STATION PAPER NO. 2'7

AUGUST 1953

Tree Planting at the Bent Creek Experimental Forest

by

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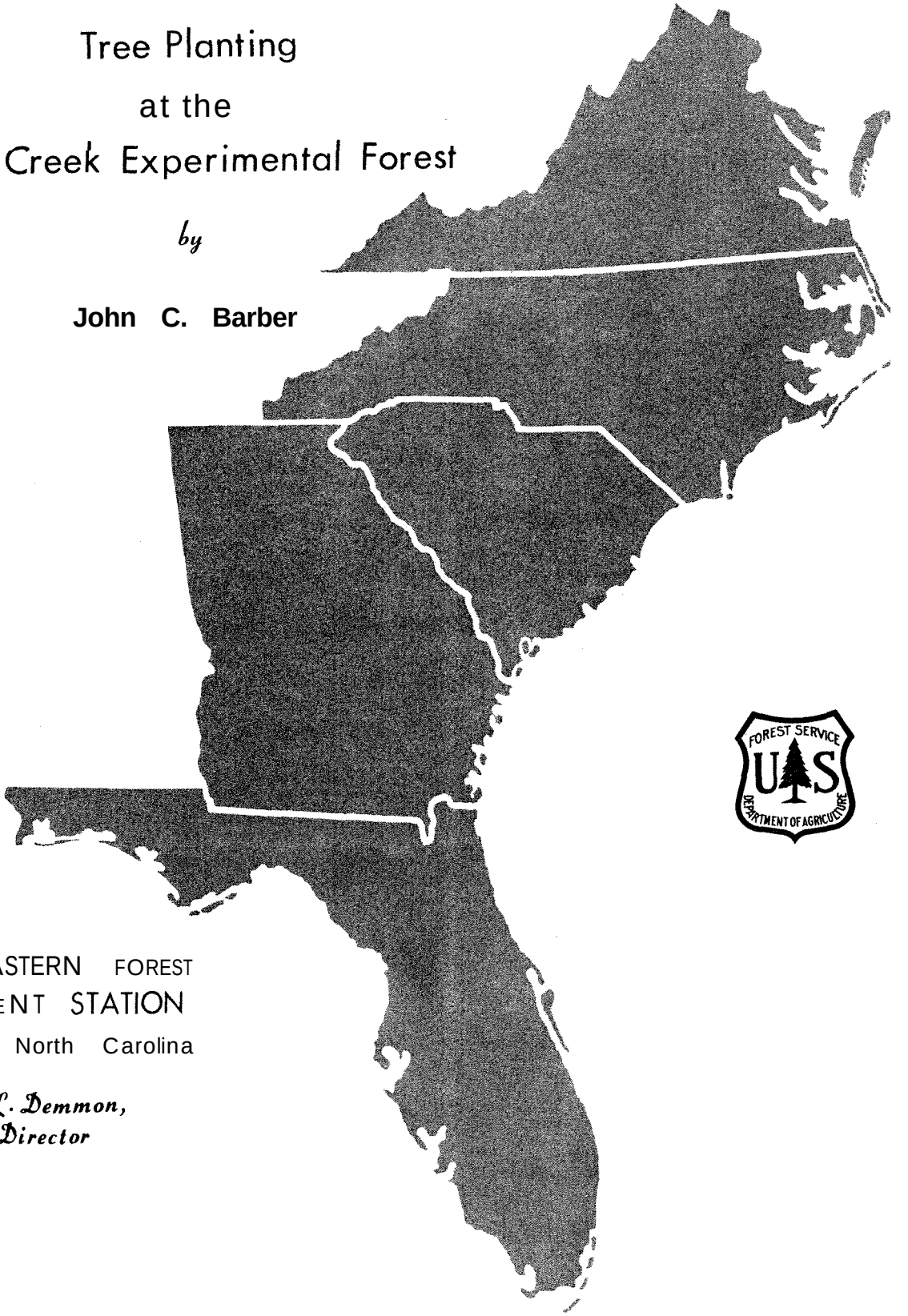

US SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

E. L. Demmon, Director

U. S. Department of Agriculture - Forest Service

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TREE PLANTING AT THE BENT CREEK EXPERIMENTAL FOREST

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INTRODUCTION

Foresters everywhere are becoming increasingly conscious of the potentialities of tree selection and breeding. In the quest for suitable breeding material, many of the plantations of the past are assuming importance, for each plantation of introduced species may provide information on its adaptability to a certain area and the desirable and undesirable traits which it may manifest in its new environment.

One group of such plantations is on the Bent Creek Experimental Forest near Asheville, in Buncombe County, North Carolina. The Bent Creek Arboretum originally contained 53 species on 69 plots. Many of these trial plantings failed, and several were destroyed. At present the area contains 32 species on 44 plots. There were 11 native species planted, 25 species from other regions of the United States, and 17 species from Europe and Asia. Seeds for some of the exotic plantings were obtained from planted trees in the United States and Canada. The plots are grouped on an area of about 10 acres along Bent Creek. Several informal examinations have been made of these plantings but no formal report has been presented since 1932.[1/] Thus, the development of these plots has not been systematically recorded; nor have they received optimum release and thinning in many cases.

HISTORY OF THE ARBORETUM

The Bent Creek Arboretum was begun informally in 1926 by F. W. Haasis, who made eight small plantings of seedling trees from seed of various sources outside the region. In 1927, I. H. Sims continued the work with the establishment of 15 additional plots. During these first years there was no formal plan of development, and the plots established were marked with temporary

1/ Bradshaw, D. E. and E. H. Bomberger. Examination of Bent Creek plantations. Southeastern Forest Expt. Sta., unpublished office report, 1932.

wooden corners only. In the spring of 1928 A. L. MacKinney established eight more plots and marked them with permanent iron stakes at the corners. He set out twenty-two additional plots in 1929 and 13 in 1930. The final plantings in this series were made in 1931, with the establishment of three small plots and the replanting of several plots which had failed.

A complete record of all plots was made in 1932, insofar as possible, and a brief report was prepared: Subsequent to this 1932 report, the arboretum received little attention. There were no further plantings until 1950, and during this period no additional observations were recorded. In the spring of 1952, Dorman listed the species which had been planted at Bent Creek.2/ This listing raised questions about the performance of exotic species and species native to the United States but planted outside their natural ranges.

During the late summer and fall of 1952 all plots were examined and the surviving trees measured. The diameters of all trees were recorded and, where possible, the heights. On many of the plots the density of the crowns made complete and accurage height measurements impossible, so that for these plots the average height given is based on a selected'sample of dominant, codominant, and intermediate individuals.

Throughout the arboretum, which had been established in abandoned fields, several species of native trees seeded in. On several of the plots this severe competition has made a serious effect upon growth and mortality of the introduced species. The faster-growing and more tolerant conifers apparently were not affected very much because they were able to close the crowns rapidly enough to smother competition or prevent its establishment. The plantings were all spaced 6 by 6 feet.

SOIL AND CLIMATE OF THE ARBORETUM

The soil in the arboretum is classed as Tate silt loam. This is a colluvial soil occurring at the bases of slopes. Tate silt loam is a productive soil with good to excessive external drainage and good internal drainage. The slopes adjacent to the arboretum are of Halewood stoney loam, steep phase. In general, the Bent Creek Arboretum is relatively level, with only small slope variations on a few plots. At time of planting, several shallow ditches were cut to supplement natural drainage.

The climate at Bent Creek can be considered moderate. Based on 12 years of weather observations, the average annual precipitation is approximately

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2/ Dorman, Keith W. Directory of forest genetics activities in the South. Southeastern Forest Expt. Sta. Station Paper 17. 17pp. 1952.

44 inches, with a range of from 38 to 55½ inches. The average minimum temperature recorded is 3 degrees F., with a range of from -10 degrees F. to 10 degrees F. The average maximum temperature is 94 degrees F., with a range from 90 degrees F. to 98 degrees F. Average killing frost dates are October 13 to April 28, with ranges of September 27 to November 6, and April 17 to May 14. Elevation of the arboretum is 2050 feet. Location is Lat. 35° 30' N., Long. 82° 38' W.

GROWTH OF TREES IN THE ARBORETUM

On the basis of the 1952 observations, the plantings may be arbitrarily divided into three groups: successful, existing but unsatisfactory, and unsuccessful. Table 1 lists the plantings which have done well and may be considered successful. Table 2 lists the plantings which still exist but have not demonstrated vigor or adaptability to the site and are unsatisfactory. Table 3 lists those plantings which can be considered failures. It must be kept in mind that this is only one test planting and that the critical factors affecting success or failure may be peculiar to this immediate area. The Bent Creek Arboretum lies in a frost-pocket which would seriously affect frost-sensitive species. It is subject to late frosts which damage the native species. Early reports indicate browsing by deer on some plots, and present observations indicate damage has also been inflicted by deer rubbing their antlers. The severe drought of 1930 is recorded as greatly affecting mortality, but the record made in that year does not mention any species in particular.

PLANTINGS OUTSIDE THE ARBORETUM

In addition to the arboretum plantings, several more extensive field plantings were made of a number of species, both native and introduced. The essential measurements on several of these plantations are recorded in table 4. A plantation of 300 Pinus rigida made in 1929 has scattered survivors of poor form and vigor, and is classed as a failure. Another failure was a plot of 1200 Abies balsamea planted in 1930. Early survival was very poor, and in 1952 no survivors were located. Several plantations of Liriodendron tulipifera were made, both pure or in mixture with Juglans nigra, Gleditsia triacanthos and Quercus alba. All of these plantations were made where there was an abundant supply of native Liriodendron seeds. The yellow-poplar is present, but the intermixing of planted and volunteer seedlings prevents an evaluation of these plots. The Juglans is recorded in table 4 and Gleditisia has no survivors. Because the plot containing Quercus alba was not accurately located, no evaluation could be made; however, an examination in 1932 records 88 percent survival.

Table 1.--Successful plantings in the Bent Creek Arboretum

Species	Seed source	Trees planted	Age in 1952	Survival & growth to 1932: Survival	Average height	Maximum height	Survival & growth to 1952: Survival	Ave. dbh.	Max. dbh.	Ave. hgt.	Max. hgt.
		No.	Yrs.	%	Ft.	Ft.	In %	Ins.	Ins.	Ft.	Ft.
Acer saccharum	Varna, N. Y.	100	27	53	2.3	7.2	35	2.7	5.0	40	46
Acer saccharum	unknown	85	26	59	.8	1.0	42	1.3	4.8	18	46
Albizzia julibrissin	unknown	26	24	100	2.8	5.2	65	1/ 4.5	7.2	30	32
Albizzia julibrissin	unknown	24	24	92	5.8	7.5	58	1/ 3.8	7.6	30	37
Chamaecyparis thyoides	Dismal Swamp, Va.	61	26	84	9.2	13.5	2/ 31	6.0	8.7	48	55
Ilex opaca	Pender Co. N. C.	16	22	3/ 81	1.1	2.3	94	3.3	5.6	19	22
Ilex opaca	Pender Co., N. C.	8	22	100	.9	1.5	100	3.7	5.0	17	22
Libocedrus decurrens	Washington	18	26	44	3.2	7.3	17	8.7	13.9	27	35
Liriodendron tulipifera 4/	Local	53	25	89	-3.5	9.5	70	5.9	11.7	42	60
Picea abies	Angus, Ontario	43	22	60	.5	.8	30	5.2	8.2	24	36
Picea glauca	unknown	48	24	3/ 85	1.0	2.2	5/ 94	3.4	8.0	19	31
Picea glauca	Unknown	24	24	92	1.1	1.8	87	4.2	5.6	26	32
Pinus densiflora	Japan	44	25	98	5.3	8.3	77	5.1	7.8	38	45
Pinus resinosa	Vermont	140	26	51	5.4	7.8	27	7.5	10.6	39	47
Pinus resinosa	Michigan	36	26	30	3.4	5.6	14	7.0	7.9	28	33
Pinus resinosa	Essex Jct., Vt.	100	27	29	5.6	8.5	21	6.2	8.4	32	38
Pinus resinosa	Glenn, Minn.	100	27	30	4.5	7.5	19	5.7	7.4	27	35
Pinus regida	unknown	24	24	100	3.4	6.1	62	5.1	9.1	40	48
Pinus regida var. serotina	Burgaw, N. C.	62	23	92	2.3	7.0	61	8.0	11.8	52	58
Pinus sylvestris	Unknown	65	24	91	1.5	3.4	57	3.4	5.5	20	30
Pinus taeda	N. C. (Coastal Plain)	47	23	87	5.2	8.2	70	8.6	14.1	56	62
Thuja occidentalis	Cornell, N. Y.	100	27	97	3.3	7.3	74	4.9	9.6	29	41
Thuja occidentalis	Cornell, N. Y.	10	27	100	5.3	8.3	90	5.7	7.8	26	29
Thuja occidentalis	Cornell, N. Y.	135	26	96	1.4	3.6	84	4.3	7.0	28	33

1/ All trees were multiple stemmed; therefore, these measurements were based on the largest stem of each individual.

2/ This species is being attacked by a white, stringy root and butt rot caused by Fomes annosus. (See Toole, E. R. and Boyce, J. S. Jr. Fomes Annosus on white cedar. Plant Dis. Rptr. 36(8):330. 1952) Mortality has been high and the fungus is progressively destroying the plot.

3/ This plot was probably replanted, because there are more trees present now than in 1932.

4/ Evaluation of this planting was complicated by the presence of native volunteers; therefore, the measurements cited are based on a selected sample of the ten best trees believed to have been planted.

5/ A canker believed to be caused by Cytospora sp. is present on one tree. There are no fruiting bodies present on the canker and positive identification has not been made.

Table 2. --Existing but unsatisfactory plantings in the Bent Creek Arboretum

Species	Seed source	Trees planted	Age in 1952	Survival & growth to 1932: Survival	Average height	Maximum height	Survival & growth to 1952: Survival	Ave. dbh.	Max. dbh.	Ave. hgt.	Max. hgt.
		No.	Yrs.	%	Ft.	Ft.	%	Ins.	Ins.	Et.	Ft.
Castanea crenata 1/	unknown	25	24	88	2.8	5.3	88	0.9	2.8	10	20
Castanea mollissima 1/	Unknown	23	24	91	3.1	4.1	91			18	36
Castanea mollissima 1/	China	13	26	85	4.3	6.8	85	1.6 2.8	6.2	24	43
Castanea seguini 2/	Unknown	5	24	80	2.1	2.5	60	--	0.5	5	7
Cercis canadensis	Unknown	21	24	90		2.7	29	1.6	2.8	18	22
Cornus mas	France	4	24	75	1.4	.6	(3/)	--	--	--	--
Cornus sanguinea	France	2	24	100	1.6	1.9	(3/)	--	--	--	--
Cupressus macnabiana	Amador Co., Calif.	12	23	25	1.9	2.9	8	--	6.1	--	28
Gleditsia triacanthos	unknown	48	24	96	1.9	7.4	2	--	6.1	--	48
Picea sitchensis	unknown	84	26	18	1.5	2.8	12	2.5	5.1	12	18
Pinus densiflora	Japan	22	25	95	5.0	7.0	14	7.4	10.5	36	40
Pinus densiflora	Japan	37	24	97	3.7	6.3	49	4.8	8.0	36	41
Pinus echinata	'Local	13	26	54	8.6	11.0	23	8.4	9.5	40	44
Pinus monticola	Unknown	70	26	53	1.7	3.7	13	3.3	5.1	19	24
Pinus palustris	Pender Co., N. C.	20	24	80	.2	.6	30	6.4	9.5	34	42
Pinus pungens	Mt. Mitchell, N. C.	36	23	92	1.9	3.1	4/	6.4	7.0	31	36
Populus deltoides	Local	126	25	54		8.6	(67)	2.4	4.4	24	28
Quercus montana	Local	27	24	81	2.8	1.7	67			13	33
Rhamus purshiana	Roy, Wash.	10	26	70		2.0	60	1.3	4.0	6	14
Rhamus purshiana	Roy, Wash.	10	26	70	1.2 1.3	2.8	20	1.1	1.9	15	18

1/ Evidence indicates that some of the stems now present are of sprout origin. Chestnut blight cankers are present on most of the individuals.

2/ All existing stems are of sprout origin and show evidence of infection by the chestnut blight fungus.

3/ The two species of Cornus are shrubby and have spread on the plot until it is impossible to make accurate observations on the original stems.

4/ This plot contains several individuals of P. alba which apparently were introduced in planting. Measurements are based on a selected sample. Numerous stems are present from root suckers of both species.

Table 3.--Unsuccessful plantings in the Bent Creek Arboretum

Species	Seed source	Date planted	Trees planted	Survival and growth to 1932: Survival	Average height	Maximum height	Survival in 1952
		Year	No.	Percent	Feet	Feet	Percent
Arbutus menziesi	unknown	1929	3	0	--	--	0
Castanea crenata 1/	Unknown	1929	28	3	--	--	0
Castanea dentata	Eastern, N. C.	1928	4	25	--	3.0	0
Castanea mollissima 1/	unknown	1929	26	11	--	--	0
Cercis sp. 2/	Brignoles, France	1929	12	0	--	--	0
Chamaecyparis lawsoniana	Eldorado Co., Calif.	1939	30	47	0.9	1.5	0
Daphne gnidium	France	1929	3	0	--	--	0
Fraxinus oregona	Newberry, Ore.	1930	16	81	.9	1.8	0
Ginkgo biloba	Washington, D. C.	1929	46	0	--	--	0
Larix leptolepsis	Japan	1928	27	37	2.2	6.6	0
Larix occidentalis	Coeur d'Alene Nat'l For., Idaho	1930	19	10	1.6	2.6	0
Pinus attenuata	Eldorado Co., Calif.	1930	84	38	1.6	2.4	0
Pinus caribaea	Louisiana	1927	7	71	5.0	6.7	0
Pinus contorta	Unknown	1927	18	78	1.2	2.9	0
Pinus contorta	Unknown	1926	48	72	1.6	4.2	0
Pinus contorta latifolia	Eldorado Co., Calif.	1930	46	93	.7	1.2	0
Pinus koraiensis	Korea	1929	50	16	1.1	1.9	0
Pinus nigra poiretiana	unknown	1928	21	52	3.4	4.9	2
Pinus radiata	Placerville, Calif.	1929	1	0	--	--	0
Pinus sabiniana	Eldorado Co., Calif.	1930	12	50	2.5	2.9	0
Pseudotsuga taxifolia	Idaho	1929	50	52	.8	1.5	0
Quercus alba 2/	Local	1929	20	0	--	--	0

1/ Plot destroyed by road constraction.
2/ Plot location was not found in 1932 or 1952.

Table 4.--Plantations on the Bent Creek Experimental Forest outside the arboretum

Species	Year planted	Trees planted	Estimated survival	Average d.b.h.	Average height	Maximum d.b.h.	Maximum height
	Year	Number	Percent	Inches	Feet	Inches	Feet
Pseudotsuga taxifolia	1929	108	2 4	--	--	1.5	10
Juglans nigra	1928	245	--	--	--	5.6	34
Liriodendron tulipifera 1/	1928	750	20 75	-- 8.9	-- 63	11.2	42 65
Pinus nigra poiretiana	1928	234	2	--		9.8	41
Pinus resinosa 2/ (A)				7.1	--	7.9	28
(B)	1931	258	20		35		41
(C)	1926	262	30	6.4	31	9.1	
(D)	1926 1927	70	35	5.5	35	7.0	41 40
Pinus sylvestris	1928	966	25	6.0	28	8.3	31
Pinus densiflora	1931	200	30	7.0	34	7.6	36

1/ These plantations were in areas with an abundant natural seed source; therefore, in every instance there are numerous volunteers which complicate any attempts to examine and evaluate the original plantations.

2/ Seed sources: (A) Minnesota
(B) Cloquet, Minnesota
(C) Gerrish, N. H.
(D) Seed source unknown, stock from Mt. Alto, Pa.

The average figures of table 4 are from a selected sample of dominant and codominant individuals thought to be representative of the potential crop trees in each plantation. Where the plantation survival is extremely poor, only maximum individual measurements are stated, as it would be impossible to give a valid average based on such a small sample.

GROWTH OF RED PINE FROM DIFFERENT SOURCES

The plots of Pinus resinosa represent several seed sources and may be considered as a test along with those of the arboretum. Table 5 lists the comparisons of Pinus resinosa from several seed sources. Although variations between individual lots are quite marked, no regional trend is apparent. However, with the exception of the Cloquet source, the New England sources appear superior, especially in height growth. The Cloquet stock may owe its superiority to selection of seed source and not to geographic variability. The seed source information is not complete enough to evaluate this possibility.

Table 5. --Plantings of Pinus resinosa on the Bent Creek Experimental Forest

Location	Seed source	Date planted	Trees planted	Survival 1952	Ave. DBH	Max. DBH	Ave. hgt.	Max. hgt.
		Year	No.	Percent	Ins.	Ins.	Ft.	Ft.
Arboretum	Essex Jct., Vt.	1926	100	21	6.2	8.4	32	38
Arboretum	Glenn, Minn.	1926	100	19	5.7	7.4	27	35
Shut-in ridge	Cloquet, Minn.	1926	262	15	6.4	9.1	35	41
Shut-in ridge	Gerrish, N. H.	1926	364	1/ 30	4.8	7.7	31	41
Arboretum	Vermont	1927	140	27	7.5	10.6	39	47
Arboretum	Michigan	1927	36	14	7.0	7.9	28	33
Shut-in ridge	Unknown 2/	1927	70	1/ 35	5.5	7.0	35	40

1/ Survival percentage estimated because some of the plot boundaries could not be accurately located.
2/ Planting stock from nursery at Mt. Alto, Pa.

RECENT PLANTINGS ONTHEEXPERIMENTALFOREST

In the spring of 1951, a field test of Pinus resinosa was instituted with the planting of 6000 seedlings, 3-0 stock, produced from seed collected

in 1939 on the Chippewa National Forest, Minnesota, at an elevation of 1300 feet.

In 1949, another planting was made of 3900 Picea abies, 2-2 stock, as a Christmas tree plantation. The stock was furnished from the U. S. Forest Service nursery at Parsons, West Virginia; To date, survival and growth have been good. Some harvesting of small trees should begin in 1953.

Twenty-five seedlings of Metasequoia glyptostroboides were planted at the Bent Creek Experimental Forest in 1950. These-seedlings were provided by Mr. Ralph W. Chaney, of the Museum of Paleontology, Berkeley, Calif. The seeds were collected in western Humpeh, central China in 1948. 'At the end of three growing seasons, 20 seedlings have survived and have an average height of 1.4 feet with a maximum of 2.8 feet.

In 1951 a test planting was made of two pine hybrids produced at the Institute of Forest Genetics, Placerville, California. The seedlings were transplanted to the field after 9 -months in greenhouse flats.. Plot B was again transplanted at the beginning of the third growing season in the field. Table 6 contains a summary of the measurements of all seedlings at the end of two growing seasons in the field.

Table 6.--Survival and growth of hybrid pines

Hybrid and parents	Plot A			Plot B		
	Survival 1/	Ave. hgt.	Max. hgt.	Survival 2/	Ave. hgt.	Max. hgt.
	Percent	Ft..	Ft.	Percent	Ft.	Ft.
Pinus rigida x Pinus taeda	65	1.4	2.3	88	0:9	1.8
P. rigida (parent)	67	(3/)	--	100	.5	.9
P. monticola x P. strobus	76	.4	.7	--.	--	--
P. monticola (parent)	38	.3	.6	--	--	--
P. strobus (parent)	57	.4	.6	--	--	--

1/ Survival after 2 years in the plantation.
2/ Survival 1 year after second transplanting, based on number transplanted,
3/ Trees not sufficiently erect to permit height measurement.

It appears that the hybrid stock of Pinus monticola x Pinus strobus is not' superior to the native P. strobus, though it is superior to its parents. A cross is now planned between native P. strobus from the Southern Appalachians and P. monticola. Pollen for this hybrid has been collected at the Bent Creek Experimental Forest and forwarded to Placerville for breeding purposes.

CONCLUSION

In conclusion, it appears that only about ten introduced species approach the native species in vigor and growth. Of these, three seem worthy of further investigation. The first, Chamaeyparis thyoides, (see figure 1) is subject to a root and butt rot in the arboretum, but on other sites it may prove satisfactory. If this disease is controllable, the species may be valuable for planting wet and poorly drained sites. The second and third species are Pinus taeda (figure 2) and Pinus rigida var. serotina. These two species are superior to any other of the test plantings and may in themselves be valuable for planting or for breeding purposes in the Southern Appalachians.

Several other species such as Picea abies, Picea glauca, Pinus resinosa (figure 3), Pinus densiflora, and Thuja occidentalis (figure 4) may not be valuable for forest planting, but adaptability to the area has been demonstrated to date, thus offering potential qualities for the forest geneticists to consider.

Figure 1.--Atlantic white-cedar (Chatnaecyparis thyoides), age 26 years. Maximum height 55 feet, maximum d.b.h. 8.7 inches. Note mortality due to Fomes annosus.

Figure 2.--Loblolly pine (Pinus taeda), 23 years old. Maximum height 62 feet, maximum d.b.h. 14.1 inches.

Figure 3. --Red Pine (Pinus resinosa), 26 years old. Maxima height 47 feet, maximum d.b.h. 10.6 inches.

Figure 4. --Northern white-cedar (Thuja occidentalis), age 27 years. Maximum height 41 feet, maximum d.b.h. 9.6 inches.