PITCH PINE: A LITERATURE REVIEW[1]

John H. Fryer and F. Thomas Ledig[2]

Pitch pine (*Pinus rigida* Mill.) is the only native hard pine which occurs over most of the Northeast. It has some significant advantages over many of the pines which have been introduced into this region. It is frost resistant, relatively pest resistant, and remarkably drought and fire resistant. Pitch pine is well-adapted to the infertile soils which typify many pine sites in the Northeast, and offers a strong, durable general purpose building timber, with some potential for pulping.

On the debit side, pitch pine is characterized over much of its range by poor form and its rate of growth declines at an early age. To what extent these characteristics are governed by genetic factors and what improvements are possible by genetic means, are unanswered questions.

This review is a brief summary of those aspects of pitch pine directly or indirectly relevant to the genetics of this species, and particularly to genetic improvement.

TAXONOMY

Pinus rigida was first described in 1768 by Miller, an English botanist and taxonomist. It has been known under the synonyms P. *frazeii* Loddiges, P. *Loddigesii* Louton, P. *canadensis trifolia* Du Hamel, P. serotina Long, P. *taeda* var. *rigida* Aiton, and probably many others (Dallimore and Jackson, 18; Gordon, 1958). Common names for this species (in addition to pitch pine) include black pine, black Norway pine, hard pine, longleaf pine, longschat pine, rigid pine, seep pine, torch pine, and yellow pine (Dallimore and Jackson, 1948; Illick, 1921).

According to Shaw's (1914) classification, P. *rigida* was placed in the subgenus *Diploxylon,* subsection *Pinaster,* group Insignes -- the closed cone pines. The reason for its position in this group was not entirely sound but was based on its close relationship to pond pine (P. *serotina* Michx.), a species with serotinous, or closed, cones. More recently, Duffield (1952) reclassified the subgenus and included P. *rigida* in group XI, based on crossability patterns and similarities in oleoresins. Other members of this group were P. *caribaea* Morelet, P. *palustris* Mill., P. *echinata* Mill., P. *taeda* L., P. *glabra* Walt., P. *occidentalis* Sw., and P. *serotina* Michx. A new classification by Critchfield and Little (1966) retains essentially the same grouping under the subsection *Australes* Loud. but includes P. *pungens* Lamb., P. *elliotii* Engelm., and P. *cubensis* Griseb. in addition to the species of Duffield's group XI.

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[2] Respectively: Graduate student and Assistant Professor of Forest Genetics, Yale University, School of Forestry, New Haven, Connecticut.

SUBSPECIES OR VARIETIES

The number of named varieties is often indicative of the genetic variation in a species. Though pitch pine exhibits a variety of form and grows over a wide range of adverse sites, it has no recognized varieties. However, varieties are difficult to define in the absence of intensive study and testing, and pitch pine has never been the object of a rigorous provenance experiment.

At various times, pond pine was considered a variety of pitch pine and until recently was included by Harlow and Harrar (1953) as P. *rigida* var. *serotina* (Michx.) Loud. in their dendroloxy text. A globose form of pitch pine was named *P*. *rigida* forma *globosa* based on the occurrence of one individual (Allard, 1940).

RANGE AND HABITATS

Pitch pine has a broad latitudinal range, occurring from extreme southern Quebec to northern Georgia, and from the Atlantic Coast to the Cumberland Plateau in Tennessee and Kentucky (see map in Fowells, 1965). From Maryland southwest it is restricted to the mountains and the western edge of the Piedmont. This covers an area of half-a-million square miles, but the distribution tends to be very patchy or discontinuous and extensive stands are found only in the northeastern portion of its range on the Coastal Plain or on glacial outwash plains. Range maps have indicated outliers in western Kentucky, but it is uncertain whether native pitch pine now occur in these areas. In addition, it has been rumored to occur along the coast as far north as southwestern New Brunswick (Morton et al., 1961).

While pitch pine tolerates a wide variety of climates, it appears to prefer high humidity and well-distributed rainfall. It is commonly restricted to the less-fertile sites, particularly sandy or gravelly soils, shallow soils, and rocky outcrops. In the northeastern portion of its range (Maryland, Delaware, New Jersey, New England, and eastern New York), it is found almost exclusively on glacial outwash plains and coastal sands. West of this area it is most common on the shallow soils of ridges and on dry southern exposures. It endures a wide variety of soil moisture conditions, from excessively drained to swampy. However, though it may grow adjacent to stands of Atlantic white cedar [*Chamaecyparis* *thyodes* (L.) B.S.P.1, it is generally considered a xeric species.

Pitch pine is not common on better sites, though it is known to grow well under good conditions. Its absence from such sites appears to be due to its strong intolerance of hardwood competition and possibly a requirement for fire for successful regeneration. In all mature stands which we have observed, pitch pine is rapidly replaced by hardwoods if fire has been excluded.

BIOGRAGRAPHY

Like other species of the Northeast, the distribution and evolution of pitch pine was profoundly influenced by the Wisconsin and earlier glaciations. Fossil and pollen deposits indicated that pine is probably now as far north as it has ever been in its history (Mirov, 1967). The adaptation of pitch pine to coastal plain soils enabled it to migrate north on the sterile outwash plains left by retreating glaciers, and made it well-suited to prolonged succession on these sites in the presence of fire.

Refugia for pitch pine probably existed relatively near the glacial front. The continental shelf off New Jersey and Maryland, exposed by a drop in the ocean level, may have served as a source of pitch pine for post-glacial migration northward. Migration occurred along the Coastal Plain and up the river bottoms of New England, particularly through the Hudson, Connecticut, and Merrimac River valleys. Another and more probable refuge was the foothills and slopes of the southern Appalachians. Migration northward was predominantly along the ridges through Pennsylvania and western New York. Speculation upon variation in pitch pine due to the original source of migration and subsequent evolution could be endless, but largely fruitless in the absence of experimental evidence.

HYBRIDIZATION

Natural Hybrids

Pitch pine is generally acknowledged to form natural hybrids with shortleaf (P. *echinata* Mill.), pond, and loblolly (P. *taeda* L.) pines, and putative hybrids with table-mountain pine (P. *pungens* Lamb.) are suspected (P. E. Smouse, personal communication). The occurrence of hybrids between pitch pine, on the one hand, and pond and loblolly pines, on the other, was described in detail by Little et al. (1967). A current investigation of the extent of natural hybridization and introgression between pitch and loblolly, pond, and shortleaf pines is being conducted by P. E. Smouse and L. C. Saylor at the School of Forest Resources, North Carolina State University, Raleigh.

Pitch pine is sympatric with pond and loblolly pines over only the extreme southeastern portion of its range, but a broad and extensive zone of inter-gradation between the species seems to occur in eastern Maryland and Delaware. A gradation between pitch and pond pines was reported in New Jersey (Clausen, 1939), but it is not certain whether this is the result of recent hybridization or of incomplete speciation. Smouse (personal communication), at this time, believes the influence of introgression from pond pine can be detected throughout the extensive stands of pitch pine in New Jersey, north to an area near the city of New Brunswick.

Pitch and shortleaf pines occur sympatrically over a large area. The hybrid between the two has frequently been inferred (Austin, 1929; Illick and Aughanbaugh, 1930; Little and Somes, 1951), but never subjected to a thorough investigation, to our knowledge.

There appears to be no substantial phenological barrier against hybridization between pitch pine and any of the other four species with which hybridization is suspected. At the middle of their latitudinal range, all have maximum pollen shed and female receptivity in the second and third weeks of May (Fowells, 1965).

Controlled Hybrids

The first artificial hybrid of pitch pine, P. *rigida* X P. *taeda,* was made in 1933 at the Institute of Forest Genetics, Placerville, California, and was back-crossed to pitch pine in 1942 (Liddecoet and Righter, 1961). Successful hybrids have been produced at the Institute with pond and shortleaf pines (Little and Somes, 1951).

Needle anatomy of hybrids between pitch and loblolly pines was on the whole intermediate, while the characteristics of pitch and pond pine hybrids resembled those of pitch pine rather closely (Keng and Little, 1961). Botanical descriptions of all these artificial pitch pine hybrids have been published (Little and Righter, 1965). In at least one case, it was reported that the pitch pine parents originated from seed collected in southern New Jersey and in another, that it was a closed cone form. Therefore, it may be assumed that the pitch pine used for controlled hybridization could have been affected by introgression from pond pine.

The pitch and loblolly pine hybrid has been produced on a mass scale in Korea where it was given the binomial XP. rigitaeda (Hyun and Ahn, 1959a). Over many years, between 11,000 to 30,000 pollination bags have been placed in 10- to 14-year-old pitch pine plantations. From 2 to 3 bags were mounted on each tree, mainly in the upper crown. Up to 20 sound seeds per cone, representing about 30 percent of the total seed, have been obtained in some years (Hyun and Ahn, 1959a; Hyun, 1962a, b). The Korean hybrids were intermediate between their parents in needle characteristics (length, width, fascicle sheath length, and color) and in speed of germination and cold-hardiness. Cone and seed characteristics resemble those of pitch pine (Hyun and Ahn, 1959b) while tracheid length was closer to that of loblolly pine (Koo and Hung, 1967). The karyotype of the hybrid was investigated by Kim (1963). Backcrosses of XP. rigitaeda to loblolly pine are distinctly less cold-hardy than the F_1 hybrid (Hyun and Koo, 1965).

A putative hybrid of pitch and Monterey (P. radiata D. Don) pines has been produced by the Korean Institute of Forest Genetics at Suwon. When first attempted, the cross was very fertile (Hyun, 1956), yielding 30 percent viable seed, but in subsequent trials proved more difficult, giving only 3 percent, or less, sound seed (Hyun et al., 1967). Investigations of reproductive cytology indicated a complete breakdown of nucellar development and pollen tube growth in most cases (Hyun and Yim, 1964) with an occasional fertilization followed by difficulties in the zygotic stage (Hyun and Lee, 1964). The surviving hybrids were intermediate between their parents in cone, seed, and needle characteristics (Hyun et al., 1967). Though reported as cold-hardy and more rapidly growing than pitch pine, personal communication with S. K. Hyun indicates that the hybrid is apparently of little promise. It is of major interest because it is a hybrid between members of two separate subsections or groups under the classification of Critchfield and Little (1966) or that of Duffield (1952). This hybrid forms the only verified link between subsections Australes Loud. and Oocarpae Little and Critchfield.

Other apparently successful attempts at controlled hybridization were the cross of pitch pine with Japanese red pine (P. densiflora Sieb. et Zucc.) of subsection Sylvestres Loud. and with slash pine (Ahn, 1963).

The suitability of some of the pitch pine hybrids for afforestation has been investigated in the field. The hybrid with pond pine was very similar to pitch pine in form and growth rate and the shortleaf X pitch hybrid was of poorer form and growth than the shortleaf parent (Little and Righter, 1965). In outplantings of the early pitch X loblolly hybrids in Korea and Illinois, they were superior to pitch pine in growth and form and were frost-hardy (Hyun, 1956; Lorenz and Spaeth, 1953). They did not grow as rapidly as loblolly pine, but loblolly failed to survive or was badly damaged by the severe winters in both regions. Pitch X loblolly hybrids planted in Maryland and New Jersey were not improved over native pitch pine, but Little[3] attributed much of this performance to poor selection of

[3] Little, S. 1969 Progress report on breeding work with pitch and loblolly pines at New Lisbon, New Jersey. Unpublished report on file at the Northeastern Forest Experiment Station, Upper Darby, Pennsylvania. 16 pp.

parent trees. In Mississippi 6-year-old pitch X loblolly from unknown parental sources were relatively slow growing even compared to the pitch pine parent (Schmitt, 1968). Performance was also poor for hybrids of pitch pine from New Jersey with pond pine from Florida and for a double cross of (pitch X loblolly) X (shortleaf X loblolly) in the plantation reported by Schmitt.

Currently, S. Little, of the Northeastern Forest Experiment Station, and I. F. Trew, of Westvaco, Inc., are engaged in a program of selection and subsequent hybridization in loblolly and pitch pines. A grafted orchard has been established in New Jersey with 30 clones each of phenotypically superior loblolly pine from Delaware and Maryland and pitch pine from Virginia northward (Little, 1965). The orchard was designed for the purpose of facilitating controlled hybridization and not for the natural exchange of pollen between the two species. Some initial pollinations were made in 1968 and outplanting trials are planned[4]. The objective is: "to produce a source of high-quality, locally adapted pines for most sections of the Northeast" through hybridization[5].

REPRODUCTIVE CHARACTERISTICS

The life history of pitch pine is a typical pine cycle. In fact, the classic work by Ferguson (1904) used pollen grains, ovules, and fertilization in pitch pine to illustrate the life history of Pinus. Chromosome morphology (2n = 24) is similar to that of other pines (Kim, 1963).

Apparently, pitch pine is a strongly outcrossing type and suffers pronounced inbreeding depression (classed as "self-sterile" according to Wright, 1962). Wright pictures progeny of selfed pitch pine as weak and decidedly inferior to wind-pollinated progenies. In an attempt to induce male sterility in order to facilitate a program in mass hybridization, Hong (1963) tested the effect of many growth regulators on the development of the male gametophyte. None was successful for the purpose desired.

Pitch pine tends to be more precocious than most pines. Young seedlings, one as early as 12 months from seed, have borne female strobili in the field (Namkoong, 1960; Andresen, 1957). Vigorous stump sprouts may bear cones after 4 to 5 years, but stems from seed origin usually do not bear mature cones in any quantity until 8 to 12 years of age. However, we have observed a great deal of variation over the range of pitch pine. On Cape Cod, Massachusetts, it was common to observe seedlings which were less than 6 feet tall but carrying over 50 cones, whereas most trees nearly 70 feet tall in Georgia showed little evidence of present or previous cone crops. Coning has an irregular periodicity, but there is probably a good crop every 3 years on the average (Fowells, 1965).

Pitch pine may produce two whorls of cones per year. Such observations are fairly common in the Pine Barrens of New Jersey, but it is not known what the yield of viable seed might be from the second whorl, which presumably was receptive after most pollen had been shed.

[4] Little, ibid.

[5] Little, S. 1964. Master plan for breeding and testing pitch-loblolly pine hybrids, selected loblolly pines, and selected pitch pines. Unpublished report on file at the Northeastern Forest Experiment Station, Upper Darby, Pennsylvania. 26 pp.

Some pitch pine bear serotinous cones. Serotinous cones are those which remain closed for at least one year after maturity and may require fire or high temperatures for opening (e.g. Critchfield, 1957). Pitch pine from the Pine Plains of New Jersey (an area repeatedly subjected to hot fires over many centuries and, in general, supporting trees much less than 12 feet tall) are entirely or almost entirely serotinous. Serotinous-coned types are frequent throughout New Jersey, Long Island, and Cape Cod, although their relative proportion in the population is not known but is obviously variable. It has been hypothesized that serotiny in these regions is an adaptation to the high frequency and severity of forest fires. However, it may actually reflect long-continued introgression from pond pine. We have observed no evidences of serotiny in any other portions of the range, including areas such as the Albany-Schenectady Sand Plain on which severe fires have been frequent for many generations. The degree or mode of inheritance of the serotinous cone habit is unknown; according to Jack McCormick, a lifelong student of the Pine Barrens:

> "...no one has planted an open-cone pitch pine and a closed-cone pitch pine side by side to see what would happen. Nor has anyone cross-pollinated open- and closed-cone pines. We don't know which is dominant. We don't know what a hybrid would do. We don't know a God-damned thing." (in McPhee, 1968).

In addition, reproductive phenology of pitch pine has not been investigated over much of its range. In the middle of its latitudinal range, male strobili appear at the end of April, female strobili in early May, and pollen is shed about the third week in May (Dorman and Barber, 1956; Fowells, 1965; Schaeffer, 1949). Seed dispersal usually begins in November, but at least in Pennsylvania, only 10 percent of the cones open prior to 1 January (Perry, 1922). Seed yield is 12 ounces per bushel or 2 to 3 pounds per 100 pounds of cones and averages 62,000 seed per pound (U.S. Forest Service, 1948).

In a series of publications, Mergen and co-workers have reported the effects of ionizing radiation on reproductive potential of stands, germination of seed, cytology and growth of seedlings of pitch pine, and the effect of seed handling on the results of irradiation treatment (Mergen and Stairs, 1962, 1963a, b; Mergen and Johansen, 1964; Mergen and Cummings, 1965; Mergen and Thielges, 1966). These reports have demonstrated a retardation in reproductive phenology, an increase in aberrations of both reproductive and chromosome morphology, an increase in pollen abortion or decrease in pollen germination, a depression in seed germination and a reduction in hypocotyl length, a high mortality of vegetative primordia and an initial increase in sprouting, and many morphological abnormalities attributable to the lethal effects of irradiation on cells. This information on the effect of radiation on reproductive characteristics would be basic to programs concerned with the production of mutants through irradiation.

VEGETATIVE PROPAGATION

For any species which is to be utilized in tree improvement, the production of clonal stock is of considerable interest. Percentage rooting from cuttage with pitch pine declined with age of the ortet, and cuttings from the lower third of the crown had a higher rooting ability than those from the upper crown in the study of Hyun and Hong (1968). The authors also found that cuttings collected early in the growing season (March and April for greenhouse stock) had far superior rooting ability than that of cuttings collected later.

There is much variation among trees in their ability to yield rooted cuttings at a given age and physiological and biochemical differences have been demonstrated between easy- and difficult-to-root genotypes (Yim, 1962; Hyun and Hong, 1968). In these studies, a low nitrogen level was associated with trees which produce easy-to-root cuttings. Difficult-to-root pitch pine showed larger amounts of alanine, leucine, phenylalanine, threonine, valine, and y-aminobutyric acids. These amino acids proved to be inhibitory to root initiation in mung bean. Two growth promoters and two growth inhibitors were extracted from pitch pine and the relative amount of these substances in cuttings and the balance and interaction between them were considered by Hyun and Hong (1968) to be one of the important factors causing the difference in rootability among trees.

Pitch pine has a remarkable ability to produce sprouts from dormant buds after fire and logging. This may be the most important factor contributing to its fire resistance. Stumps from 20- to 30-year-old trees seemed to produce the greatest number and most vigorous sprouts (Fairbrothers and Andresen, 1957). Of cuttings from succulent stump sprouts of a 30-year-old tree, 66 percent rooted (after treatment with Hormodin No. 3), but no rooting occurred if the sprouts had hardened-off (Santamour, 1965).

Grafting of pitch pine is relatively uncomplicated and may be carried out in the field using side or cleft grafts. The scion should be protected with polyethylene bags and kraft covers. Little[6] has noted much less incompatibility and overgrowth in grafted pitch pine than in loblolly pine in the same orchard. Scion material stored well at 0 to 5°C for up to two months and preliminary investigations indicated that success in grafting is associated with a high C/N ratio in the scion material (Choi, 1967). Heteroplastic grafting of pitch pine has been carried out successfully with loblolly, Japanese red, Japanese black (*P. thunbergii* Parl.), and Korean (*P. koraiensis* Sieb. et Zucc.) pines as stock and has served as a rootstock for the latter three plus slash pine (Mergen, 1954; Choi, 1967; Little[7]).

GENETIC STUDIES

What can be said about genetic variation in pitch pine? Actually very little at this moment. Pitch pine does grow under a wide range of photoperiods, edaphic conditions, and minimum winter temperatures, to name only a few environmental influences. It is highly conceivable that there is adaptation to these factors. Form and growth rate vary from the excellent stands of 80+ feet in Pennsylvania to the stunted hedges of Long Island and the New Jersey Pine Plains. Andresen's (1959) study suggested that the dwarf form of trees from the Pine Plains was merely a result of environmental modification, a pseudo-nanism. Illick (1919) 50 years ago recognized the fine form of pitch pine native to the Michaux State Forest in Pennsylvania and advised it as a seed source for reforestation, but its genetic superiority remains to be proven. The pitch pines of the New England coast are tolerant of salt spray and hence have also been useful as a species for dune stabilization (e.g. Fernald, 1945). Is this tolerance restricted to coastal provenances or could inland sources be used for the same purpose?

[6] Little, *ibid*.

[7] Little, ibid.

The answers to such questions await intensive provenance study. At Yale, we are establishing a range-wide collection of pitch pine. During this fall, cones from about 40 stands, extending from Canada to Georgia, will be collected, and in future years the number of sources will ultimately total 60. A nested sampling scheme will be employed to allow estimation of the effects due to differences among regions, among stands within regions, and among trees within stands. Outplantings are tentatively planned in New Jersey, North Carolina, and Nebraska and additional investigations will be carried out in controlled environment facilities at Yale University. Wood properties are being evaluated in cooperation with the North Carolina State - Industry Cooperative Tree Improvement Program and early results indicated record specific gravities for pitch pine cores (compared to other southern pines) because of high extractive contents.

A small provenance experiment was established in 1966 with 1-2 stock at the Harvard Black Rock Forest, Cornwall, New York (Jack Karnig, personal communication) with additional outplantings at Greenbank, New Jersey, and Petersham, Massachusetts. Four sources, using unreplicated row plots, were included in each planting. Although the planting at Cornwall was wiped out by deer, the other two tests indicated that two Burlington County, New Jersey, sources were superior to sources from Cape Cod and Cornwall.

In general, however, the previous work on pitch pine is so meager that even tentative suggestions on patterns of variation are few. Apparently, needle length decreases from south to north and, perhaps, with increasing altitude as suggested from samples collected by P. E. Smouse (personal communication). Treeto-tree variation in cone size and shape was observed by Perry and Coover (1933) who commented on the uniformity within trees of pitch pine compared to shortleaf pine. Variation in cone serotiny and reproductive maturity has been mentioned above.

Polyploids have been induced in pitch pine by colchicine treatment and they were as inferior as those observed in other members of the genus (Kim et al., 1967). In addition, aberrant individuals have appeared spontaneously in back-cross progeny of P. rigitaeda with loblolly pine and have been subjected to intensive investigation (Hyun et al., 1967). Some of these aberrants were tetraploids and all showed some deformity of leaf morphology or anatomy.

TREE IMPROVEMENT PROGRAMS

In addition to the loblolly X pitch pine breeding program of S. Little and I. F. Trew and the phenomenal hybridization program of Hyun in Korea, 3 states now have grafted orchards of phenotypically superior pitch pine or are planning such orchards. One orchard grafted by the State of Pennsylvania is now several years old, but not yet in production (J. Winieski, personal communication). The State of North Carolina has made some selections and is also establishing a grafted orchard (Jones, 1969). Connecticut has begun selection and eventually hopes to produce superior pitch pine for planting (P. Merrill, personal communication).

Whether pitch pine will ever prove to be of value to tree improvement in its own right, we cannot prophesy, but we nevertheless hope to preserve an adequate sample of this species for future generations of breeders. Part of our motivation is that pitch pine is a vanishing species in many areas; with better fire control, the succession to hardwoods is eliminating it as the over-mature stands fade. The large sand plains are being cleared for suburban development, industrial parks, airports, and thruways. These well-drained soils are ideal for such development. The vast 1,800 square miles of the Pine Barrens in New Jersey are threatened by plans for a huge jetport and an entirely new city to accompany it. Even should these plans fail to materialize, the area can no longer be immune to suburban sprawl, for it lies too close to the urban corridor between New York and Philadelphia. For our part, we will be sad to see pitch pine disappear. It is a tree with character, and is readily recognized by many people. In its way, a twisted and gnarled pitch pine, existing tenaciously on an adverse site, lent a form of picturesque beauty and interest to the landscape.

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DISCUSSION

GABRIEL - How good is that information?

FRYER - It is purely observational.

GABRIEL - If no data is involved, aren't we apt to go away from here with the wrong impression?

FRYER - I know, but even though they haven't been measured, just to look at them, The New Jersey provenances are growing somewhat better than the one from Massachusetts.

GABRIEL - I'm leery of any experiment that is not replicated after seeing the variability that is present in seed beds. You're better off to not say anything unless you have good data because you may impress someone falsely and send them off on a wild goose chase for the rest of their lives.

FRYER - Oh, no! I haven't done that.

TEDIG - I can comment on this. I've seen those tests planted by Jack Karnig, and I believe the only reason that John mentioned them is to indicate that someone did plant out a few seed sources of pitch pine-- for what it's worth. No, you can't say much about it except that the New Jersey material seems to survive pretty well on the top of Black Rock Mountain around Cornwall, N. Y. In addition, although there is no replication of the row plots on any one planting site; the three planting areas; Cornwall, N. Y.; Petersham, Mass.; and Green Bank, N. J.; serve as 3 replicates if you consider this as one experiment. In this case, it is obvious that the Burlington Co., N. J., source does best-- it is consistently superior in height growth.

ELIASON - Dr. Stairs of Syracuse is hybridizing pitch pine with a Florida pine. The pitch pine are located at Saratoga nursery area-- six trees there were pollinated with pollen brought up from Florida from spruce pine -- if we get a hybrid, that would be very interesting. We are collecting the cones this year. If they took, we have some hybrids; if they didn't, we do it again.

LEDIG - I would like to mention that Si Little with, I believe, John Andresen and Jack McCormick, is bringing out a bibliography on pitch pine as a Northeastern Forest Experiment Station Paper. I believe that this has already been submitted to the editor. It will include publications on silvics, utilization, and tree improvement up to 1965.

FRYER - If Dr. Ledig has not approached a lot of you people yet, he probably will. We are very anxiously looking for cooperators to help us collect pitch pine material. Its spread over a long range and difficult to cover. If anyone does know stands that might be suitable for us and would be willing to help us collect cones, we would be very pleased to hear from you.