 16 years, loblolly pine had produced 167 square feet of basal area per acre, white pine 145, Virginia pine 118, and



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Figure 12.—Even-aged stands and moderately level topography facilitate management and harvesting of southern pines. Longleaf pine in the Osceola National Forest, Florida.

shortleaf pine 124 (Kormanik and Hoekstra 1963). Farther south, in the Carolina Sandhills, several species grew at widely differing rates (McGee 1964; Harms 1968). In northern Florida on prepared sites the major southern pines differed greatly in both survival and height growth (Hoekstra 1957a). On the deep, sandy soils of west Florida after 12 years sand pine had grown the fastest, and it was followed by slash, longleaf, loblolly, Virginia, and shortleaf pines in descending order (Burns 1968). In Tennessee after 10 years loblolly pine had suffered damage from snow and ice, but shortleaf had very little damage, and white pine none at all (Zarger 1965). In Louisiana under simulated drought conditions shortleaf pine survived best, followed by loblolly pine and slash pines (Stransky and Wilson 1966).

There are large differences among southern pine

species in the kind and importance of insect and disease enemies. Also, for some species in certain parts of the natural range extreme importance must be attached to diseases such as fusiform rust (*Cronartium fusiforme*) of slash and loblolly pines, littleleaf disease caused by *Phytophthora cinnamomi* and soil factors, and brown-spot needle blight (*Scirrhia acicola*) of longleaf pine. The 10 most important forest disease pests in the South were described by Hepting (1961). The information about diseases and insects of Georgia's forest trees given by Jackson *et al.* (1957) is applicable to many other southern states.

Diseases and insect enemies and the possibility of large losses to drought, freezing rain, and other environmental factors are of sufficient importance in the southern pine region to affect choice of species for planting, cultural practices in stands,

and probably rotation age. Therefore, tree breeding project plans must provide for resistance breeding either as the main objective or an important part of breeding for volume growth and tree quality. Pests that decrease plantation survival, such as certain weevils, fusiform rust, or brown-spot, affect volume growth on an area basis just as much or more than those attacking large trees.

Research in silviculture has contributed much information about requirements of species and their average growth or performance characteristics.

Forest genetics research has extended some of the same subject matter fields to the specific geographic area or areas in which species grow, their characteristics when seed is planted in other than local areas, and the differences among individual trees growing in stands—or what might be called a similar environment. Studies of variation within species have contributed much to the foresters' knowledge of what constitutes the "internal" makeup of southern pine species.