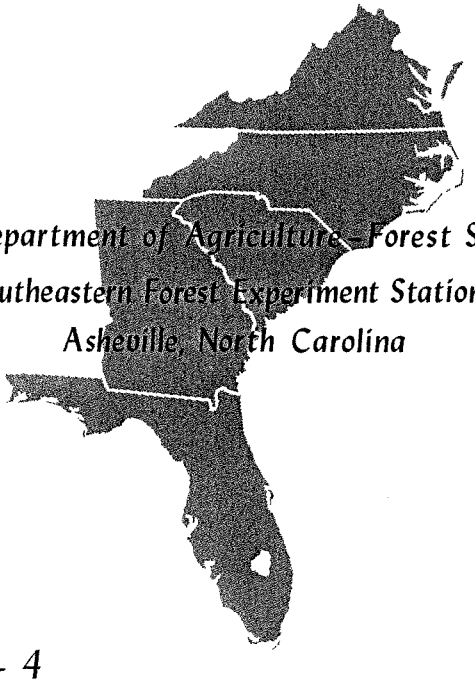
THE OLUSTEE ARBORETUM

performance of 67 species of forest trees

by

John F. Kraus



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Introduction

Tree improvement research at the Lake City (Florida) Research Center of the Southeastern Forest Experiment Station is aimed primarily at improving oleoresin yield of slash pine (Pinus elliottii Engelm.). The wide range in variation of this trait among individual trees is already being utilized in the improvement of the species. The results of intraspecies hybridization have been reported by Mergen (1954), Mergen et al. (1955), Bourdeau and Schopmeyer (1958, pp. 313-319), Squillace and Dorman (1961), and Squillace and Bengtson (1961).

An additional source of variation in oleoresin yield and chemical composition exists in the various species of pines. Many of these species are used in their native lands as a source of oleoresin, some of them on a commercial scale. The Olustee Arboretum was established in an attempt to make available as large a pool of the genetic variation existing among species as could be obtained. 1/ Previous reports have described briefly the establishment of the arboretum, its first species acquisitions, and their early performance (Hoekstra 1954; Kraus 1958).

The thought that introduced tree species might have a place in southern forestry is not new. Performance of eucalypts in Florida has been discussed by Zon and Brisco (1911). The possibility that maritime pine from France might be useful in the naval stores belt was advanced by Eldredge (1921), and a number of additional species and varieties were suggested by Gemmer (1931). Trials of subtropical hardwoods are continuing in south Florida under the auspices of the Florida Forest Service (Schory 1957).

The use of exotics as a substitute for applied breeding was advanced by Hardee (1956). An account of some successful uses of exotics is given by Moulds (1957). More recently, the importance of exotics was discussed at the World Forestry Congress by Achaya (1960) and Fielding (1960). Fielding

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1/ Mergen, Francois. Arboretum establishment. Unpublished working plan on file at Southeastern Forest Experiment Station, U. S. Forest Service, Asheville, North Carolina. 1954.

recognized some of the difficulties involved in tree introduction and described some of the factors important in such work. Dorman (1962) reviewed the conditions under which tree introduction work has been successful and showed some of the limitations in use of exotics in specific tree breeding projects.

Native and exotic species have been planted in arboreta or on estates in the United States for many years. Some arboreta were strictly for forestry purposes and others became available for scientific work in forestry after passing from private ownership. Only a few of the arboreta need to be listed here to indicate their age and the forest region in which they occur. The Mont Alto State Forest Arboretum was started in 1903 (Pennsylvania Department of Forests and Waters 1954); the arboretum at the Cloquet Experimental Forest, of the University of Minnesota, was started in 1922 (Schantz-Hansen and Hall 1952); The Eddy Arboretum, of the Institute of Forest Genetics at Placerville, California, was begun in 1925 (Liddicoet and Righter 1960); The Morgan Arboretum, of Macdonald College and McGill University in Quebec, Canada, began in 1946 (Macdonald College, no date); and the Norris Oak Arboretum was started by the Division of Forestry Relations, Tennessee Valley Authority in 1948 (Hatmaker 1957).

Throughout this report names of native species are from Little (1953), and non-native species generally are from Dallimore and Jackson (1961).

Location and Description

At present the Olustee Arboretum consists of two outplanting areas. The oldest, established in 1954, is an 8-acre area one-quarter of a mile south of Ocean Pond on the Osceola National Forest. It is locally known as either the "old" arboretum, or the "wet" arboretum (fig. 1). The soil in this area is a Leon fine sand. It is described as a nearly level, moderately wet, sandy, acid hardpan soil, low to medium in organic content and natural fertility. Despite the uniformity of soil type, there is a slight moisture gradient in the arboretum, the south end being slightly drier than the rest of the area. At the time of establishment the area was fenced for protection from cattle, and this has resulted in the development of a heavy sod of carpet grass (*Axonopus affinis*). During summers of normal rainfall the water table over most of the area is very close to the soil surface, and in some small spots actually rises an inch or two above it. Since this condition seemed unfavorable to the establishment of many exotic species, a drier area has been added to the arboretum.

The "new" or "dry" arboretum, established in 1958, is a 6-acre area one-third of a mile southeast of Ocean Pond (fig. 2). The soil is a Blanton fine sand, characterized as nearly level, droughty upland; subject to slight erosion; very deep acid sandy soil, low in organic matter, natural fertility, and available moisture.

On both areas a single outplanting consists of a square 25-tree plot, with 12 by 12-foot spacing, and a 20-foot-wide access lane between plots on all sides.

Figure 1. --General view of the wet-site area, Olustee Arboretum, July 1962.

Figure 2. --General view of the dry-site area, Olustee Arboretum, July 1962.

Climate

Climate is best described as humid temperate. Freezing temperatures occur yearly, light falls of snow rarely, and glaze ice, such as that experienced in February 1962, is extremely rare.

The long-term rainfall pattern is marked by two periods of above average rainfall, and two of below average (fig. 3). The wettest period of the year is from June through September, when the mean monthly rainfall usually exceeds 5 inches. A smaller peak in the rainfall pattern occurs from February through April, when the rainfall averages about $3\frac{1}{2}$ inches a month. The driest season of the year is usually from November to January, with a short dry period commonly occurring in May.

The climate during the period 1954 to 1961 has followed fairly closely the long-term trends. The more pertinent weather data for the 8-year period are as follows:

Average annual rainfall	49.83 inches
Growing season rainfall (March-October)	40.00 inches
Average annual temperature	69.0° F.
Average temperature of coolest year	67.2° F.
Average temperature of warmest year	70.8° F.
Growing season temperature (March-October)	74.9° F.
Highest temperature recorded (1954)	105.0° F.
Lowest temperature recorded (1959 and 1961)	17.0° F.
Average frost-free period	258 days

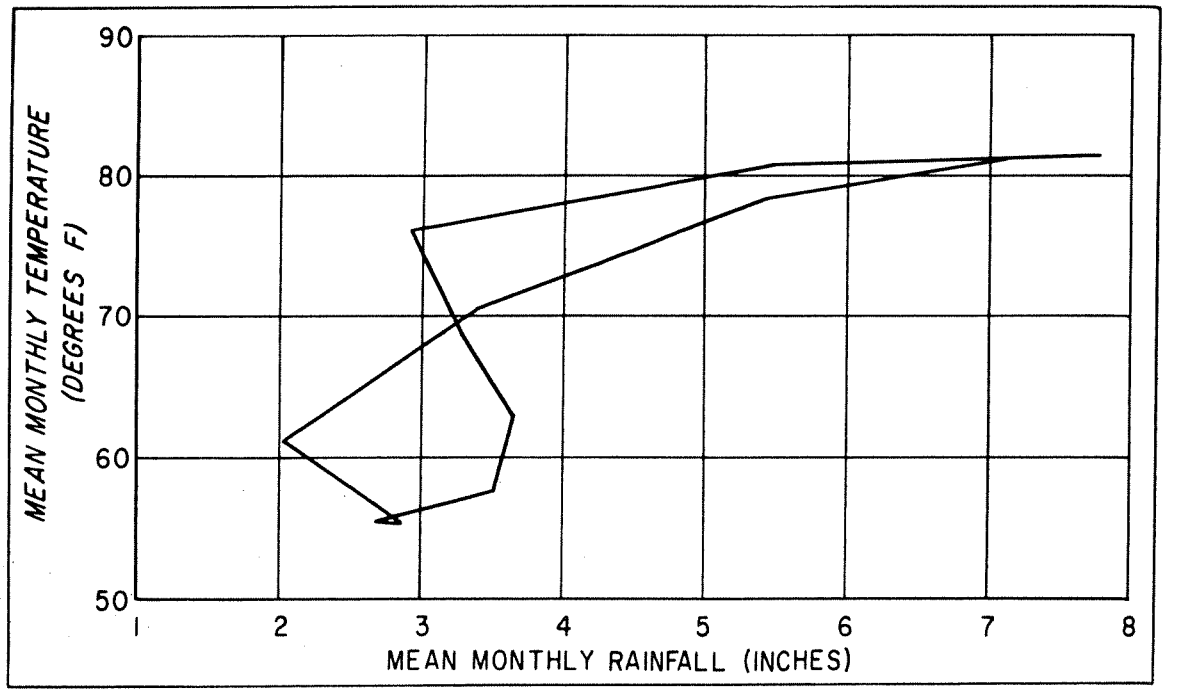

Figure 3. --Climograph, Lake City, Florida (Base: 1883-1961).

The Pines

Since 1954 a total of 67 species or varieties, and 7 interspecific hybrids, have been received for use in the arboretum. In some cases more than one provenance of a species was acquired so that all told 159 acquisitions of pine (seed or seedlings) have been recorded.

Forty of the species outplanted, comprising 100 acquisitions, were not native to the United States. Only 29 of these non-native sources, including 7 species, were still active in April 1962.

Twenty-seven pine species involving 50 sources native to the United States have been tried, and of these only 7 species are still active, 6 of which are considered as "southern pines."

Of the seven interspecific hybrids (nine seed lots) only one was not a cross between "southern pines," and it is the only one which failed to survive.

The characteristics and performance of the surviving pine acquisitions are given in the following section. Table 1 contains data on the exotic pine acquisitions considered failures and no longer active. Table 2 contains similar data on native pines.

Pines Not Native to the United States

PINUS DENSIFLORA SIEB. & ZUCC.--JAPANESE RED PINE

This species is the most common forest tree in Japan. Its range extends from Kyushu to Hokkaido. It makes its best development at higher elevations in Hokkaido.

Two of three acquisitions are still active in the Olustee Arboretum. In general the performance of *P. densiflora* has been characterized by relatively good survival in comparison to other exotic pines, profuse flowering at 2 to 3 years of age, slow growth in comparison to *P. elliottii*, and poor form apparently due to high susceptibility to attack by tip moth (*Rhyacionia* spp.).

Lot No. 113.--Received as seed in 1955 from a commercial seed dealer, the seed source is Japan, prefecture unknown. It was first outplanted in the wet-site arboretum in January 1957 as 2-0 stock. A total of 35 trees were planted, 10 replacements being made the first year.

Table 1.--Foreign pine acquisitions no longer active in the Olustee Arboretum

Species	Lot No.	Seed source				Trees planted	Site	At time discarded--			Remarks
		Location	Latitude	Longitude	Altitude			Age of trees	Survival	Av. height	
					Feet	Number		Years	Number	Feet	
Pinus canariensis C. Smith	68	Commercial dealer	--	--	3,700 to 6,600	--	--	--	--	--	Frost injury in the nursery and transplant bed.
P. caribaea var. *hondurensis* (*P. caribaea* Morelet)	137	British Honduras	--	--	Sea level	--	--	--	--	--	Frost killed.
P. caribaea var. *hondurensis* (*P. caribaea* Morelet)	138	British Honduras	--	--	1,500	--	--	--	--	--	Frost killed.
P. halepensis Miller	4	Rabat, French Morocco	33° N.	5° W.	--	10	Wet	4	2	--	--
P. halepensis Miller	168	Central coast of Italy	--	--	Sea level	68	Wet & dry	3	3	1.5	Survival and growth best on dry site.
P. halepensis Miller	179	Genoa, Italy	44°30' N.	09°00' E.	Sea level	71	Wet & dry	3	1	1.3	Survival and growth best on dry site.
P. halepensis Miller	191	Pisa and Livorno, Italy	43°30' N.	10°30' E.	--	78	Wet & dry	3	4	2.6	Survival and growth best on dry site.
P. hondurensis Loock (*P. caribaea* Morelet)	66	Unknown	--	--	--	--	--	--	--	--	Frost killed in transplant beds
P. khasya Royle	115	Commercial dealer	--	--	--	--	--	--	--	--	Frost killed in seedbed.
P. laricio Poir. (*P. nigra* Arnold)	86	Jaen, Spain	37°54' N.	2°52' W.	--	--	Wet	4	1	--	--
P. laricio var. *Corsica* Loud. (*P. nigra* var. *poiretiana* (Ant.) Aschers. & Graebn.)	131	Commercial dealer	--	--	--	50	Wet	6	1	0.4	--
P. longifolia Roxb. (*P. roxburghii* Sarg.)	62	Unknown	--	--	--	10	Wet	6	4	1.2	--

P. longifolia Roxb. (P. roxburghii Sarg.)	185	W. Pakistan	--	--	--	90	Wet & dry	3	0	0.9	--
P. longifolia Roxb. (P. roxburghii Sarg.)	193	Commercial dealer	--	--	--	96	Wet & dry	3	0	1.1	Initial survival best on dry site.
P. michoacana Martinez	61	Unknown	--	--	--	5	Wet	4	0	--	--
P. michoacana Martinez	81	Mexico	--	--	--	25	Wet	6	0	--	--
P. michoacana Martinez	160	Mexico	--	--	--	79	Wet & dry	3	2	0.2	Survival best on dry site.
P. michoacana var. cornuta Martinez	78	Mexico	--	--	--	25	Wet	5	2	--	--
P. mugo var. gallica (P. mugo Turra)	54	Commercial dealer	--	--	--	25	Wet	3	1	--	--
P. mugo var. mughus (Scop.) Zenari	53	Tyrolean Alps	--	--	--	25	Wet	3	1	--	--
P. nigra Arnold	121	South central Europe	--	--	--	37	Wet	8	2	1.4	Tetralopha spp.
P. nigra Arnold	123	Austrian hills	--	--	--	25	Wet	7	0	0.6	--
P. nigra var. poiretiana Schneid. (P. nigra var. poiretiana (Ant.) Aschers. & Graebn.)	116	Commercial dealer	--	--	--	10	Wet	2	0	--	--
P. oocarpa Schiede	127	Mexico	--	--	--	--	--	--	--	--	Frost killed in seedbed.
P. pinaster Ait.	87	Unknown	--	--	--	25	Wet	11	1	1.4	Brown spot needle blight.
P. pinaster var. Maghrebiana (H.-Villar) (P. pinaster Ait.)	89 & 104	Talaruak Forest, Spanish Morocco	35° N.	5° W.	--	20	Wet	9	0	0.8	Brown spot needle blight and tip moth.
P. pseudostrobus	63	Unknown	--	--	--	15	Wet	4	1	--	--
P. pseudostrobus Lindley	92	San Jose, Michoacan, Mexico	19°25' N.	102°00' W.	8,200	10	Wet	4	1	--	--
P. pseudostrobus Lindley	161	Mexico	--	--	--	91	Wet & dry	4	3	0.1	Initial survival was best on the dry site.

Table 1.--Foreign pine acquisitions no longer active in the Olustee Arboretum (continued)

Species	Lot No.	Seed source				Trees planted	Site	At time discarded--			Remarks
		Location	Latitude	Longitude	Altitude			Age of trees	Survival	Av. height	
					Feet	Number		Years	Number	Feet	
P. pseudostrobus Lindley	176	Zarco, Mexico	19° N.	99° W.	--	64	Wet & dry	3	1	0.2	--
P. sylvestris L.	42 & 94	Granada, Spain	37°05' N.	3°37' W.	4,900	10	Wet	4	1	--	Poor germination.
P. sylvestris L.	43 & 90	Burgos, Spain	42°04' N.	3°01' W.	4,600	20	Wet	5	3	--	Germination poor.
P. sylvestris L.	44 & 72	Huesca, Spain	42°41' N.	0°39' W.	3,600	10	Wet	4	1	--	Germination poor.
P. sylvestris L.	46 & 88	Tervel, Spain	40°19' N.	1°39' W.	4,900	5	Wet	5	1	--	Germination poor.
P. sylvestris L.	47 & 85	Balsain Forest, Segovia, Spain	42°52' N.	4° W.	4,600	25	Wet	5	4	--	Germination poor.
P. teocote Schl. & Cham.	91	El Salto, Durango, Mexico	24° N.	106° W.	--	10	Wet	5	2	--	--
P. yunnanensis Franchet	36	Lu Shan Botanical Garden, Kuling Kiukiang, China	29°30' N.	116°04' E.	--	5	Wet	4	1	--	--

In April 1962, 24 trees were still alive having an average height of 3 feet, with a range of from 1.6 to 5.2 feet (fig. 4). Female strobili were observed on three trees the first year after outplanting. In 1962, 16 trees produced either male or female strobili.

Figure 4. --P. densiflora No. 113, 8 years old from seed.

Lot No. 136.--Twenty-five 1-0 seedlings received from the Southern Institute of Forest Genetics, in January 1957. The seed source was Ishikawa Prefecture, Japan. The seedlings were outplanted in the wet-site arboretum when received.

In April 1962, 12 trees survived, averaging 3.1 feet in height, with a range of from 1.5 to 4.9 feet. All but one of the dead trees succumbed in the first year after planting. Female strobili were recorded on one tree in 1958, and male or female strobili on nine trees in 1962.

PINUS HALEPENSIS MILLER--ALEPPO PINE

Aleppo pine is widely distributed in the countries bordering the Mediterranean. It is highly drought resistant, and best adapted to hot, dry sites. Aleppo pine is tapped for oleoresin in Spain, Portugal, Algeria, and Greece, and has been ranked as the third largest naval stores producing pine in the world (Rudolf 1932).

Table 2. --Species of pine native to the U. S. no longer active in the Olustee Arboretum

Species	Lot No.	Seed source				Trees planted	Site	At time discarded--			Remarks
		Location	Latitude	Longitude	Altitude			Age of trees	Sur-vival	Av. height	
					Feet	Num-ber		Years	Num-ber	Feet	
P. aristata Engelm.	5	Inyo County, California	36°30' N.	117°50' W.	--	5	Wet	3	0	--	--
P. aristata Engelm.	55	Arizona	--	--	--	5	Wet	3	0	--	--
P. banksiana Lamb.	11	Chippewa National Forest, Minnesota	47°30' N.	94°00' W.	--	15	Wet	4	0	--	--
P. banksiana Lamb.	12	Superior National Forest, Minnesota	47°30' N.	92°30' W.	--	10	Wet	4	1	--	--
P. edulis Engelm.	96	Unknown	--	--	--	2	Wet	4	0	--	--
P. flexilis James	19	Santa Catalina Mts., Arizona	32° N.	111° W.	4,500	4	Wet	3	1	--	--
P. flexilis James	97	Santa Catalina Mts., Arizona	32° N.	111° W.	4,500	5	--	2	0	--	Poor survival in transplant bed. Seed source probably identical to lot #19.
P. jeffreyi Grev. & Balf.	3	Lake Valley, Eldorado Co., California	38°50' N.	120°15' W.	6,500	10	Wet	3	2	--	--
P. jeffreyi Grev. & Balf.	95	California	--	--	--	8	--	2	0	--	Died in transplant bed.

P. muricata D. Don	14	Bishop Pine Lodge, Trinity Co., California	41° N.	124° W.	200	5	Wet	3	0	--	--
P. muricata D. Don	50	California	--	--	--	3	Wet	3	0	--	--
P. ponderosa Laws.	27	Eldorado Co., California	--	--	1,800	25	Wet	3	1	--	--
P. ponderosa Laws.	26	Placerville, California	39° N.	121° W.	2,750	25	Wet	3	2	--	--
P. ponderosa Laws.	28	Eldorado Co., California	--	--	2,120	10	Wet	4	0	--	--
P. ponderosa var. arizonica (Engelm.) Shaw	70	Coronado National Forest	32°20' N.	110°40' W.	--	25	Wet	4	3	--	--
P. ponderosa var. arizonica (Engelm.) Shaw	80	Unknown	--	--	--	25	Wet	4	5	--	--
P. radiata D. Don	22	New Zealand	--	--	--	25	Wet	3	1	--	--
P. radiata D. Don	25	Eddy Arboretum	38°44' N.	120°40' W.	2,800	25	Wet	3	0	--	--
P. radiata D. Don	65	Unknown	--	--	--	25	Wet	3	0	--	Pales weevil.
P. radiata D. Don	79	Watsonville, California	36°50' N.	121°45' W.	--	25	Wet	4	0	--	--
P. sabiniana Dougl.	112	Commercial dealer	--	--	--	5	Wet	3	0	--	--
P. torreyana Parry	117	Unknown	--	--	--	5	Wet	2	2	--	--
P. X attenuradiata Stockwell & Righter	75	Placerville, California	38°44' N.	120°40' W.	2,600	25	Wet	4	0	--	--

Attempts to establish P. halepensis in the Olustee Arboretum have generally met with failure. Of the seven acquisitions tried, one failed in the nursery, four failed after outplanting, and the remaining two lots are on the verge of being abandoned. No single cause of failure has been noted, but the species is susceptible to damage from brown spot needle blight (Scirrhia acicola [Dearn.] Siggers) and from tip moth. In general, the species has shown better initial survival when planted in the dry site arboretum.

Lot No. 156.--Received as seed in August 1957. Except that the seed were collected in Spain, no provenance data are available. The seed were sown in the nursery in March 1958. Seedlings were outplanted as 1-0 stock averaging 0.6 foot in height. Including replacements, a total of 53 trees were planted in the wet arboretum between January and November 1959. Mortality was complete by March 1961. The apparent cause of mortality was the wet site.

A total of 32 seedlings were planted in the dry-site arboretum; 7 of these were alive in April 1962. They averaged 0.8 foot in height with a range of from 0.5 to 1.5 feet, and were generally of poor form and low vigor. Future survival of these trees appears doubtful.

Lot No. 178.--Received as seed in December 1957 from a commercial seed dealer in Austria. The seed were collected from an unknown number of trees 80 to 100 years old. The location given was Terni, Italy, (lat. 42°30' N., long. 12°30' W., alt. 980 to 1,300 feet).

The seed were sown in March 1958, and 1-0 seedlings averaged 0.4 foot in height when planted. A total of 38 seedlings were planted in the wet arboretum during 1959; only 1 survived until March 1961, when the plot was abandoned.

In the dry-site arboretum 29 trees were planted, 4 of which were still alive in April 1962. They averaged 1.6 feet in height, with a range of from 0.6 to 2.3 feet, were poorly formed, and of low vigor.

PINUS LONGIFOLIA ROXB. (P. ROXBURGHII SARG.)[2]--LONG-LEAVED INDIAN PINE

One of the most common trees of the Himalayas, P. roxburghii is the major oleoresin-producing species of India. It has been ranked fifth in world naval stores production (Rudolf 1932).

Only one of four acquisitions is still active in the Olustee Arboretum.

Lot No. 182.--Received as seed in 1957 from a commercial seed dealer. The seed source given was Maler-Kotla, India, (lat. 31°30' N., long. 75°50' E., alt. 2,350 feet).

2/ Throughout this report the first scientific name given is that under which the seed were obtained, while in parentheses is the currently accepted nomenclature.

The seed were sown in the nursery in March 1958 and 1-0 seedlings averaged 0.9 foot in height. In January 1959 a full plot was outplanted in both arboretum areas. On the wet site, mortality was replaced three times the same year, a total of 58 seedlings being planted. There were no survivors when the plot was inventoried in March 1961.

On the dry site, 10 replacements were made in 1959, but in June 1960 only 9 trees were still living. In April 1962, four trees still survived, having an average height of 1.1 feet (fig. 5).

Figure 5. --P. longifolia No. 182, 6 years old from seed.

The cause of the heavy mortality of P. longifolia in the Olustee Arboretum seems to have been mainly cold damage. Seedlings do well the first year in the nursery but do not harden off enough to escape frost damage. The outplanting data indicate that in the wet arboretum some mortality occurred during the summer, when the plots were occasionally flooded for a week or more, and the water table level remained close to the soil surface.

PINUS MASSONIANA LAMB.--MASSON'S PINE

This little-known species is a relatively small tree native to southeastern China. It bears a strong resemblance to P. densiflora, and is worked for oleoresin in Indochina, and probably in China.

Only one seed lot of this species has been tested in the Olustee Arboretum.

Lot No. 15.--Received as seed in December 1953 from the Institute of Forest Genetics, Placerville, California. The locality of origin was given as Purple Mountain, Nanking, China, (lat. 32° N., long. 119° E.). The seed were sown in March 1954, and 25 trees were outplanted as 1-1 stock in February 1956. Survival has been good, with 20 trees still living in April 1962 (fig. 6). They averaged 8.1 feet in height, with a range of from 4.2 to 11.7 feet. The outstanding characteristic of this species has been its precocious flowering; 3 seedlings produced male strobili in the seedbed, and 14 trees produced either male or female strobili the year after outplanting. Repeated damage by tip moth has resulted in poor form and much less height growth than might have developed.

Figure 6.--*P. massoniana* No. 15, 9 years old from seed.

PINUS PATULA SCHLECHTENDAL AND CHAMISSO--SPREADING-LEAVED PINE

Pinus patula is native to the higher elevations of the subtropical areas of Mexico. Specimens in the Olustee Arboretum are easily recognizable by their slender, graceful, drooping needles. The species has been characterized by extreme susceptibility to tip moth, as well as by very poor form. Many trees have branched heavily close to the ground, with no single stem assuming dominance (fig. 7).

Lot No. 67.--Received as 1-0 seedlings (48) from the Ida Cason Calloway Foundation, Hamilton, Georgia, in December 1953. The seed had been obtained from Mr. R. P. Stephens, of Piggs Peak, Swaziland, Africa, (lat. 26°30' S., long. 31°30' E.). The Mexican origin of the seed parents is unknown.

Figure 7. --P. patula No. 83, 10 years old from seed. The multiple stems have been characteristic of this species in the Olustee Arboretum.

The seedlings were held in a transplant bed until November 1954, when a full plot was outplanted in the wet-site area. Initial survival was comparatively good, 18 trees still living 4 years after outplanting. Mortality has not ceased, and each year one or two more trees have died. In April 1962, only 11 of the original seedlings were still alive.

The height of the seedlings averaged 6.4 feet in April 1962, with a range of from 2.5 to 9.0 feet. All trees have been repeatedly attacked by tip moth, some show symptoms of brown spot needle blight, and four trees have sustained attacks in the stem by larvae of Dioryctria spp.

Flowering has been recorded on four trees, the earliest record being the production of female strobili in 1958.

In January 1958, 20 scions were collected and cleft grafted onto 1-0 slash pine stock. Of the 16 successful grafts, 6 were outplanted back to the same plot in spaces caused by mortality; 5 of the grafts still survived in April 1962. The form of the grafts above the union continues to be poor. The prevalence of tip moth attack has prevented grafts from flowering. The grafts averaged 5.1 feet in height in April 1962, with a range of from 3.7 to 8.5 feet.

Lot No. 83.--Received as 1-0 seedlings (50) from the Forest Genetics Laboratory, Texas Forest Service, in January 1954. Nothing is known of the Mexican origin of the seed. The seedlings were held in a transplant bed, and 25 trees outplanted in the wet area in November 1954. Initial survival was only fair, with 12 trees surviving 4 years after outplanting. Since 1958, new mortality has been low, and 11 of the original seedlings were still alive in April 1962. These trees now average 9.7 feet in height, with a range of from 6.2 to 15.5 feet. Although tree form is still very poor, these trees generally appear more vigorous than lot No. 67. All trees have been attacked by tip moth; in addition, three trees have had stem attacks by *Dioryctria* larvae.

Flowering was first recorded in 1962 when five trees bore male strobili and two of the same trees produced female strobili.

In January 1958, 20 scions were collected and cleft grafted onto 1-0 slash pine; 17 of these grafts being successful, 13 were outplanted back to the same arboretum plot. Of these grafts 12 still survive. They average 6.2 feet in height, with a range of from 4.3 to 12.5 feet. In general these grafts have a greater tendency to be single-stemmed than those of lot No. 67, despite continued attack by tip moths. One of these grafts has performed exceptionally well. It is 12.5 feet tall, has a comparatively straight single stem, and a noticeably greener and more vigorous appearance than either the original seedlings or the other grafts. No flowering has been recorded on any of the grafted trees.

Lot No. 164.--Received as seed in August 1957 from Dr. Maximino Martinez of the Sociedad Botanica de Mexico. The seed were collected in the Valley of Mexico (lat. 19°25' N., long. 99°15' W., alt. 8,500 feet).

Seed sown in March 1958 produced seedlings which averaged 0.6 foot in height in October 1958.

In January 1959, 25 seedlings were planted on both the wet- and dry-arboretum sites.

During the first summer, 20 replacements were made in the wet area, but only 2 trees survived in March 1961, and the plot was abandoned.

On the dry site, 13 replacements were made the first year. Three years after outplanting, 13 trees survived. They averaged 1.8 feet in height, with a range of from 0.9 to 3.1 feet. Due to repeated tip moth damage, they are poorly formed and generally appear of low vigor. In addition to tip moth, three trees have had small populations of an unidentified scale insect, and brown spot needle blight was recorded on one tree.

Female strobili were recorded on one tree in April 1962.

PINUS PINASTER AIT.--MARITIME PINE

Maritime pine is native to the Mediterranean area, ranging from the Atlantic Coast of Portugal and France to Greece in the east, with scattered occurrence in Algeria and Morocco. In its native habitat, particularly Spain, Portugal, and France, it is intensively worked for the production of oleoresin. It has been ranked as second only to slash and longleaf pine in world naval stores production (Rudolf 1932), accounting for 22.6 percent of the total output.

In the Olustee Arboretum, P. pinaster has been notable for its extreme susceptibility to brown spot needle blight. Observations indicate that this disease has been the most probable primary pathogen of the species. It appears that, given control of brown spot needle blight, maritime pine could survive and grow despite adverse soil conditions and tip moth attack. Sparse foliage on the upper branches, with an accumulation of dead needles and branches on the lower stem, has typified the appearance of many individuals (fig. 8).

Lot No. 60.--Received as seedlings (41) in December 1953 from the Ida Cason Calloway Foundation, Hamilton, Georgia. No record of the seed source is known. The seedlings spent the summer in a transplant bed, and 25 trees were outplanted in the wet area in November 1954. Mortality has been slow but steady, seven trees dying the first 2 years, and in April 1962 only eight trees were still living. The remaining trees averaged 9.0 feet in height, with a range from 5.5 to 14.0 feet (fig. 9). In addition to brown spot needle blight, tip moth has damaged most of the trees periodically.

Flowering has been recorded on three trees, the earliest record being the production of female strobili on one tree in 1958.

Figure 8.--P. pinaster. This 9-year-old tree is typical of maritime pine in the Olustee Arboretum. Many individuals attained this size before dying.

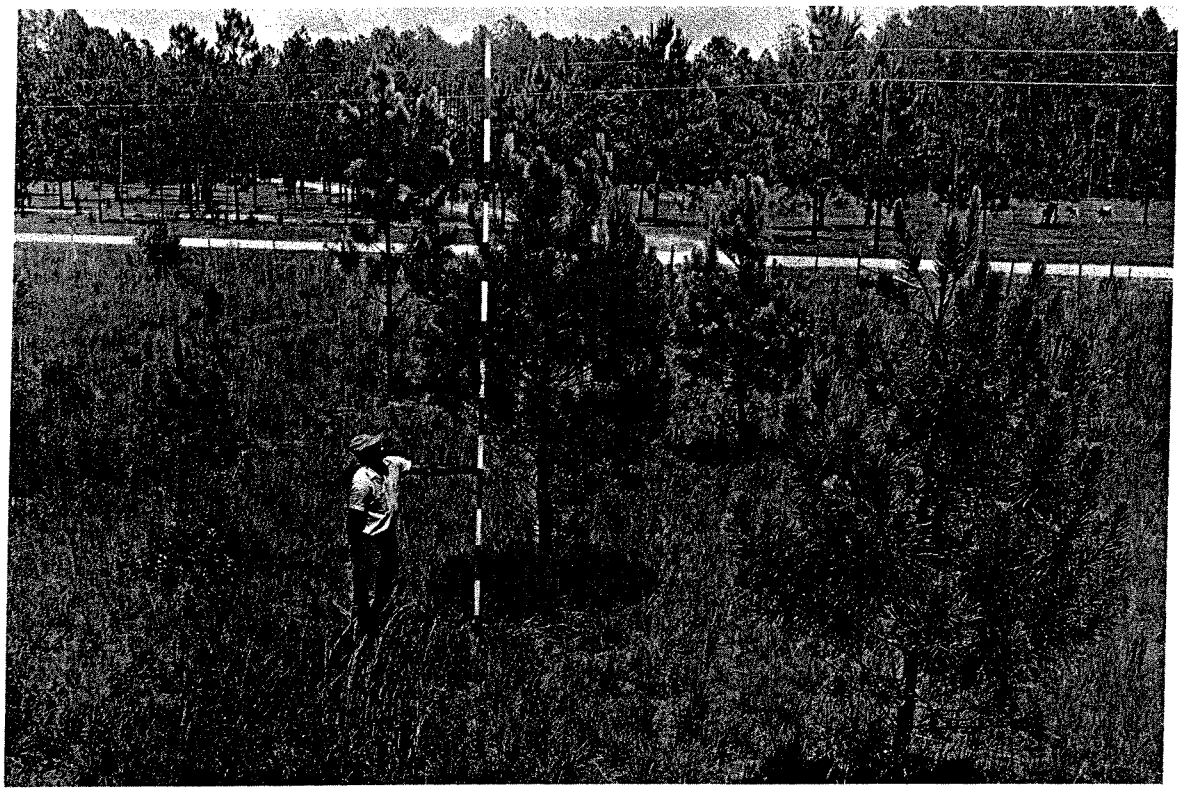

Figure 9. --*P. pinaster* No. 60, 11 years old from seed.

Lots No. 73 and 105.--Received as seedlings (66) in February 1954 from the Forest Genetics Laboratory of the Texas Forest Service, and the East Gulfcoast Research Center of the Southern Forest Experiment Station. The seed were collected in the vicinity of Burgos, Spain, (lat. 42°47' N., long. 3°23' W., alt. 1,800 feet) in 1950. It apparently came from a single tree having a straight stem, a height of 29.6 feet, and a production of about 3.5 pounds of raw gum in 1950.

After one summer in a transplant bed, 30 trees were outplanted in the wet area in November 1954. In April 1962, after seven growing seasons, only four trees survived. These trees averaged 2.8 feet in height, with a range of from 2.3 to 3.5 feet. Repeated infection by brown spot needle blight has stunted growth considerably. None has produced flowers.

Lots No. 74 and 102.--Received as seedlings (65) in January 1954 from the Forest Genetics Laboratory of the Texas Forest Service, and the East Gulfcoast Research Center of the Southern Forest Experiment Station. The seed were collected in 1952 in the vicinity of Cuenca, Bonidies, Spain, (lat. 39°55' N., long. 1°41' W., alt. 3,600 feet). The seedlings were held in a transplant bed until November 1954, when 30 seedlings were outplanted in the wet arboretum. In April 1962, eight trees survived, having an average height of 4.1 feet, and a range of from 2.6 to 6.7 feet. Brown spot needle blight has been recorded on all trees. None has flowered.

Lot No. 76.--Received as seedlings (50) in January 1954 from the Forest Genetics Laboratory, of the Texas Forest Service. The seed were obtained from trees in Mexico, sent as P. patula and later identified as P. pinaster. Whether the seed were collected from a plantation of maritime pine in Mexico, or were from a seed shipment which originated in Spain, is not known. The seedlings were outplanted in the wet-site arboretum in November 1954, after spending the summer in a transplant bed. Only nine trees still survived in April 1962. These trees averaged 7.7 feet in height, with a range of from 4.3 to 14.0 feet. All trees have sustained damage from brown spot needle blight and tip moth. Flowering has been recorded on four trees, the first record being in 1961, when two of the trees produced male strobili, and one produced female strobili.

Lots No. 82 and 99.--Received as seedlings (52) in February 1954 from the Forest Genetics Laboratory of the Texas Forest Service, and the East Gulfcoast Research Center of the Southern Forest Experiment Station. The seed were collected in the vicinity of Soria (Tardelcuende), Spain, (lat. 41°43' N., long. 2°34' W., alt. 3,600 feet) in 1950. The collection was made in a natural stand having rather crooked stem form, with an average total height of 39 feet. It had been worked for oleoresin from 1947 through 1949, with an average production per tree of 5.5 pounds of crude gum.

After one summer in a transplant bed, 30 trees were outplanted in the wet-site area in November 1954. In April 1962, only four trees survived. These trees averaged 3.6 feet in height, with a range of from 2.5 to 4.7 feet. All of the trees have been infected by brown spot needle blight. None of the trees has produced flowers.

Lots No. 93 and 101.--Received as seedlings (29) in February 1954 from the Forest Genetics Laboratory of the Texas Forest Service, and the East Gulfcoast Research Center of the Southern Forest Experiment Station. The seed were collected in the vicinity of Avila, Spain, (lat. 40°14' N., long. 5°05' W., alt. 1,600 feet) in 1949. The parent trees averaged 56 feet tall.

In November 1954, after one summer in the transplant bed, 10 trees were outplanted in the wet-site area. In April 1962, only three trees still survived. These trees averaged 4.9 feet in height, with a range of from 4.5 to 5.2 feet. They have been attacked by both brown spot needle blight and tip moth. One tree produced female strobili in 1961.

Lot No. 106.--Received as seedlings (16) in February 1954 from the East Gulfcoast Research Center, of the Southern Forest Experiment Station. The seed were collected in 1952 in the vicinity of Pontevedra, Spain, (lat. 42°07' N., long. 8°20' W., alt. 1,300 feet). The collection was made in a natural stand having an average height of 49 feet. After one summer in a transplant bed, five trees were outplanted in the wet area in November 1954. In April 1962, after seven growing seasons, only one tree survived. This tree was 11 feet tall, has been attacked by brown spot needle blight, and has not yet flowered.

Lot No. 110.--Received as seed in February 1954, origin not known. The seed were sown in the nursery in March 1954, and a full plot of 1-0 stock outplanted in the wet-site arboretum in January 1955. In April 1962, after six growing seasons in the arboretum, 10 trees were still alive. These trees averaged 6.8 feet in height, and ranged from 4.4 to 9.5 feet (fig. 10). Infection by brown spot needle blight has been recorded on all trees still present in the plot. Flowering has been recorded on three of the trees, the earliest in 1961, when three trees produced female strobili and one produced male.

Lot No. 143.--Received as seed in 1953. The seed were collected from a single tree somewhere in Portugal, described as being the best gum-producer seen in that country.

The seed were sown in the nursery in March 1957, and a full plot of seedlings outplanted in August 1957 on the wet-site area. One tree was replaced in December 1957, and four trees were replaced in December 1958. In April 1962, only 10 trees survived. They averaged 2.0 feet in height, with a range of from 1.5 to 2.7 feet.

Figure 10.--*P. pinaster* No. 110, 9 years old from seed.

PINUS PINEA L.--ITALIAN STONE PINE

Pinus pinea is native to the Mediterranean region from Portugal to Asia Minor. Highly valued because of its large edible seed, it has long been planted for this purpose. The origin of most stands is very difficult to determine. It is regularly worked for naval stores in Spain and Portugal, at one time being ranked fourth in world naval stores production (Rudolf 1932).

This species has been characterized in the Olustee Arboretum by slow growth, susceptibility to brown spot needle blight, and a reluctance to produce secondary needles. Tip moth attack has killed back the central terminal of many trees, producing a rather bushy plant (fig. 11).

Figure 11. --Typical appearance of 5-year-old P. pinea; primary, as well as secondary, needles are still being produced.

A total of 11 acquisitions have been obtained, and 10 of these are still active.

Lot No. 130.--Received as seed of unknown origin in February 1956, and sown in the nursery the same spring. Five seedlings were outplanted in the wet-site area in January 1957. In April 1962, three trees were still alive. They averaged 1.3 feet in height and ranged from 1.0 to 1.6 feet. The slow growth of these trees seems to be due to a combination of brown spot needle blight, tip moth damage, and yearly competition from grass and herbaceous plants.

Lot No. 157.--Received as seed in September 1957 from an unknown seed source somewhere in Spain. The seed were sown in the nursery in March 1958, and the seedlings averaged 0.8 foot in height as 1-0 stock. A full plot was outplanted in the wet-site area in January 1959. During 1959, 15 replacements were made, and in April 1962 five trees were still alive which averaged 1.2 feet in height, with a range of from 0.8 to 1.5 feet. Tip moth damage has caused a loss in height growth, with some trees being shorter in 1962 than they were in 1961.

A full plot was also planted in the dry-site area. During 1959, two replacements were made and in April 1962, 21 trees were still alive. These trees averaged 1.0 foot in height, with a range of from 0.5 to 1.6 feet. Despite higher survival on the dry site, tip moth has still caused losses of height increment. The foliage of many of the trees still consists principally of the characteristic bluish primary needles.

Lot No. 158.--Received as seed in August 1957 from the Conservator of Forests, Ilanoth, Israel. The seed were collected in 1954 from a 25-year-old plantation of unknown origin in the Baharan Forest, Nazareth District, (lat. 32°43' N., long. 35°18' E., alt. 1,150 feet).

The seed were sown in the nursery in March 1958 and germinated very poorly. The seedlings averaged 0.7 foot as 1-0 stock. Twelve seedlings were outplanted in the wet-site area in January 1959. In April 1962, three of these trees were still alive. They averaged 0.7 foot in height, with a range of from 0.5 to 0.8 foot.

Lot No. 166.--Received as seed in October 1957 from the Instituto Di Selvicoltura, Firenze, Italy. The seed were collected from an unknown number of trees in the State Forest of Cecina (lat. 43°20' N., long. 10°30' E., alt. 0 to 50 feet).

The seed were sown in the nursery in March 1958, and 1-0 stock averaged 0.9 foot in height. A full plot was outplanted in December 1958, and six trees replaced during 1959. In April 1962 the one tree still alive was lifted and used as a replacement in the dry-site area.

A full plot was outplanted in January 1959 on the dry-site area. Survival of these seedlings has been good. Two trees were replaced in 1959. In April 1962, 23 trees were still alive. Brown spot needle blight has not been so evident on the dry-site area as on the wet site. However, some trees on the dry site have lost increment due to tip moth damage. In April 1962, the survivors in the dry-site area averaged 1.5 feet in height, with a range of from 1.1 to 1.8 feet (fig. 12).

Lot No. 167.--Received as seed in October 1957 from a commercial dealer in Italy. The seed were collected from a stand at sea level somewhere along the central coast of Italy.

Sown as seed in the nursery in March 1958, the 1-0 stock averaged 0.8 foot in height. Full plots were planted on both the wet- and dry-site areas. On the wet-site area, six replacements were made in 1959. In April 1962, only eight trees survived, having an average height of 0.7 foot, with a range of from 0.5 to 1.0 foot.

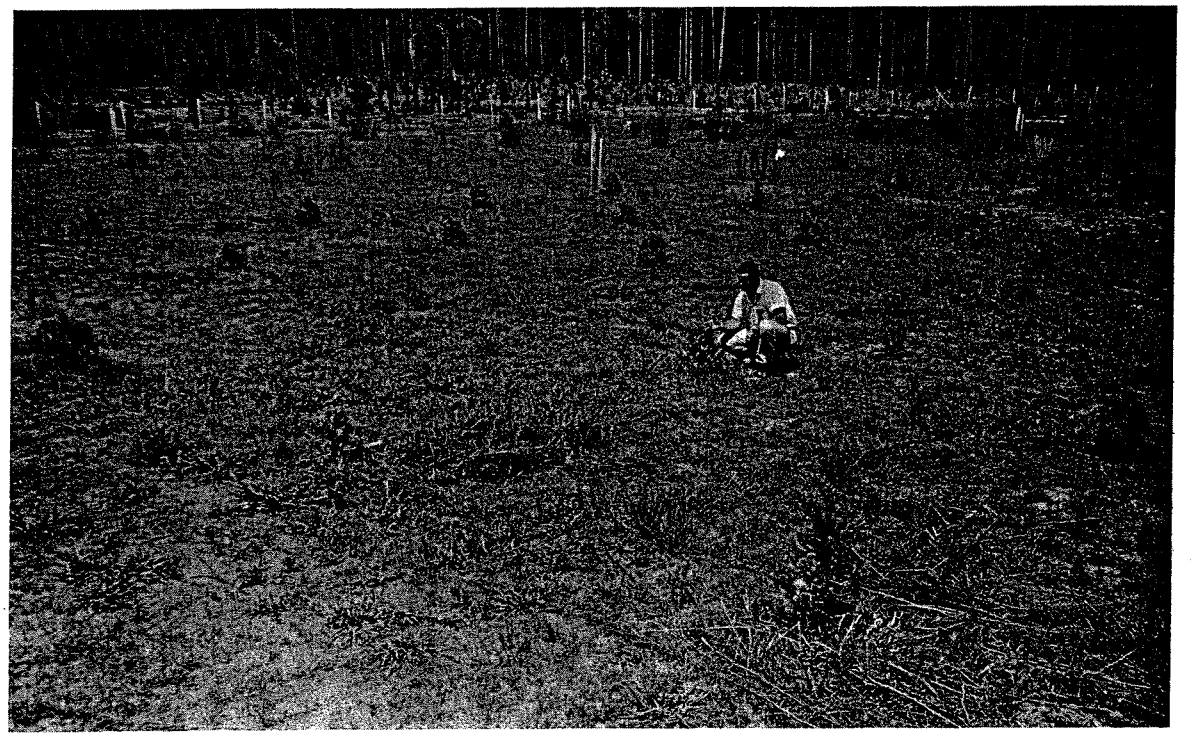

Figure 12.--*P. pinea* No. 166, 5 years old from seed.

Survival on the dry-site area has been higher, only one replacement being made in 1959. In April 1962, 24 trees were still alive, with an average height of 1.2 feet and a range of from 0.7 to 2.0 feet.

Lot No. 174.--Received as seed in November 1957 from the Minister of Agriculture, Madrid, Spain. The seed were collected in the vicinity of Avila, Spain, (lat. 40°40' N., long. 5°40' W.).

From seed sown in the nursery in March 1958, seedlings averaged 0.8 foot in height as 1-0 stock. Full plots were planted in both the wet-site and dry-site areas in December 1958. On the wet-site area, seven replacements were made in 1959, and in April 1962, 12 trees survived. These trees averaged 1.6 feet in height, with a range of from 0.6 to 1.5 feet. On the dry-site area only one replacement was needed in 1959, and 21 trees survived in April 1962. These trees averaged 1.1 feet in height, with a range of from 0.4 to 2.0 feet. Tip moth damage has kept the average height of these seedlings almost constant for the past three growing seasons.

Lot No. 175.--Received as seed in November 1957 from the Minister of Agriculture, Rome, Italy. The seed were collected in the vicinity of Orbetello, Italy, (lat. 42°24' N., long. 11°10' E., alt. sea level). The collection was made from an unknown number of trees which had been planted along the seashore to consolidate sand dunes.

The seed were sown in the nursery in March 1958, and 1-0 stock averaged 0.9 foot in height. Full plots were outplanted in December 1958 in both the wet- and dry-site areas. On the wet-site area, four replacements were made in 1959. In April 1962, only three trees still survived. They were lifted and used as replacements on the dry-site area. Survival on the dry-site area has been better. In April 1962, 22 trees still survived, having an average height of 1.2 feet, and a range of from 0.4 to 2.1 feet. Tip moth damage to these trees during the 1961 growing season caused a slight decrease in average height.

Lot No. 177.--Received as seed in November 1957 from the Acting General Director of Forests, Ankara, Turkey. The seed were collected in 1957 from a 25-year-old stand in the vicinity of Izmir, Turkey, (lat. 38°30' N., long. 27°00' E., alt. 13 feet).

The seed were sown in the nursery in March 1958, and averaged 0.6 foot as 1-0 stock. Full plots were planted on both arboretum sites in December 1958. Because survival on the wet-site area was very poor, the three trees remaining in April 1962 were lifted and transferred to the dry-site area.

On the dry-site area, two replacements were made in 1959. In April 1962, 16 trees survived, having an average height of 1.2 feet, with a range of from 0.8 to 1.5 feet.

Lot No. 180.--Received as seed in December 1957 from Vilmorin-Andrieux, Paris, France. The seed were collected from an unknown number of trees on the shore of the Adriatic at Cervia, near Ravenna, Italy, (lat. 44°30' N., long. 12°00' E., alt. sea level).

The seed were sown in the nursery in March 1958, and averaged 0.8 foot in height as 1-0 stock. Full plots were planted in December 1958 in both the wet- and dry-site areas. Two trees were replaced in the wet-site area during 1959, but survival has been poor. Only two trees remained alive in April 1962. They were lifted and used as replacements on the dry-site area. One replacement was made on the dry-site plot in 1959, and in April 1962, 20 trees survived. They averaged 1.5 feet in height, with a range of from 1.0 to 2.2 feet.

Lot No. 190.--Received as seed in January 1958 from a commercial seed dealer in Verona, Italy. The seed were collected in the vicinity of Pisa, Italy, (lat. 43°30' N., long. 10°30' E.).

The seed were sown in the nursery in March 1958, and 1-0 stock averaged 0.9 foot in height. Full plots were planted in both arboretums in December 1958. One replacement was necessary in 1959 in the wet-site area. In April 1962, 14 trees survived on the wet-site area, having an average height of 0.9 foot and a range of from 0.6 to 1.5 feet. Damage due to tip moth has caused almost all of the trees in this plot to have a negative height increment during the 1961 growing season.

On the dry-site area, four replacements were made during 1959, and in April 1962, 22 trees survived. These trees averaged 1.3 feet in height, with a range of 0.9 to 1.6 feet. Here again tip moth damage has caused the height increment to remain constant for the past two growing seasons.

PINUS THUNBERGII PARL.--JAPANESE BLACK PINE

A native of Japan, this species has been cultivated for many years. It is the principal Japanese pine worked for naval stores.

In common with other Asiatic species, P. thunbergii has been characterized in the Olustee Arboretum by relatively good survival and early flowering. The trees are generally poorly formed, with a slower growth rate than that of slash pine.

Lot No. 71.--Received as seedlings (50) in January 1954 from the Forest Genetics Laboratory, of the Texas Forest Service. The seed were collected in 1952 from an unknown number of trees in Gifu Prefecture, Harusato, Japan, (lat. 35°30' N., long. 136°45' E.).

The seedlings were held in a transplant bed until November 1954, when a full plot was outplanted in the wet-site area. No replacements were made, and in April 1962, 24 trees survived, having an average height of 5.7 feet, with a range of from 2.2 to 8.2 feet in height (fig. 13). The trees have been repeatedly attacked by tip moth, causing some of the poor form,

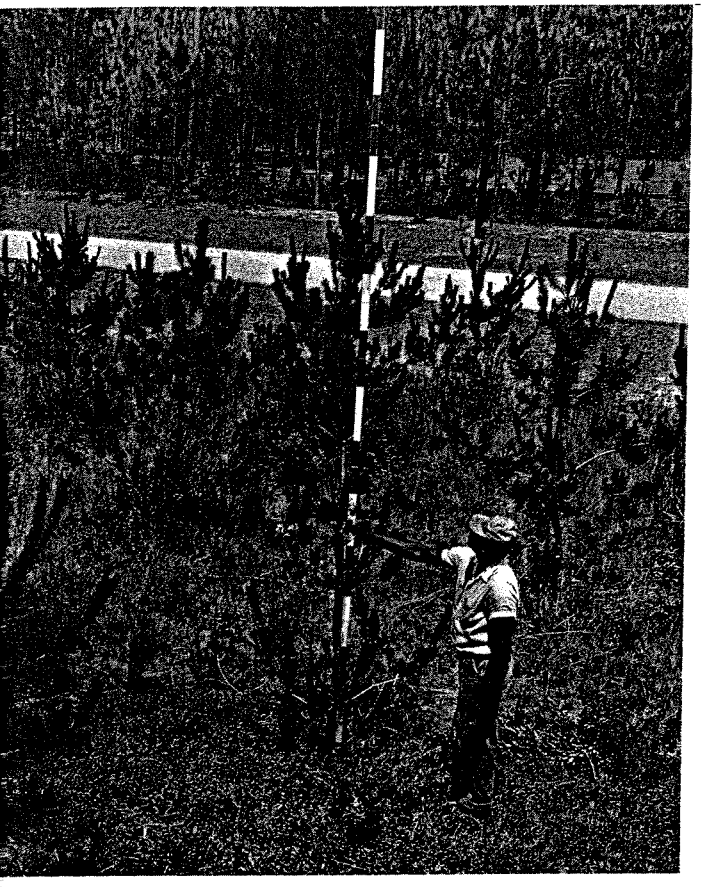

Figure 13. --P. thunbergii No. 71, 11 years old from seed.

and unidentified scale insects have been recorded as occurring on some trees in some years. Flowering was first noted in 1958, when three trees produced female strobili, and two trees produced male strobili. Flowering has increased, and in 1962, 19 trees were recorded as having either male or female flowers.

Lot No. 135.--Received as seedlings (25) in January 1957 from the Southern Institute of Forest Genetics. The seed originated in Ishikawa Prefecture, Japan. A full plot was outplanted in January 1957 on the wet-site area. Most of the mortality occurred during the first year, when eight trees died. In April 1962, 15 trees were still alive. These trees averaged 3.1 feet in height, with a range of from 1.8 to 4.7 feet. Flowering was first recorded in 1958, when three trees produced female strobili. Flowering has continued and in April 1962 female strobili were recorded on all trees in the plot, and male strobili on nine of them.

Pines Native to the United States

PINUS CLAUSA (CHAPM.) VASEY--SAND PINE

Sand pine is considered one of the minor species of southern pine in the United States. Its range is almost entirely confined to the State of Florida. Two "races" of sand pine have been recognized (Little and Dorman 1952). The first of these, distinguished by its closed cone characteristic, occurs in north central Florida and is commonly known as "Ocala sand pine." The second race, which is geographically isolated from the first occurs in the western part of Florida along the Gulf Coast. It is distinguished by its open cones and is known as the "Choctawhatchee sand pine." Only the Ocala or closed cone race has been tried in the Olustee Arboretum.

Lot No. 139.--Received as seed in 1955 from a collection made on the Ocala National Forest in Florida (lat. 29°08' N., long. 81°50' W.). In January 1957, 1-0 stock of this seed source was outplanted in the wet-site arboretum. Survival being very poor, replacements were made several times, but these also failed.

In November 1959, a full plot was outplanted in the dry-site arboretum. Survival and growth on this area has been much better. In April 1962, 13 trees survived, having an average height of 7.1 feet and a range of from 3.4 to 10 feet (fig. 14). Flowering in this species begins at an early age, and female strobili were recorded on 12 trees in March 1961.

PINUS ELLIOTTII VAR. DENSA (LITTLE & DORMAN)--SOUTH FLORIDA SLASH PINE

This variety of slash pine occurs in southern Florida and north along the coasts to central Florida (Little and Dorman 1954). It is characterized in its native range by its grass-like seedlings and its thick taproot resembling that of Pinus palustris.

Lot No. 189.--Received as seed in January 1958 from a collection made in Hendry County, Florida, (lat. 26°30' N., long. 82°00' W.). Seed were sown in March 1958, and at the time of outplanting seedlings in the nurserybed averaged 0.7 foot in height. Complete plots were outplanted in both the wet-site and dry-site arboretum in January 1959. Fourteen replacements were made in the wet-site area during 1959. In April 1962, 17 trees survived, having an average height of 0.7 foot and a range of from 0.3 to 1.3 feet in height.

Initial survival on the dry-site area was poor in 1959, and 21 trees had to be replaced. In April 1962, 13 trees survived, having an average height of 1.9 feet and a range of from 0.5 to 3 feet (fig. 15). When planted in north Florida, this variety commonly sustains some cold injury. It is very possible that part of the poor initial survival was due to the outplanting of stock which had been damaged by cold while still in the nurserybed.

PINUS ELLIOTTII VAR. ELLIOTTII--SLASH PINE (TYPICAL)

This well-known species ranges from the Atlantic Coastal Plain in southern South Carolina to central Florida and west along the coast to southeastern Louisiana.

Lot No. 192.--Received as seed in January 1958 from a single tree having proliferated cones in the vicinity of Dublin, Georgia, (lat. 32°30' N., long. 82°50' W.). Seedlings were outplanted as 1-0 stock in December 1959 in both the wet- and dry-site arboretums. Survival on both sites has been good and no replacements were made. On the wet-site area, 24 trees remained in April 1962, averaging 1.6 feet in height, with a range of from 1.2 to 2.2 feet. On the dry-site area, 23 trees still survived in April 1962, with an average height of 2.2 feet and a range of from 1.6 to 2.8 feet.

PINUS GLABRA WALT.--SPRUCE PINE

This minor southern species ranges from the Atlantic Coast in South Carolina through north central Florida and west to southeastern Louisiana. Nowhere abundant, it occurs principally as a scattered tree in association with southern bottomland hardwoods.

Figure 14. --P. clausa No. 139, 5 years old from seed.

Figure 15. --P. elliottii var. densa No. 189, 5 years old from seed.

Lot No. 35.--Received as seed from a collection made in the vicinity of Charleston, South Carolina, (lat. 33° N., long. 80' W.). Seed were sown in the nursery in March 1954, and twenty 2-0 seedlings were outplanted in the wet-site arboretum in December 1955. No mortality has occurred, and in April 1962 the trees averaged 13.8 feet in height, with a range of from 9.6 to 16.6 feet (fig. 16). The average diameter at breast height was 2.7 inches, ranging from 1.4 to 3.8 inches. The first evidence of flowering occurred in 1962, when four trees produced female and one tree produced male strobili.

Figure 16. --*P. glabra* No. 35, 10 years old from seed.

Lot No. 244.--Received as seed collected in the fall of 1958 from several trees in mixture with hardwoods on a hammock site along Rose Creek, southwest of Lake City, Florida, in Columbia County, (lat. 30° N., long. 82° W., alt. 200 feet). The seed were sown in the nursery in April 1959, and a full plot of seedlings outplanted in the dry arboretum in January 1960. In April 1962, 13 trees survived, having an average height of 1.3 feet and a range of from 0.8 to 1.9 feet. Most of the mortality in this plot occurred the first summer following outplanting and was probably due to the dryness of the site.

PINUS RIGIDA MILL.--PITCH PINE

This species is native of the eastern portion of the United States. It ranges from Maine to southern Ohio, and into western South Carolina. The virgin stands of this species supplied the major portion of the naval stores used in the early American colonies.

This species has been characterized in the Olustee Arboretum by its slow growth and poor form. Since tip moth has attacked most trees, at least a portion of the poor form can be attributed to damage by this insect.

Lot No. 21.--Received as seed in December 1953 from the Western Institute of Forest Genetics. The seed were collected between Milford and Amherst on Highway 10 in New Hampshire (lat. 43° W., long. 72° N.). Seed were sown in the nursery in March 1954, and 25 seedlings were outplanted as 2-0 stock in December 1955 in the wet arboretum. In April 1962, 21 trees survived, having an average height of 5.0 feet and a range of from 2.4 to 7.1 feet (fig. 17). Female strobili were recorded on two trees in March 1958, and in 1962, 10 trees produced female strobili and 8 produced male.

Lot No. 150.--Received as seed in April 1955 from a commercial seed dealer. The geographic origin of the seed is unknown. Seed were sown in the nursery in March 1957, and 25 trees planted in the wet-site arboretum in December 1957. In March 1958, hogs uprooted part of the plot and nine 1-1 replacement trees were planted in December 1958, restoring the plot to full stocking. In April 1962, 14 trees were still alive, having an average height of 2.7 feet and a range of from 1.2 to 4.2 feet. Male strobili were recorded on eight trees in March 1961 and again in the spring of 1962.

PINUS SEROTINA MICHX.--POND PINE

This tree is considered one of the minor species of southern pine. It ranges along the Atlantic Coastal Plain from southern New Jersey, to northwestern Florida and Alabama.

Lot No. 201.--Seed were collected in February 1958 from three trees located 4½ miles west of the Olustee Experimental Forest on the north side of the right-of-way of U. S. Highway 90, in Columbia County, Florida, (lat. 30° N., long. 82° W., alt. 110 feet). The trees from which the seed were collected averaged 14 inches in d. b. h., and had an average height of approximately 70 feet. Seed were sown in the nursery in March 1958, and 1-0 nursery stock averaged 0.8 foot in height. Full plots were planted in January 1959 in both the wet- and dry-site arboretums. Two replacements were made in 1959 in the wet-site plot. In April 1962, 24 trees survived, averaging 2.1 feet in height, with a range of from 1.1 to 3.2 feet (fig. 18). Tip moth damage has been recorded on five trees in the wet-site area. None of these trees has yet produced flowers.

On the dry-site area three replacements were made in 1959. In April 1962, 25 trees were alive, averaging 6.3 feet in height, with a range of from 4.6 to 8.7 feet. Two of the trees in this area produced female strobili in the spring of 1961, and in 1962 female strobili were produced by 13 trees, and male strobili by seven trees. No insect or disease damage has been recorded on this species in the dry arboretum. Pond pine is generally thought of as a species better adapted to wet sites; hence, the growth on these two areas is somewhat at a variance with what would have been expected. However, a possible explanation is that the wet arboretum has a rather heavy sod cover, in comparison with the dry arboretum, in which almost no ground cover exists, making the availability of moisture to these widely spaced trees possibly greater on the dry site than on the wet site. In addition, the plot on the dry site is located in the lower and moister end of the area, although it is still drier than the wet arboretum.

Figure 17. --P. rigida No. 21, 9 years old from seed.

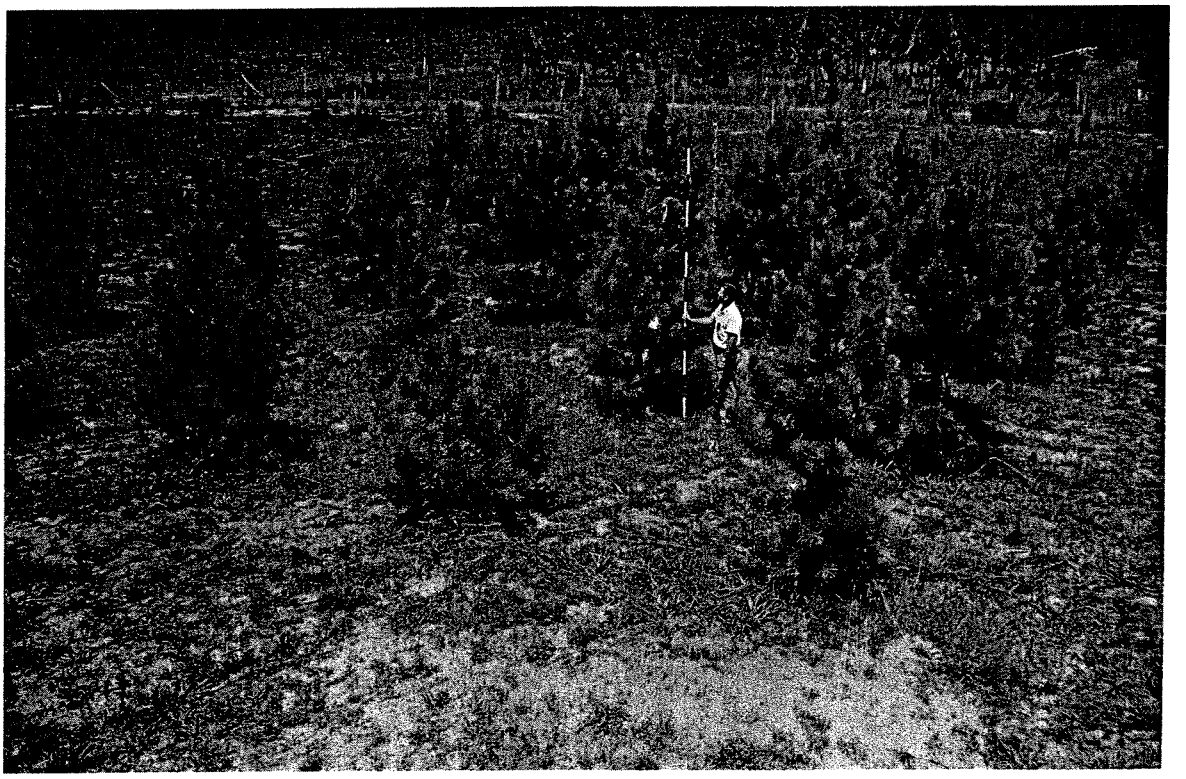

Figure 18. --P. serotina No. 201, 5 years old from seed.

PINUS TAEDA L.--LOBLOLLY PINE

This species ranges from southern New Jersey through the Atlantic Coastal States west to Texas, and from Florida north to southern Tennessee.

Lot No. 59.--Received as seedlings (39) in December 1953 from the Ida Cason Calloway Foundation in Hamilton, Georgia. The seed had been collected in the Union of South Africa and while the original seed source in the United States is unknown, it is quite likely that it came from southern Georgia. The seedlings were held in a transplant bed until November 1954, when a full plot was outplanted in the wet arboretum. In April 1962, 20 trees survived, having an average height of 24 feet and a range of from 18 to 28 feet (fig. 19). The average diameter at breast height was 6.4 inches, with a range of from 3.7 to 8.4 inches. Many of the trees have been damaged by tip moth, and on some trees cankers of Cronartium fusiforme (A. & K.) Hedgc. and Hunt have developed. Female strobili were produced on three trees in the spring of 1958; in 1962, 12 trees produced female strobili and 3 produced male strobili.

Interspecific Pine Hybrids

PINUS ECHINATA X PINUS ELLIOTTII VAR. ELLIOTTII

Lot No. 152.--Received as cuttings in March 1954 from the Western Institute of Forest Genetics at Placerville. The cuttings were field grafted on wildling slash pine, and graft survival was poor. In February 1957, scion material was collected from those grafts still living and regrafted on slash pine stock in the nursery. Sixteen of these grafts were outplanted in the wet arboretum in May 1957. In April 1962, 15 trees survived, having an average height of 9.5 feet, and a range of from 7.5 to 11 feet (fig. 20). Flowering was first recorded in March 1961, when 10 trees produced female strobili and 3 trees produced male strobili. These trees have shown a marked susceptibility to stem attacks by the larvae of Dioryctria spp. However, it has not been determined whether the susceptibility to attack is a characteristic of the hybrid or whether the attraction is to the grafted material.

PINUS ELLIOTTII VAR. ELLIOTTII X PINUS ECHINATA

Lot No. 151.--Received as seedlings (2) in February 1954. This cross was made in 1951 by the Southern Forest Experiment Station and carries their seed lot number AL-8. The seedlings were outplanted when received as part of a larger study of pine hybrids. The only surviving seedling was lifted and moved to the arboretum in January 1957. In April 1962, this tree was 15.5 feet in height, with a diameter at breast height of 4.8 inches (fig. 21). It first began to produce female strobili in the spring of 1961. It has been repeatedly treated for stem attacks by larvae of Dioryctria spp.

Figure 19. --P. taeda No. 59, 10 years old from seed.

Figure 20. --P. echinata X P. elliottii var. elliottii No. 152, 6 years old from time of grafting.

Figure 21.--*P. elliottii* var. *elliottii* X *P. echinata* No. 151, 10 years old from seed.

PINUS ELLIOTTII VAR. *ELLIOTTII* X *PINUS PALUSTRIS*

Lot No. 140.--Seed produced in a cross made by the Lake City Research Center in 1954. Seed were sown in the nursery in April 1956, and 25 trees outplanted in the wet-site arboretum in January 1957. In April 1962, 19 trees survived, having an average height of 10.9 feet and a range of from 6.0 to 16.5 feet (fig. 22). The average diameter at breast height of 17 of the trees was 2.6 inches, and ranged from 1.1 to 4.4 inches. These trees have not been troubled by insect or disease attack, and have not yet produced flowers.

PINUS PALUSTRIS X *PINUS ELLIOTTII* VAR. *ELLIOTTII*

Lot No. 141.--Seed from a cross made by the Lake City Research Center in 1954. Seed were sown in the nursery in April 1956, and 25 seedlings outplanted in the wet arboretum in January 1957. In April 1962, 15 trees survived, having an average height of 6.1 feet, with a range of from 0.2 to 12.5 feet (fig. 23).

Lot No. 142.--Seed from a cross made by the Lake City Research Center in 1954. These seed were sown in the nursery in April 1956, and in January 1957, 25 trees were outplanted in the wet-site arboretum. In April 1962, 18 trees survived, having an average height of 5.2 feet and a range of from 0.3 to 11.4 feet.

Figure 22. --P. elliottii var. elliottii X P. palustris No. 140, 7 years old from seed.

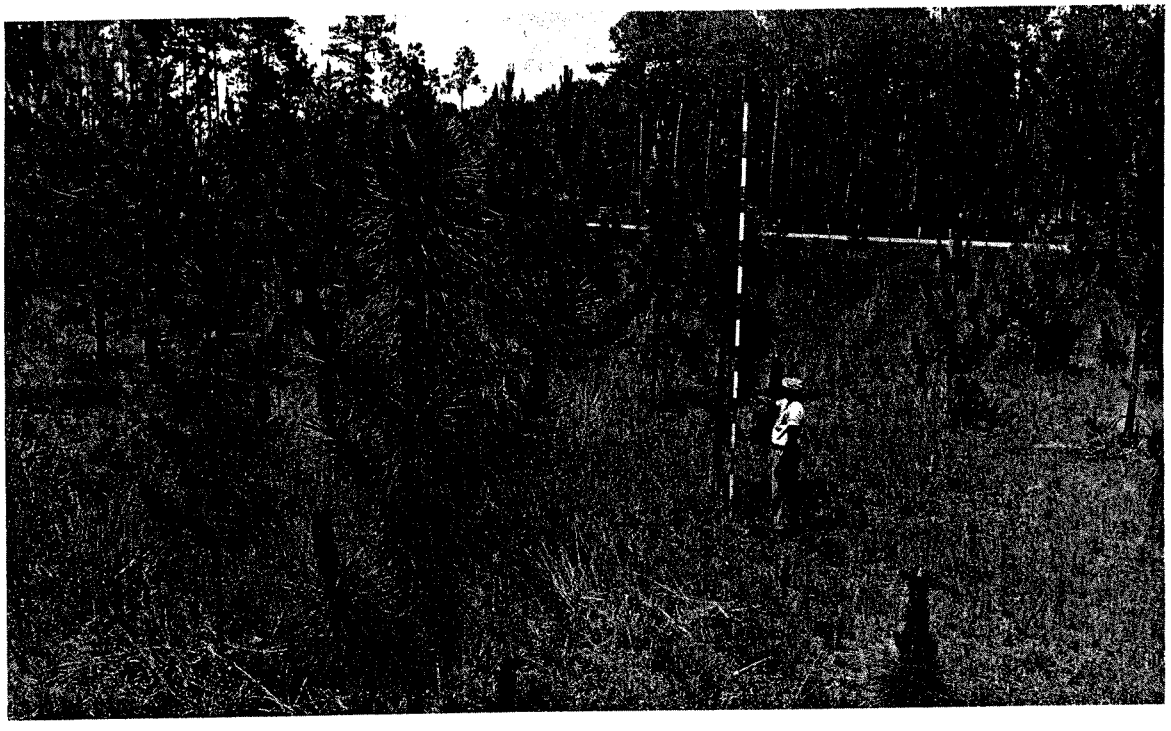

Figure 23. --P. palustris X P. elliottii var. elliottii No. 141, 8 years old from seed.

PINUS X SONDEREGGERI H. H. CHAPM.

This well-known hybrid is the result of natural crossing between P. palustris and P. taeda. Open pollinated progeny of three of these natural hybrids have been sown in the Olustee Arboretum.

Lot No. 77.--Received as seedlings (50) in January 1954 from the Forest Genetics Laboratory, of the Texas Forest Service. The seed were collected from one of the outstanding Sonderegger pines under test in Texas. The parent tree was located in Tyler County, Texas, (lat. 31° N., long. 94° W.). The Texas Forest Service designation is S4 hybrid 9. The seedlings were held in the transplant bed until November 1954, when a full plot was outplanted in the wet arboretum. In April 1962, 22 trees survived, having an average height of 21.0 feet and a range of from 9.4 to 28.1 feet (fig. 24). The average diameter at breast height of 21 of the trees was 5.0 inches and ranged from 1.3 to 8.6 inches. The trees in this group have been characterized by very poor form, most of which cannot be attributed to occasional attacks by tip moth (fig. 25). At least five of the trees have sustained attack by the larvae of Dioryctria spp. Flowering was first recorded in the spring of 1961, when seven of the trees produced either male or female strobili.

Lot No. 107.--Received as seed in March 1954 from the Southern Forest Experiment Station. The seed were collected from an unusual tree, probably Pinus X sondereggeri, called to the attention of G. F. Erambert of the W. W. Ashe Nursery. The parent tree is located in Perry County, Mississippi, (lat. 31°11' N., long. 89°00' W.). The seed were sown in the nursery in 1954, and 25 seedlings outplanted in the wet arboretum in January 1955. In April 1962, 16 trees survived, having an average height of 12.7 feet and a range of from 1.5 to 19.9 feet. This group of trees is characterized by its wide range of variability, both in form and in susceptibility to tip moth.

Lot No. 111.--Seed collected in October 1953 by members of the staff of the Lake City Research Center from a single suspected natural hybrid growing in Laurens County, Georgia, (lat. 32°30' N., long. 82°54' W.). The seed were sown in the nursery in March 1954, and a full block of seedlings outplanted in the wet arboretum in January 1955. In April 1962, 21 trees survived, having an average height of 13.2 feet and a range of from 3.8 to 20.8 feet. Several of the trees are very poorly formed and the plot as a whole has exhibited some slight susceptibility to tip moth, brown spot needle blight and stem attack by larvae of Dioryctria spp. Flowering was first recorded in March 1961, when 11 trees produced either male or female strobili.

Figure 24. --P. X sonderegger No. 77, 10 years old from seed.

Figure 25. --Several poorly formed Sonderegger pines in Lot No. 77.

Miscellaneous Species at the Olustee Arboretum

From time to time seed has been received of species other than naval stores pines. In almost all cases this seed has been sown and an attempt made to raise the species if possible, despite the fact that the seed source of these acquisitions has usually been poorly documented.

During the years 1957 and 1958, some effort was made to secure seed and seedlings of species other than pine that might be suitable for the north Florida area. Most emphasis at this time was given to species of eucalyptus and podocarpus, outplantings of these species being made, whenever possible, in both the wet-site and dry-site arboretums. The same plot size was used as for the pine species except that spacing was decreased to 6 by 6 feet, resulting in plots containing 81 trees. All of these trials can best be described as unqualified failures. In almost all cases the eucalypts succumbed to frost at an early age, while the seed of almost all the podocarps proved extremely difficult to germinate. The following section describes the miscellaneous acquisitions still active in the Olustee Arboretum as of April 1962.

Table 3 contains whatever information is available on the miscellaneous acquisitions considered failures and no longer active.

ARAUCARIA ANGUSTIFOLIA BERTOL.--PARANA PINE

This is a fair-sized timber tree 80 to 100 feet tall. It grows in scattered stands in the mountains of southern Brazil and northern Argentina. One of the major difficulties in working with this species is the short length of time the seed remain viable. Unless the seed is sown fairly soon after collection, or given special handling in storage, germination is apt to be poor and spread out over a longer period of time than is desirable.

Lot No. 211.--Received as seed (120) in June 1958 from the Forest Service of Sao Paulo, Brazil. Upon arrival, the seed were sown in pots, and in seed flats, and placed in a lathhouse. A total of 41 seedlings were obtained, and in October 1958 these had an average height of 0.62 foot. In March 1959, 25 seedlings were outplanted in the wet-site arboretum and 16 on the dry site. In the wet-site arboretum, 8 trees died the first year after outplanting, 10 the second year, and in April 1962, the 3 trees remaining averaged 2.3 feet in height (fig. 26). Of the 16 trees planted in the dry-site arboretum, 9 died during the first year, and in April 1961, only 1 tree survived. This lone survivor was 1.5 feet tall and died during an attempt to move it to the wet-site plot.

Table 3. --Miscellaneous species acquisitions no longer active in the Olustee Arboretum

Species	Lot No.	Seed source				Trees planted	Site	At time discarded--			Remarks
		Location	Latitude	Longitude	Altitude			Age of trees	Survival	Av. height	
					Feet	Number		Years	Number	Feet	
Adenanthera microsperma Teijsm. & Binn.	233	Formosa	--	--	--	--	--	--	--	--	Frost killed in seedbed.
Adenanthera pavonema L.	232	Formosa	--	--	--	--	--	--	--	--	Frost killed in seedbed.
Agathis australis Sailsb.	170	Waipoua Forest, New Zealand	35°39' S.	173°33' E.	250	24	Dry	2	0	--	Frost killed.
Agathis loranthifolia Sailsb. (A. alba (Lam.) Foxw.)	200	Sukabumi (West Java)	6° S.	106° E.	1,950	46	Wet & dry	2	0	0.4	Frost killed.
Araucaria angustifolia (Bertol.) Kuntze	125	Brazil	--	--	--	5	Wet	2	0	--	--
Araucaria excelsa R. Brown	126	Unknown	--	--	--	--	--	--	--	--	Frost killed.
Callitris hugelii Knight	210	New South Wales, Australia	--	--	--	25	Dry	2	0	1.0	Frost killed.
Cryptomeria japonica D. Don	194	Japan	--	--	--	128	Wet & dry	3	1	0.6	--
Cryptomeria japonica D. Don	196	Yanase National Forest, Kochi Prefecture, Japan	33°37' N.	134°7' E.	2,600	124	Wet & dry	2	9	0.5	--
Cryptomeria japonica D. Don	197	Iiyama, Nagano Prefecture, Japan	36°52' N.	138°20' E.	1,950	142	Wet & dry	3	1	0.5	--
Cryptomeria japonica D. Don	198	Nasumichi National Forest, Fukushima Prefecture, Japan	36°59' N.	140°17' E.	1,950	140	Wet & dry	3	7	0.5	--
Cryptomeria japonica D. Don	199	Kumano, Mie Prefecture, Japan	34°00' N.	136°06' E.	3,300	126	Wet & dry	2	5	0.6	--
Eucalyptus delegatensis R. T. Baker	229	Victoria, Australia	--	--	--	30	Wet & dry	1	0	--	Frost killed.

Eucalyptus drepanophylla F. v. M.	220	Brisbane Forest Department, Australia	--	--	--	164	Wet & dry	1	0	--	Frost killed.
Eucalyptus grandis (Hill) Maiden	218	Brisbane Forest Department, Australia	--	--	--	164	Wet & dry	1	0	--	Frost killed.
Eucalyptus maculata Hook	217	Brisbane Forest Department, Australia	--	--	--	133	Wet & dry	1	0	--	Frost killed.
Eucalyptus microcorys F. v. M.	222	Brisbane Forest Department, Australia	--	--	--	162	Wet & dry	1	0	--	Frost killed.
Eucalyptus nitens Maiden	235	Powelltown, Victoria, Australia	37°55' S.	145°55' E.	2,500	120	Wet & dry	1	0	--	Frost killed.
Eucalyptus pilularis Sm.	221	Brisbane Forest Department, Australia	--	--	--	42	Wet & dry	1	0	--	Frost killed.
Eucalyptus regnans F. v. M.	237	Bendsc, Victoria, Australia	--	--	3,100	90	Wet & dry	1	0	--	Frost killed.
Eucalyptus robusta Sm.	242	Melbourne, Florida	28°00' N.	80°30' W.	20	25	Wet	1	8	2.8	Frost killed.
Eucalyptus saligna Sm.	207	Fort Myers, Florida	--	--	--	86	Wet	2	0	1.2	Frost killed.
Eucalyptus tereticornis Sm.	219	Brisbane Forest Department, Australia	--	--	--	164	Wet & dry	1	0	--	Frost killed.
Eucalyptus viminalis Labill.	238	Mansfield Forest District, Victoria, Australia	37°05' S.	146°05' E.	2,000	220	Wet & dry	2	0	0.9	Cause of mortality uncertain.
Grevillea robusta A. Cunn.	206	Homestead, Florida	25°30' N.	80°45' W.	--	38	Wet & dry	2	0	--	Frost killed.
Platanus orientalis L.	226	Macedonia, Yugoslavia	41°20' N.	22°80' E.	330	50	Wet & dry	1	0	0.5	--
Podocarpus gracilior Pilger	181	Dehra Dun, India	30°30' N.	78°10' E.	2,235	25	Wet	1	0	1.5	Frost killed.
Podocarpus spicatus R. Vr.	171	Minginui State Forest, New Zealand	38°40' S.	176°42' E.	1,650	22	Dry	1	0	--	--

Figure 26. --Araucaria angustifolia No. 211, 6 years old from seed.

EUCALYPTUS PAUCIFLORA SIEBER.--SNOW GUM

This species occurs in the mountain and sub-Alpine area of Victoria, New South Wales, and Queensland, Australia. In its native habitat snow and frost are not uncommon, and it is considered one of the more frost-hardy species of eucalyptus. It is used principally for fuel wood, fencing, and watershed protection.

Lot No. 209.--Received as seed in May 1958 from the Forestry and Timber Bureau, Canberra, Australia. The seed were collected in New South Wales in 1957, and bore Australian seed lot No. S4111. The seed were stratified in moist peat moss at a temperature of approximately 4° C. until September 1958, when they were sown in flats in the greenhouse. Seedlings were transplanted from the flats to pots, and in March 1959, 37 trees were planted in both the wet- and dry-site arboretums. The seedlings in the wet-site arboretum were apparently doing all right until June 1959, when damage was noted shortly after the arboretum had been sprayed with a 2-percent solution of DDT. Mortality was so heavy that the plot was abandoned. In April 1962, 11 trees still remained in the dry-site arboretum. These trees averaged 3 feet in height, with a range of from 0.4 to 5.5 feet (fig. 27). They have been repeatedly damaged by frost, which usually causes the outer bark to split (fig. 28). Most of the stems surviving have very poor form and are of sprout origin.

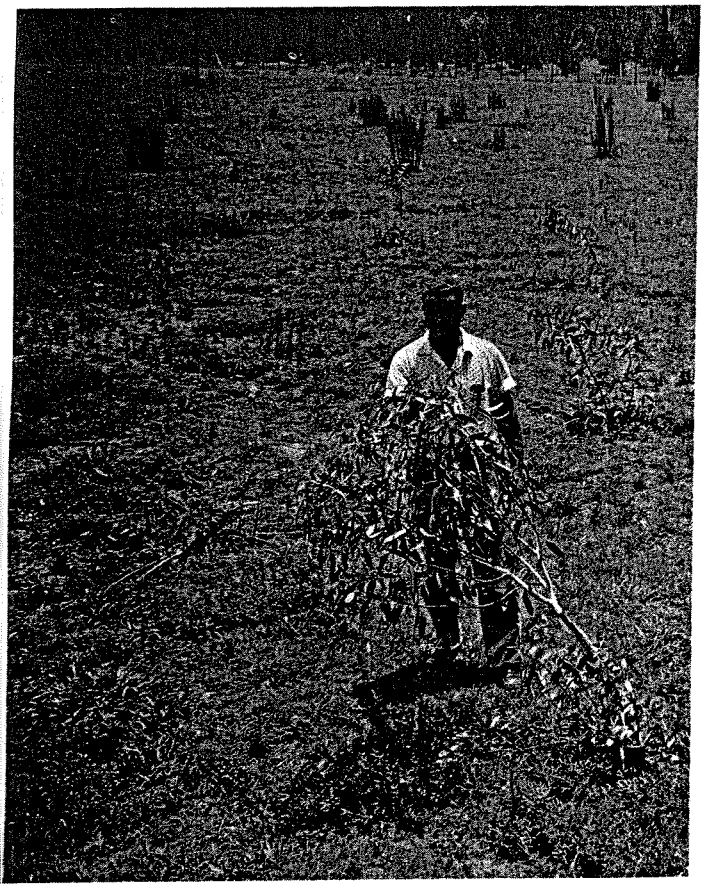

Figure 27. --Eucalyptus pauciflora No. 209, 5 years old from seed.

Figure 28. --Snow gum stem which has been damaged by cold. The old xylem is completely separated from the growing tissues but is acting as a support for the upper stem. New sprouts have begun to grow at the root collar.

NYSSA SYLVATICA VAR. BIFLORA (WALT.) SARG.--SWAMP TUPELO

This little-recognized variety of N. sylvatica occurs along the Coastal Plain from Delaware through Florida and east to Texas.

Lot No. 251.--Received as seed in October 1958 from a single tree collection made in Columbia County, Florida. The seed were cleaned and stratified in moist sand at a temperature of approximately 4° C. and sown in the nursery in April 1959. In January 1960, 25 seedlings were outplanted in each of the arboretum sites. At the time of outplanting, seedlings averaged 2 feet in height. Survival in the wet-site arboretum has been excellent, 24 trees remaining in April 1962. Growth, however, has been slow, the average height being 2.3 feet, with a range of 0.5 to 3.2 feet.

On the dry site, mortality was heavy during the dry summer of 1961. In April 1962, 11 trees survived, having an average height of 1.4 feet and a range of from 0.5 to 2.9 feet. Of the trees in this plot, seven were shorter than at the time of outplanting. This reduction in height is probably due to a lack of adaptability to dry conditions.

TAXODIUM DISTICHUM (L.) RICH.--BALDCYPRESS

This excellent, but increasingly rare timber tree ranges along the Coastal Plain from Delaware through Florida to Texas and north in the Mississippi valley to Indiana.

Lot No. 245.--Received as seed collected from a single tree in November 1958 by the Lake City Research Center staff. The collection was made along the bank of Swift Creek in Hamilton County, Florida, (lat. 30°23' N., long. 82°48' W.). Seed were sown in the nursery in April 1959, and 25 trees outplanted on both arboretum sites January 1960. Survival on the wet site has been excellent, 24 trees remaining in April 1962. Growth, however, has been slow. The trees averaged 2.2 feet in height, with a range of from 1.6 to 2.9 feet. As might be expected, mortality on the dry site has been heavy, the nine trees remaining in April 1962 having an average height of 1.4 feet and a range of from 0.1 to 2.5 feet. Negative height increment on the dry site is very likely due to adverse conditions for this species.

TAXODIUM DISTICHUM VAR. NUTANS (AIT.) SWEET--PONDCYPRESS

This less well-known variety of *T. distichum* ranges along the Coastal Plain from Virginia through Florida to Louisiana. It is a comparatively small tree and, as its name implies, occurs principally in the small stagnant ponds of the flatwoods seldom being found along the banks of moving waters.

Lot No. 228.--Seed were collected in September 1957 from several trees in Hamilton County, Florida. The seed were sown in the nursery in March 1958, and in October the seedlings averaged 1.9 feet in height. In January 1959, full plots were outplanted in both the wet- and dry-site arboretum. No mortality has occurred in the wet-site plot, and in April 1962, trees averaged 2.8 feet in height, with a range of from 1.6 to 3.5 feet. Mortality in the dry-site plot has been low. Twenty-four trees remained in April 1962, having an average height of 2.7 feet and a range of from 1.7 to 3.5 feet.

Discussion

The poor performance of exotic pines in the Olustee Arboretum is not without precedent (Zobel et al. 1956). The patterns of survival and growth observed, and the conclusions which can be drawn from them, agree very closely with those of Namkoong and Jewell;[3] that is, the European pines and the pines of the Southwestern United States appear to be least well-adapted to the Southeastern environment. The Asiatic species of pine, although of slow growth and of comparatively poor form, seem to have a higher potential for survival in a strange environment. The poor showing of the Mexican species has been disappointing, but is apparently similar to performance in east Texas reported by Zobel and his associates.

The concept that plants grow in harmony with their environment has been advanced by ecologists for many years. In forestry the general site requirements of important species are well known, and guide species selection for planting in various geographic areas. Within broad areas, species selection is also based on site conditions and in some forest areas relative site indexes have been developed for several important species that can be grown on the same soils.

In some tree introduction work there has been notable lack of concern with ecological requirements of the species. Failure to recognize the site requirements of different species is probably the largest single cause of failure in tree introduction work.

Accurate information for species growing in remote locations is difficult to obtain. The lack of reliable data applies to factors important in survival, such as tolerance to heat, cold, and flooding. We also need more information on factors important for optimum growth, such as soil moisture relations, soil fertility requirements, length of growing season, and average temperature.

In addition to edaphic and climatic factors of the native habitat of a tree species, several others affect performance of a species as an exotic. For example, susceptibility to soil- or air-borne pathogens as well as to insects may cause death, slow growth, or low-quality wood products. High winds, abrupt temperature changes, freezing rain, or snow may seriously affect growth and general tree quality. The reaction of a foreign species to local conditions can be determined only by test plantings.

To some extent, experiences with exotics in the South parallel those reported for the Pacific Northwest (Silen 1962). Trying to answer the question why most exotics perform poorly in the United States, Silen hypothesizes

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[3] Namkoong, G., and Jewell, F. F. Non-native pines in south Mississippi. Publication pending, Southern Forest Expt. Sta., U. S. Forest Serv., New Orleans, La.

that in an excellent climate, natural selection over the years has favored the fast growth rates of the native species of the Pacific Northwest. The favorable climate of the Southern United States also creates conditions in which natural selection might favor rapid growth. Considering the areas from which many of our exotic pines have come, an alternate explanation suggests itself. With the exception of Mexico, the major sources of exotic pines are areas having a history of long civilization. It seems probable that over the ages, and until a fairly recent time, most of the forestry, or lack of forestry, in both Europe and Asia has resulted in a progressive, disgenic deterioration of the pine species native to those areas. Particularly in Asia does it seem probable that cutting practices have resulted in the evolution of genotypes of pines having a high potential for survival but with growth rate and form considerably poorer than they were before the advent of man. On the other hand, in Mexico there are still large areas of virgin timber; then why do the pines of Mexico perform so poorly in the Southern United States? It is not explainable on the basis of past cutting practices. Some Mexican species, notably P. patula, have been highly successful as exotics in other parts of the world. Any hypotheses regarding the performance of the Mexican pines must be highly speculative; however, it is possible that evolution in Mexico has resulted in the development of a number of species, each of which is adapted to a fairly narrow range of environmental conditions. Whether these are primarily adaptations to soil, rainfall patterns, or photoperiods will not be known until the results of future research become available.

Past experiences both at Olustee and in other parts of the South indicate that the introduction of exotics in competition with the major southern pines is not likely to produce important results. None of the exotics thus far tested is faster growing or better formed than the southern pines. Most of them are at least as susceptible or more susceptible to insects and disease, and the question remains, which characteristics of the exotics might be desirable when hybridized with one of the southern pines. No data are yet available on the gum-yielding performance of exotics when grown in the South. On the basis of growth rate, it does not seem likely that an exotic species will be capable of out-producing our highest-gum-yielding species, or the high-gum-yielding strains already being developed by intraspecific hybridization.

The variation between species in chemical composition of oleoresin (Mirov 1961) constitutes one characteristic of exotic pines that might have value in a breeding program. Research indicates that yield and chemical composition of oleoresin may be factors affecting the attractiveness and resistance of trees to insect attack (Smith 1961; Vite and Gara 1962). The possibility exists that at some time in the future a change may become desirable in the over-all composition of oleoresin, or that some one particular component of oleoresin may become of major importance. Whether exotics would attain greater importance as breeding material in these circumstances is purely a matter of speculation, since the breeding scheme used would depend on what changes were desired.

Several of the exotic pines are characterized by precocious flowering. This characteristic is a survival mechanism and appears to be most common among less desirable species, such as P. densiflora, P. thunbergii, P. clausa, and P. banksiana. If early flowering is a sufficiently desirable trait, it is quite likely that it could most advantageously be incorporated by single-tree selection and intraspecies hybridization into the new strains of pines being developed in the South.

As originally conceived, the Olustee Arboretum was to be an introduction and breeding garden of exotic pines used by the naval stores industry. Our experience has shown that most introduced species must have special care if they are to survive and become available for breeding. At the Olustee Arboretum most of the introductions have died. In an introduction arboretum the principal interest is to test the adaptability of non-indigenous species to a strange environment. Under these circumstances special care need not be carried beyond the nursery and outplanting stages. On the other hand, in order to maintain a breeding arboretum containing a reasonable number of species and individuals, we must make plans to provide adequate protection from insects and disease. In some cases additional cultural practices such as mulching and fertilizing may be required and some species may have special site requirements.

The species present in the Olustee Arboretum provide a source of plant material for future experimentation. New acquisitions will be made as seed becomes available. Plans call for the protection and maintenance of those species still active in the arboretum, for records on the phenology of flowering, observations on the incidence of insects and diseases, records of growth data, and tests of oleoresin-yielding ability.

Tests at the Olustee Arboretum confirm findings at other southern arboreta, and indicate that southern forestry problems are not likely to be solved by a foreign miracle tree.

Literature Cited

ACHAYA, T.
1960. The role of exotic species in forest improvement. Fifth World Forestry Conf. Proc. 1960: 494-497.

BOURDEAU, P. F., and SCHOPMEYER, C. S.
1958. Oleoresin exudation pressure in slash pine: its measurement, heritability and relation to oleoresin yield. In, The Physiology of Forest Trees. 678 pp. New York: Ronald Press.

DALLIMORE, W., and JACKSON, A. B.
1961. A handbook of coniferae including ginkoaceae. Ed. 3. (Reprinted with correction.) 686 pp., 39 plates. Edward Arnold Publishers, Ltd.

DORMAN, KEITH W.
1962. Forest tree improvement for Georgia: a problem analysis of research needs in forest tree breeding and forest genetics. Ga. Forest Res. Council Rpt. 9, 79 pp.

ELDREDGE, I. F.
1921. The maritime pine in the United States. In, Gamble, T., Naval Stores: History, Production, Distribution and Consumption, p. 229, Savannah, Ga.

FIELDING, JOHN M.
1960. The role of exotic species in forest tree improvement. Fifth World Forestry Conf. Proc. 1960: 742-746.

GEMMER, E. W.
1931. A word for exotics. Jour. Forestry 29: 92-94.

HARDEE, J. H.
1956. Genetics or exotics? Jour. Forestry 54: 473.

HATMAKER, JOHN F.
1957. Norris oak arboretum. Tenn. Val. Authority Forestry Relat. Div. Tech. Note 28, 7 pp.

HOEKSTRA, P. E.
1954. New blood for southern pines. South. Lumberman 189 (2369): 182-183.

KRAUS, J. F.
1958. Twenty non-indigenous pines grow in north Florida. Silvae Genetica 7, Heft 2. 41-80, p. 69.

LIDDICOET, A. R., and RIGHTER, F. I.
1960. Trees of the Eddy Arboretum. U. S. Forest Serv. Pacific Southwest Forest and Range Expt. Sta. Misc. Paper 43, 41 pp.

LITTLE, ELBERT L., Jr.
1953. Check list of native and naturalized trees of the United States (including Alaska). U. S. Dept. Agr. Handb. 41, 472 pp.

_____ and DORMAN, KEITH W.
1952. Geographic differences in cone-opening in sand pine. Jour. Forestry 50: 204-205.

_____ and DORMAN, KEITH W.
1954. Slash pine (Pinus elliottii), including South Florida slash pine, nomenclature and description. U. S. Forest Serv. Southeast. Forest Expt. Sta. Paper 36, 82 pp., illus.

MACDONALD COLLEGE
(n. d.) The Morgan Arboretum a project in woodland conservation. McGill Univ., Macdonald College, 16 pp.

MERGEN, FRANÇOIS
1954. Inheritance of oleoresin yield in slash pine. Naval Stores Rev. 64 (9): 8-9, 20.

_____ HOEKSTRA, P. E., and ECHOLS, R. M.
1955. Genetic control of oleoresin yield and viscosity in slash pine. Forest Sci. 1: 19-30.

MIROV, N. T.
1961. Composition of gum turpentines of pines. U. S. Dept. Agr. Tech. Bul. 1239, 158 pp.,

MOULDS, F. R.
1957. Exotics can succeed in forestry as in agriculture. Jour. Forestry 55: 563-566.

PENNSYLVANIA DEPARTMENT OF FORESTS AND WATERS
1954. Guide to the tree species in the Mont Alto State Forest Arboretum. Pa. Dept. Forests and Waters, Res. Div., 7 pp.

RUDOLF, PAUL
1932. The naval stores pines cultivated throughout the world. Gamble's Internatl. Naval Stores Year Book 1932-33, pp. 65-67.

SCHANTZ-HANSEN, T., and HALL, O. F.
1952. Results of testing exotic trees and shrubs for hardiness in northern Minnesota. Univ. Minn. School Forestry, Forestry Notes 5, 2 pp.

SCHORY, E. A.
1957. 1955-56 progress report. Tropical Forestry Project. Ft. Myers, Florida. Florida Forest Service. 22 pp.

SILEN, ROY R.
1962. A discussion of forest trees introduced into the Pacific Northwest. Jour. Forestry 60: 407-408.

SMITH, R. H.
1961. The fumigant toxicity of three pine resins to Dendroctonus brevicomis and D. jeffreyi. Jour. Econ. Ent. 54: 365-369.

SQUILLACE, A. E., and BENGTSON, G. W.
1961. Inheritance of gum yield and other characteristics of slash pine. Sixth South. Forest Tree Impr. Conf. Proc. 1961: 85-96

_____ and DORMAN, K. W.
1961. Selective breeding of slash pine for high oleoresin yield and other characters. In, Recent Advances in Botany, Sec. 14: 1616-1621. Univ. Toronto, Toronto, Ontario, Canada.

VITE, J. P., and GARA, R. I.
1962. Volatile attractants from ponderosa pine attacked by bark beetles (Coleoptera: Scolytidae). Boyce Thompson Inst. Contrib. 21: 251-273.

ZOBEL, B. J., CAMPBELL, T. E., CECH, F. C., and GODDARD, R. E.
1956. Progress report - survival and growth of native and exotic pines, including hybrid pines in western Louisiana and east Texas. Texas Forest Serv. Res. Note 17, 16 pp.

ZON, RAPHAEL, and BRISCO, JOHN M.
1911. Eucalypts in Florida. U. S. Dept. Agr. Bul. 87, 47 pp.

Agriculture - Asheville