CHAPTER 2

TAXONOMIC CLASSIFICATION OF PINES

The major and minor southern pine species are fairly closely related, but their taxonomic relations have not been clearly delineated. This has led to rather important name changes in fairly recent years in regard to species, varieties, and races. Names are important, of course, and when changes in names occur they bring about reviews of hypotheses about relationships among species and groups of species that may or may not be important in applied breeding. The characteristics of the individual maternal or paternal parents are of primary importance and the bearing on the evaluation of the progeny may be minimal, although the parents are designated as separate species, varieties, or races at different times by different taxonomists.

An extremely large amount of silviculture and forest products research has been done on the basis of the tree species. The concept of grouping "similar individual" trees under a species name has proven to be extremely useful in forest education, research, management, and industry. Although individual trees within different species may not represent the same degree of "similarity," average values for distinctive characteristics of each species have great utility, and much research effort has been expanded in computing them. As intensity of forest management and research increase with respect to individual species, there is also an increase in recognition of the degree of "similarity" or lack of it, and names or mathematical error terms are adapted to define the subdivisions of species. As might be expected, the traits or features of significant economic value may receive the most study.

In the following chapters much will be said about variation among individuals or groups of individuals within species, or the degree of "similarity," and special terms will be used to identify these differences. Extremely large groups are recognized, but very small groups or individual trees are included because genetics and tree breeding work is done on this basis.

TAXONOMY OF THE GENUS *PINUS*

Because of the importance of pines, a vast array of literature has accumulated on the phylogeny, taxonomy, and species characteristics, which has been summarized by Mirov (1967) in a comprehensive monograph "The Genus *Pinus*." Although the monograph includes the southern pines, there is a need to review here some of the problems in taxonomy that have developed within the group. A brief discussion will help develop an understanding of some of the historical events and may indicate future trends.

TAXONOMY OF SOUTHERN PINES

Even at this date universal agreement on the name-terminology for southern pines has not been achieved. Consequently, some confusion persists. Table 1 illustrates current grouping by Little and Critchfield (1969) vs. four earlier systems.

The hard pines, subgenus *Pinus* (*Diploxylon*), were rearranged from Shaw (1914) by Duffield (1952). This classification system was followed by Critchfield and Little (1966) and Little and Critchfield (1969). As shown in table 1, they retained *Sabinianae* (group *Macrocarpae* of Shaw) as distinct and gave Latin names to Duffield's groups.

Two pines, *P. rigida* and *P. serotina*, were transferred from subsection *Insignes* to subsection *Australes* by Duffield (1952). *Australes* now includes *P. palustris*, *P. taeda*, *P. echinata*, *P. glabra*, *P. rigida*, *P. serotina*, *P. elliottii*, *P. pungens*, as well as nonlocal pines and *P. caribaea*, *P. occidentalis*, and *P. cubensis*. Subsection *Contortae* contains two southern pines, *P. virginiana* and *P. clausa*, plus *P. banksiana* of northern states and *P. contorta* of the western states, whose range overlaps with the latter in west-central Canada.

The species assigned to subsections 11 and 14 are listed in the following excerpt quoted from "Subdivisions of the Genus *Pinus* (Pines)" by Little and Critchfield (1969, p. 13–15):

Subsect. 11. *Pinus* subsect. *Australes* Loud., emend.
southern yellow pines

Pinus sect. ii. ***Ternatae*** § ix. ***Australes*** Loud., Arb. Frut. Brit. 4: 2255. 1838; emend. Holotype species: *Pinus australis* Michx. f., Hist. Arb. Amér. Sept. 1: 64, t. 6. 1810 (*P. palustris* Mill., Gard. Dict. ed. 8, *Pinus* No. 14. 1768).

Pinus palustris Mill., Gard. Dict. ed. 8, *Pinus* No. 14. 1768; longleaf pine. Southeastern United States.

Pinus taeda L., Sp. Pl. 1000. 1753; loblolly pine. Southeastern United States.

Pinus echinata Mill., Gard. Dict. ed. 8, *Pinus* No. 12. 1768; shortleaf pine. Eastern United States.

Pinus glabra Walt., Fl. Carol. 237. 1788; spruce pine. Southeastern United States.

Pinus rigida Mill., Gard. Dict. ed. 8, *Pinus* No. 10. 1768; pitch pine. Eastern United States.

Pinus serotina Michx., Fl. Bor.-Amer. 2: 205. 1803; pond pine. Southeastern United States.

Pinus pungens Lamb., Ann. Bot. 2: 198. 1805; Table-Mountain pine. Eastern United States.

Pinus elliottii Engelm., Acad. Sci. St. Louis Trans. 4: 186, t. 1–3. 1380; slash pine. Southeastern United States.

Pinus caribaea Morelet, Rev. Hort. Côte d'Or 1: 107. 1851; Caribbean pine. Bahama Islands, Cuba, and Central America.

Pinus occidentalis Sw., Nov. Gen. Sp. Pl. 103. 1788; West Indian pine. Hispaniola and Cuba.

Pinus cubensis Griseb., Amer. Acad. Mem., Ser. 2, 8: 530. 1862; Cuban pine. Cuba.

Subsect. 14. ***Pinus*** subsect. ***Contortae*** Little & Critchfield

Pinus subgen. ***Pinus*** sect. ***Pinus*** subsect. ***Contortae*** Little & Critchfield, U.S. Dep. Agr. Misc. Pub. 991: 15. 1966. Holotype species: *Pinus contorta* Dougl. ex Loud., Arb. Frut. Brit 4: 2292, fig. 2210–2211, 1838.

Pinus banksiana Lamb., Descr. Genus *Pinus* 1: 7, pl. 3, 1803; jack pine. Northeastern United States and nearly across Canada.

Pinus contorta Dougl. ex Loud., Arb. Frut. Brit. 4: 2292, fig. 2210–2211. 1838; lodgepole pine. Western North America from Yukon and southeastern Alaska to northern Baja California.

Pinus virginiana Mill., Gard. Dict. ed. 8, *Pinus* No. 9. 1768; Virginia pine. Eastern United States.

Pinus clausa (Chapm.) Vasey ex Sarg., U.S. Census, 10th, 1880, vol. 9 (Rpt. Forests No. Amer.): 199. 1884; sand pine. Florida and southern Alabama.

Removal of *P. resinosa* from subsection *Australes*, where it was placed by Shaw (1914), appears logical. In his karyotype analysis of several pine species, Saylor (1961) observed differences in chromosome shape between *P. resinosa* and both *P. taeda* and *P. palustris*. The anatomical features of the wood are sufficiently different to separate *P. resinosa* from southern pines (Hudson 1960). Kim (1963) also noted close similarities in the karyotypes of *P. taeda* and *P. rigida*. Karyotypes of these two southern pines and that indicated for *P. echinata* were similar.

On the basis of interspecific hybridization work in Korea, Ahn (1963) concluded that crossability in terms of production rate of fertile hybrid seed was high between species which are closely related taxonomically.

The karyotypes of some of the southern pines are very similar but do show differences among species (Saylor 1961) (figures 13 and 14). The *b* arm patterns and the location of the chromosomes with the most median and submedian centromeres (all three features are possible diagnostic features of the karyotype) have been determined. According to Saylor's analysis, four different karyotypes exist. The karyotypes of *P. taeda* and *P. palustris* agree in all three features and thus can be considered similar. The others, *P. strobus* and *P. resinosa*, appear to differ sufficiently from this type and among themselves to be regarded as distinctive. The number and position of secondary constructions have thus far proved unreliable as diagnostic features of the karyotypes. Although it was not studied intensively, *P. echinata* apparently has a karyotype closely resembling that of loblolly and longleaf pines. On the basis of later work, it was concluded that *P. echinata* differs the most from the general pattern in *Australes* and it was the most nearly similar to *P. taeda* (Saylor 1972). It was learned also that *P. rigida* had a distinguishing feature in which the *b* arm of a chromosome other than number one is the longest. No differences were detected between the two varieties of *P. elliottii*. A very noticeable difference was found between the *b* arm sequence of the closely related *P. caribaea* and *P. elliottii*. In *Contortae*, all species have a *b* arm pattern of 5, 7, 9, except *P. clausa*, which differs at position 10.

Figure 13.—*Pinus taeda* chromosomes from a root tip subjected to 33 hours pretreatment in oxyquinoline. Arrows denote the smallest chromosomes with submedian centromeres. 1650×. (Saylor 1961)

A karyotype analysis of *P. rigida*, *P. taeda*, and their F_1 hybrid was made by Kim (1963). He found that the mean chromosome length of *P. ×rigitaeda* is the shortest and that of *P. rigida* the longest. In general, there are close similarities between the chromosomes of *P. taeda* and the hybrid. When chromosomes are arranged in descending order of the length of the short arm, the lengths of the long arms do not form continuous descending sequences. The chromosomes in which the long arms are out of order are different in each species, as shown in figure 14. In *P. rigida*, they are 4th, 6th, and 10th chromosomes, but 5th, 6th, and 9th in *P. taeda*, and 3rd, 6th, 8th, and 9th in the F_1 hybrid.

Table 1.—*Comparison of current nomenclature (left column) with that of other classifications of the genus* Pinus *involving southern pines now in Subsections 11 and 14 (Little and Critchfield 1969)*

Subdivision of genus *Pinus* L.	Duffield (1952)	Rehder (1949)	Shaw (1914, 1924)	Pilger (1926)
Subgen. 1. Ducampopinus (A. Cheval.) de Ferré				
Sect. 1. Ducampopinus				
Subsect. 1. Krempfianae Little & Critchfield			**(Group VI)**	**(Sect. 3, Subsect. 2)**
Subgen. 2. Strobus Lemm.	**Subgen. Haploxylon**	**Subgen. I. Strobus**	**Sect. A. Haploxylon**	**Subgen. I. Haploxylon**
Sect. 2. Strobus		**Sect. I. Cembra**	**Subsect. a. Cembra**	
Subsect. 2. Cembrae Loud.		**Ser. 1. Cembrae**	**Group I. Cembrae**	**Sect. 1. Cembra**
3. Strobi Loud.		**2. Flexiles**	**(II. Flexiles)**	**1. Cembra**
		3. Eustrobi	**III. Strobi**	**2. Strobus**
Sect. 3. Parrya Mayr		**Sect. II. Parrya**	**Subsect. b. Paracembra**	**Sect. 3. Paracembra**
Subsect. 4. Cembroides Engelm.		**Ser. 4. Cembroides**	**Group IV. Cembroides**	**Subsect. 1. Gerardianae**
5. Gerardianae Loud.		**5. Gerardianae**	**V. Gerardianae**	**1. Gerardianae**
6. Balfourianae Engelm.		**6. Balfourianae**	**VI. Balfourianae**	**2. Balfourianae**
Subgen. 3. Pinus	**Subgen. Diploxylon**	**Subgen. II. Eupitys**	**Sect. B. Diploxylon**	**Subgen. II. Diploxylon**
Sect. 4. Pinea Endl.			**Subsect. c. Parapinaster**	
Subsect. 7. Leiophyllae Loud.			**Group VII. Leiophyllae**	**(Sect. 10)**
8. Canarienses Loud.			**VIII. Longifoliae**	**Sect. 4. Sula**
9. Pineae Little & Critchfield			**IX. Pineae**	**7. Pinea**
Sect. 5. Pinus	**Subsect. Pinaster**	**Sect. III. Taeda**	**Subsect. d. Pinaster**	
Subsect. 10. Sylvestres Loud.	**Group X. Lariciones**	**Ser. 7 Sylvestres**	**Group X. Lariciones**	**Sect. 5. Eupitys** **9. Khasia**
11. Australes Loud.	**Group XI**	**8. Australes**	**XI. Australes**	**8. Australes** **11. Taeda**
12. Ponderosae Loud.	**Group XII**	**8. Australes**	**XI. Australes**	**10. Pseudostrobus**
13. Sabinianae Loud.	**Group XII**	**10. Macrocarpae**	**XIII. Macrocarpae**	**(Sect. 10, 11)**
14. Contortae Little & Critchfield	**Group XIII**	**9. Insignes**	**XII. Insignes**	**6. Banksia**
15. Oocarpae Little & Critchfield	**Group XIV**	**9. Insignes**	**XII. Insignes**	**(Sect. 11)**

The chemical composition of the oleoresin, and particularly the turpentine and rosin, varies widely among southern pines. It has been proposed as a diagnostic in taxonomy (Mirov 1961) (tables 2 and 3).

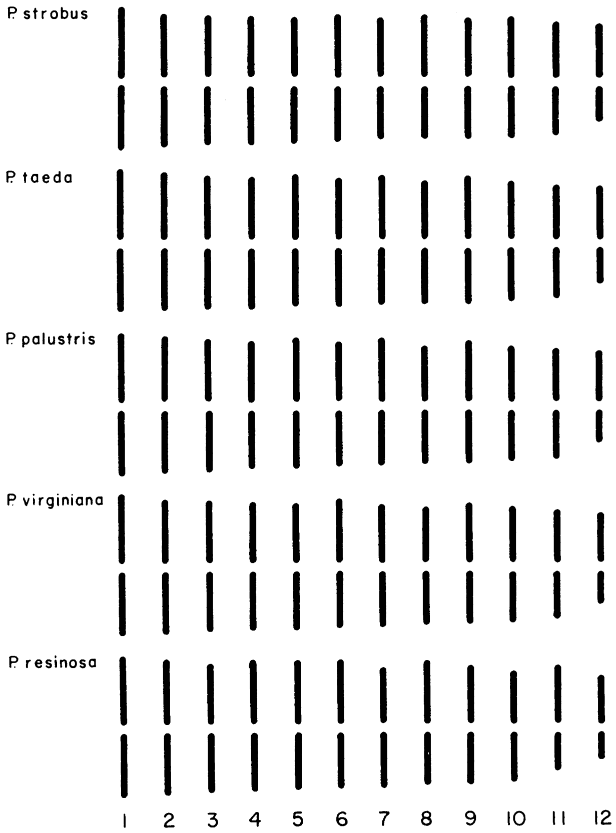

Figure 14.—Idiograms of five species of *Pinus*. Chromosomes are arranged in descending order of length of the shorter arm. Although chromosomes generally are similar in length, there are differences in other features indicating separate taxonomic groups. *P. strobus* is a member of the taxonomic group known as soft pines. *P. resinosa* is a member of the hard pines, as are all the southern pines, but has been placed in a different section. (Saylor 1961)

The presence of *l*-β-phellandrene in the turpentine of *P. elliottii* var. *elliottii* was the basis for speculation that the material may have utility in working out taxonomic relationships (Mirov *et al.* 1965). *l*-β-phellandrene occurs chiefly in pine species of Mexico, Western America, and to a lesser degree in the pines of southwestern Asia. Pine species of eastern North America do not contain *l*-β-phellandrene in their turpentine except *P. elliottii* and, also, *P. elliottii* var. *densa*, where one sample showed 19 percent. It might appear that *P. elliottii* is related chemically to Caribbean species rather than to eastern American pine species. In New Zealand, β-phellandrene was found in the turpentine of one arboretum specimen tree of *P. elliottii*, but the turpentine of one *P. rigida* tree had 9 percent, which does not agree with other reports (Williams and Bannister 1962).

These conclusions are in conflict with analyses of sulphate turpentine from limited wood samples which showed 15.9 percent β-phellandrene for pond pine, 1.4 percent to 8.1 percent for Virginia, spruce, sand, and slash pines, and less than one percent for loblolly, longleaf, and pitch pines (Drew and Pylant 1966).

More work needs to be done on the chemical composition of the turpentines of various species before definite conclusions about relationships are made. More uniformity in oleoresin extraction and analytical methods is needed. Analysis of oleoresin composition is complex, as illustrated by the work of Mirov (1961).

A summary of the work on variation in slash pine in relation to taxonomy has been given by Little and Dorman (1954) including the extensive field studies by DeVall (1941).

For slash pine, Little and Dorman (1952b) took up the older name *Pinus elliottii* Engelm. and distinguished a southern variety, South Florida slash pine, *P. elliottii* var. *densa*. This species was found to be different from the Caribbean pine, *P. caribaea* Morelet, of several West Indian islands and Central America.

P. elliottii var. *densa*, South Florida slash pine, was distinguished by the slow initial growth of seedlings and the thickened stem form of very young plants (fig. 15). The typical slash pine has a very slender stem form in seedlings. The geographic range of variety *densa* was revised by Langdon (1963a) on the basis of additional survey data. Planting studies comparing the two varieties have shown that the typical slash pine variety is more susceptible to grazing damage than variety *densa* (Bethune 1966), but the latter is much more susceptible to pitch canker caused by *Fusarium lateritium* f. *pini* (Bethune and Hepting 1963). Variety *densa* is not only less susceptible to pine tip moth (*Rhyacionia subtropica*) attack than either variety *elliottii* or loblolly pine (*P. taeda*), but the damage to individual trees is less (Bethune 1963b). Also, variety *densa* is less susceptible to southern fusiform rust caused by *Cronartium fusiforme* Hedgc. & Hunt ex Cumm., as indicated by one short-term field study (Southern Forest Experiment Station 1950). However, in inoculation tests *densa* was more susceptible than *elliottii* (Snow *et al.* 1969). Variety *elliottii* has higher survival and more resistance to wind damage in field plantings than *densa* (Bethune 1966). *Densa*, on the other hand, will sprout at the root collar and has more resistance to fire during the sapling stage of

Table 2.—*Chemical composition of the turpentine in southern pines (adapted from Mirov 1961)*

Taxonomic subsection and species	Compounds								
	d,dl-α-pinene	*l,dl*-α-pinene	*d*-α-pinene	*l*-α-pinene	*l*-β-pinene	*l*-limonene	*l*-β-phellandrene	*l*-camphene	tails and other
	Percent								
Subsection *Australes*									
Pinus palustris	64.3	0	0	0	31.1	0	0	0	4.6
P. taeda	0	0	71.0	0	22.0	0	0	0	[1] 7.0
P. echinata	0	0	85.0	0	11.0	0	0	0	0
P. elliottii var. *elliottii*	0	0	0	61.0	33.7	0	0	0	5.3
P. elliottii var. *densa*	0	71.0	0	0	4.0	0	19.0	0	[2] 5.0
P. glabra [3]	45.0	0	0	0	45.0	8.0	0	0	1.0
P. rigida [3]	0	0	0	65.0	20.0	[4] 10.0	0	0	0
P. serotina [3]	0	0	0	5.0	0	90.0	0	0	[1] 4.0
P. pungens [3]	0	70.0	0	0	20.0	8–9.0	0	0	0
Subsection *Contortae*									
P. virginiana [3]	0	0	0	[5] 98.0	0	0	0	0	0
P. clausa [3]	0	0	0	10.0	75.0	0	0	10.0	0

[1] 1 percent methyl chavicol.
[2] 3 percent methyl chavicol.
[3] Minor southern pine.
[4] This is *l,dl*-limonene.
[5] This is α-pinene.

Table 3.—*Physical characteristics of the turpentine in southern pines (adapted from Mirov 1961)*

Taxonomic subsection and species	Density	Index of refraction	Optical rotation
			Degrees
Subsection *Australes*			
Pinus palustris	0.8618	1.4657	+ 7.89
P. taeda	.8592	1.4683	+24.1
P. echinata	.8575	1.4685	+ 9.9
P. glabra	.8599	1.4735	− 4.65
P. rigida	.8560	1.4701	− 9.0
P. serotina	.8437	1.4716	−83.7
P. elliottii var. *elliottii*	.8657	1.4694	−22.58
P. elliottii var. *densa*	.8532	1.4709	−38.6
P. pungens	.8564	1.4682	−23.7
Subsection *Contortae*			
P. virginiana	.8563	1.4657	− 3.83
P. clausa	.8723	1.4767	−22.80

growth, probably because it has thicker bark than *elliottii* (Ketcham and Bethune 1963; McMinn 1967). The chemical composition of the oleoresin is quite different in the two varieties, in that variety *densa* has 19 percent or higher *l*-β-phellandrene, and *elliottii* has smaller amounts, as shown by certain tests (Mirov 1961; Squillace and Fisher 1966). Trees of variety *elliottii* 11 years old and growing in south Florida have higher wood specific gravity and lower extractives content than *densa* and, in addition, specific gravity is negatively correlated with tree volume, but in *densa* it is positively correlated with volume (Saucier and Dorman 1969). South Florida slash pine could be designated a subspecies, a higher taxonomic rank than variety, according to requirements stated in *Terminology of Forest Science, Technology, Practice and Products*, edited by Ford-Robertson (1971).

Caribbean pine growing on the Atlantic slopes of Central America from British Honduras to Nicaragua was studied morphologically and ecologically so that it could be compared with the typical Cuban form (Barrett and Golfari 1962). As a result of the investigations this species was divided into three varieties: *Pinus caribaea* var. *caribaea* (typical) from Cuba; *P. caribaea* var. *hondurensis* from Central America; and *P. caribaea* var. *bahamensis* from the Bahamas.

Little and Dorman (1952a) proposed that two races of sand pine, *P. clausa*, be recognized. Sand pine in central Florida, to be known as the Ocala race, is characterized by its closed cone habit. In west Florida, the Choctawhatchee race is known as largely open coned. No morphological differences between trees and specimens of sand pine of the two races were found. And yet, although no systematic study of all geographic areas and stands within areas has been attempted, recent investigations are showing many important differences between races. Studies of cones and seed (Barnett and McLemore 1965) indicate the sand pine races vary in number of cones per bushel, number of seed per pound, stratification treatment needed to open

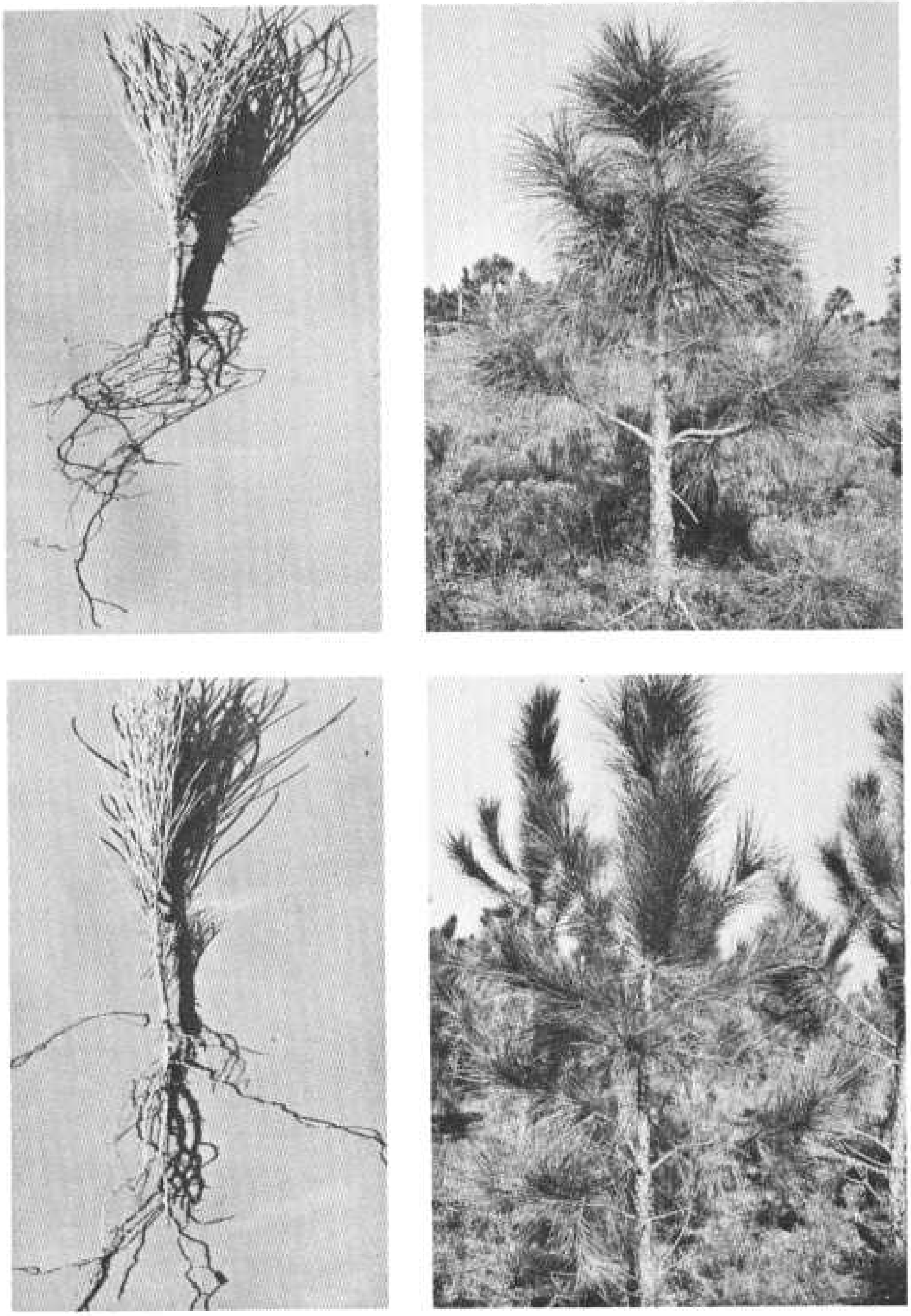

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Figure 15.—South Florida slash pine is distinguished by short and thick stems and roots in seedlings and thick-barked, highly tapered stems in saplings (above). In typical slash pine these traits are different (below). There are wide differences between the varieties in other traits also. (Bethune 1966)

cones, and seed dormancy. Ross (1970) reported differences in susceptibility to a root rot, Clark and Taras (1969) wood specific gravity and extractives content, Burns (1968) stand structure (even-aged vs. uneven-aged) and disease and insect attack, Harms (1969) and Burns (1972) damage from freezing temperatures and tip moth attack, and Morris (1967) response to fertilizer and susceptibility to mycorrhizae infection. It has been proposed by Ward (1963) that the open-coned variety of sand pine in west Florida be known as *P. clausa* var. *immuginata*, but many problems in taxonomy remain to be solved. As information accumulates about differences among sand pine stands at different geographic locations, the taxonomic status should be reviewed and may be revised upward according to rules such as those in the terminology treatise edited by Ford-Robertson (1971). Sand pine groups could be designated as subspecies because the traits differ more in number and economic importance than required of varieties. Toxonomic status upward from race through variety and subspecies to species depends largely on number and importance of traits.

NAMES FOR INDIVIDUAL TREES AND GROUPS OF TREES

The terms used in dendrology and taxonomy are well known to foresters, but much smaller groups of trees are used in forest genetics research and tree breeding. Specific names have been applied to these because they have to be accurately identified. The groups may be very small, perhaps one tree, or fairly large, and they may occur naturally in forests or they may be produced by man in various ways. Only the terms applying to the more commonly used groups or individual trees are given here, with their general rather than specific meanings. Definitions of terms vary among textbooks and, also, in some works authors cite the source of definitions of terms they prefer to use. The genetics and tree breeding terms selected were in the glossary of works by Allard (1960), Hayes *et al.* (1955), Snyder (1972b), and Ford-Robertson (1971)

Foresters designate groups of trees as *stands*. Stands may originate from natural seeding, or they might result from artificial methods such as aerial seeding or planting. Stands may be pure, all the same species, or mixed—composed of more than one species. Also, they might be even-aged or a mixture of all ages. Even-aged stands may be designated according to the age of the trees and all-aged stands by the number of trees per acre or stocking.

Tree breeders or geneticists may refer to the trees in various geographic locations as *populations*. This is a community of trees which shares a common gene pool, and thus, it differs somewhat from a population as used by statisticians.

Tree stands at various locations may be referred to as *geographic races, provenances, seed sources, physiographic races, clines, subspecies, varieties* or *ecotypes*. The inference is that differences occur in certain traits, although boundaries may be indistinct or vary gradually over fairly long distances. An ecotype is a race with characteristics that adapt it to certain habitats. A *strain* is a group of similar trees within a variety. A *cline* is a geographical gradient of phenotype or genotype within the species range. A *step-cline* is an irregular or broken cline. A *subspecies* is a taxonomic group below the species but above a variety. A *botanical variety* is a subdivision of a species distinguished by minor taxonomic characters.

It was proposed by Gilmour and Gregor (1939, p. 333) that *deme* be used as a term to indicate any specified assemblage of taxonomically closely related individuals. The term could be used with appropriate prefixes to denote particular kinds of demes. There is a need for terminology of this kind because: "The tendency is for individuals in close proximity to interbreed more frequently with each other than with individuals at a distance, and thus small, more or less isolated intrabreeding colonies are set up." The definitions of the new terms would be as follows:

Deme: any assemblage of taxonomically closely related individuals. The dictionary gives "population" for "assemblage."

Gamodeme: a deme forming a more or less isolated local intrabreeding community.

Topodeme: a deme occupying any specified geographical area.

Ecodeme: a deme occupying any specified ecological habitat.

Use has not been made of *deme* in geographic and stand variation research in forest genetics, but it seems it could serve as a substitute for *source*, which is now used to indicate both a geographic location and the trees originating from seed collected at that location.

Individual trees are known by various terms in genetics and tree breeding. A *mutation* is a tree with a sudden variation from the ancestral type because of a change in a gene or chromosome. A *polyploid* may be one with a different number of chromosomes from the usual two sets. A *plus tree* is one chosen because it may have inherently desirable traits—a good phenotype. It may be called an *elite tree* or a *good genotype* when it has proven, after tests, that it is inherently desirable for a particular purpose. A *ramet* is a vegetatively propagated tree in a group—a clone—all derived from one *ortet*, or the original source tree of the material for propagation. The ortet may or may not be a plus or elite tree. After progeny testing, if proven of acceptable quality, a clone in a seed orchard may be referred to as a *proven* or a *superior clone*.

The production, evaluation, and use of offspring from mating or crossing of forest trees constitute a very large proportion of the field of genetics. It is inevitable that much specialized terminology would develop regarding this activity, not only regarding principles, systems, and objectives, but to identify the trees produced by such work. *Sibs* are progeny of the same parents derived from different gametes or mature sex cells; *full sibs* are offspring with both parents in common; and *half sibs* are progeny with only one parent in common. A *sibling* is one plant or offspring.

The offspring of certain matings may be referred to as *hybrids*—the product of a cross between genetically unlike parents. If the parents are of different species, the offspring are *inter-specific hybrids;* if they are of the same species, the offspring are *intra-specific hybrids*. Even within species individual trees are not genetically alike, so that in breeding practice nearly all offspring may be hybrid in nature. In agriculture the word *hybrid* has been used to designate such a wide variety of crosses it has lost most of its meaning.

Offspring of various parental combinations are also known as *families* and this is a group of individuals directly related to each other. If pollen was used to pollinate conelets on the same tree, the progeny may be referred to as *selfs* after self-pollination.

The first generation of offspring is known as the *filial*, or F_1, generation. Subsequent crosses within the families are known as F_2, F_3, and so on. In forestry these terms have not been used very often because of the long-term period between generations, but they will become useful as time passes and more generations of trees are produced.