THIRD ANNUAL REPORT

N. C. STATE - INDUSTRY COOPERATIVE

FOREST TREE IMPROVEMENT PROGRAM

School of Forestry
North Carolina State College
Raleigh

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Third Annual Report

N. C. State - Industry Cooperative
Forest Tree Improvement Program

Introduction

It has been interesting to observe the change in attitude toward forest genetics from an early skepticism, through a period of rather "over-enthusiasm," to a period of what might be termed a realistic viewpoint. Especially during the past two years, the forest industries have accepted forest genetics with an increased realism so that now there is a general attitude which is still enthusiastic, but much more "down-to-earth" than formerly. Some of the early claims, usually based on sketchy knowledge, or made by over-enthusiastic promoters, are now being challenged. However, the potentials of forest genetics as a tool in forestry is now more widely recognized than it has ever been, and the use of genetics in forest management is becoming widespread.

This more natural view of forest genetics will cause a "settling down" of research so that more solid, long-term and well-designed studies will be made. Research results will become increasingly numerous, though they may not always be so spectacular as previously supposed. It would appear that, at out present state of knowledge, the demand for application of genetic principles in forestry has outstripped the fundamental information on which it should be based. This

is true when viewed from the standpoint of application of genetic principles to forestry practices, or from the standpoint of fundamental research necessary as a basis for application of genetic principles. In a number of ways, we do not at present know enough to proceed as rapidly or efficiently as we should like. For example, the establishment of commercial seed orchards has raised many questions regarding the effect of fertilization on flower development, the effect of various management practices on flower development, and the feasibility of holding the orchard trees down to workable size. But this does not mean that we should sit back and wait; it does mean, however, that we must proceed with caution in a manner such as to avoid a headlong rush into a "dead-end alley." We can move forward by using to the maximum, pertinent existing information and by applying our best "educated guess" until the exact facts are available. Such an approach will undoubtedly lead to some errors, but the urgency of using genetic information in forestry now makes some risk well worth taking.

In the past several years, expansion of applied and basic forest genetic research programs has been very rapid. The N. C. State College - Industry Cooperative Forest Improvement Program finds itself working along with other schools, federal research programs, state programs, and industrial programs, each of which is seeking a part of the answer. This cooperative program, which is supported by 12 major

pulp and paper industries[1/] in a six-state area of the southeastern United States, [1/] as well as by the North Carolina Agricultural Experiment Station, has three objectives: (1) advice and assistance to those supporting industries which are applying genetic principles in their forestry practices, (2) basic research on problems necessary for the application of forest genetics, (3) training of students in the field of forest genetics.

The Research Program

The 1958 report, the second of the annual series, stressed the achievements and problems resulting from one phase of forest genetics application; namely, tree selection and seed orchard establishment. The current report will emphasize the status of the basic research of the cooperative program, as well as bring up to date the results achieved in the application and student training phases of work.

Tree Selection and Seed Orchard Establishment. - There has been considerable activity in tree selection during the past year, and our liaison geneticist has been kept busy about two-thirds of the time grading trees for the cooperating companies. During the past year several companies made tree selections for the first time, and others added to their previous year's selections. Every company but one in the program has made tree selections and had trees graded for use in seed orchards.

1/ States in which work is undertaken are Alabama, Georgia, Tennessee, North Carolina, South Carolina, and Virginia. The specific companies are listed on the last page of this report.

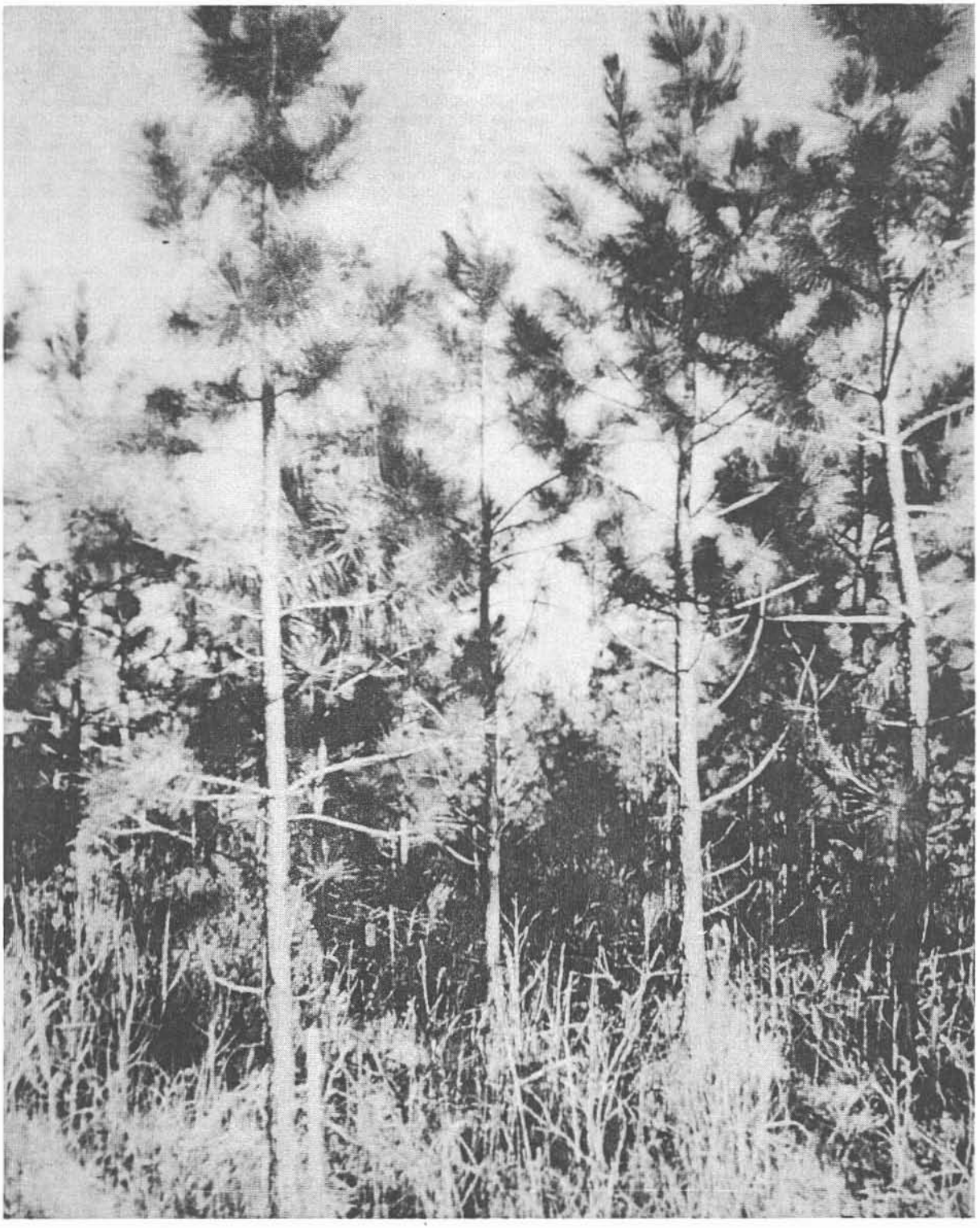
Of the several thousand trees that have been selected, approximately 550 were good enough to warrant detailed grading. About half this number were found to have highly desirable growth, form, and wood characteristics suitable for use in the company seed orchards. Most of these desirable trees have now been grafted into seed orchards, and tests of their genetic suitability have been started.

Seed orchard grafting has proceeded at a rapid pace, being done either by field grafting or pot grafting. Overall, the grafting results have been good; in fact, considerably better than expected. In nearly every case the loss from freezing that was so disastrous to last year's early grafts has been avoided, as each company commenced its major grafting efforts at a later date to avoid the exceptionally cold weather.

Several companies have erected shade houses or plastic greenhouses, enabling them to start grafting earlier than would normally be possible. Those who tried soft-tissue field grafts throughout last summer had surprisingly good success. Adequate shading was found to be the key to success for this type of graft.

The bulk of the current seed orchard requirements of several companies will be completed during the current year. Others have started on a more modest scale and plan to expand throughout a several-year period. In two cases the field grafts have grown so rapidly that cultural methods will need to be initiated next year to "bush them out," giving rounded, wide crowns that should make seed collection simpler, and possibly increase the cone crop per tree.

Shown is one of the highest grading loblolly pines found on industry lands. This tree, growing on lands of N. C. Pulp Co., was also used by Mr. Thorbjornsen in his studies on seed yields and limb volume.



This illustrates difference in limb form and bole shape observable in young plantations. Several studies have been initiated to determine how the characteristics of young trees can be used to estimate those of older trees. Note the fine limbs and straight bole of the tree on the left, and the crooked bole of the tree on the right.

Fundamental Research (General). - In past reports, it has been emphasized that the bulk of the basic research done in this cooperative program has been directly related to wood properties. Other important studies are also being made, as outlined below:

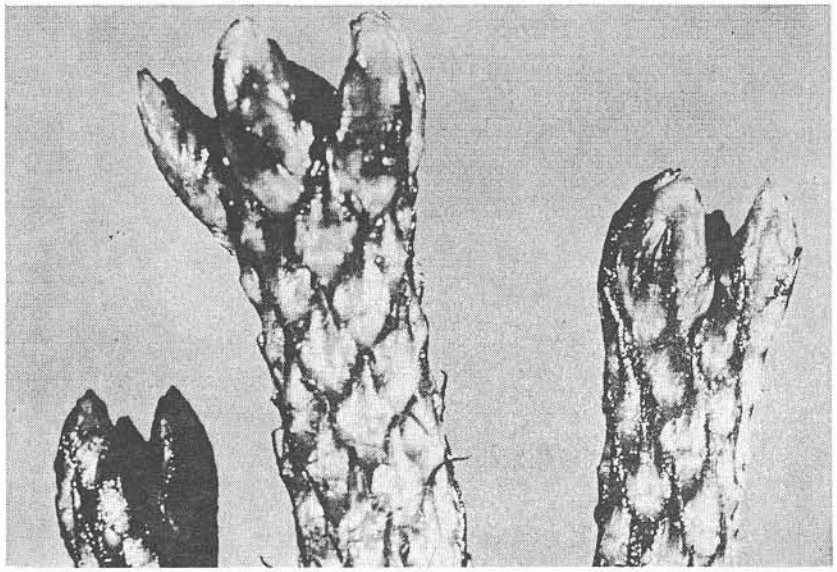
1. The relationship between certain juvenile characters of a tree and its mature characters. - Information is urgently needed on the predictability of mature from juvenile characters. Such information will enable the researcher to observe young trees and predict what they will look like when mature. This will enable early assessment of breeding results or valuation of clones in seed orchards by indicating results in a few years instead of waiting for the full rotation period. Such studies are obviously long-term, but must be started now to get usable results as early as possible. However, these studies could not be expected to yield publishable results in the immediate future.

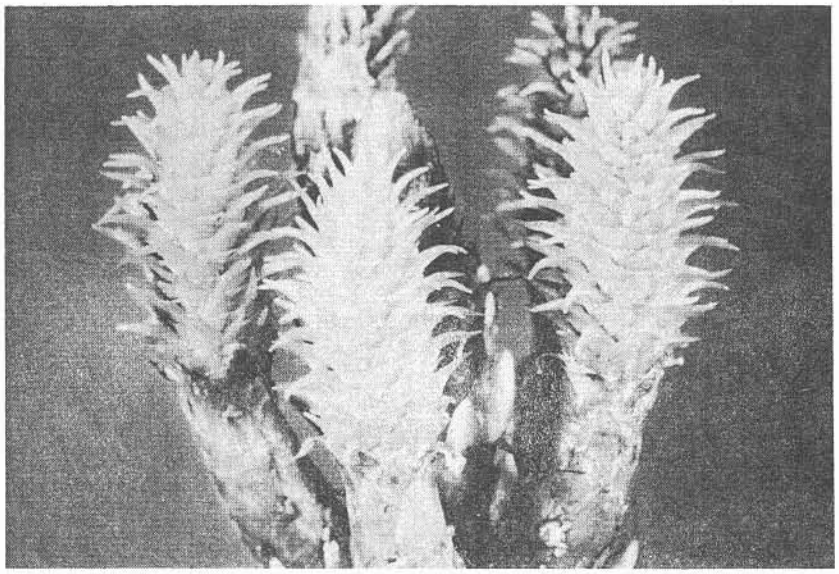
Several research plots to study juvenile-mature relationships have been established. In 1957, with the cooperation of the North Carolina Pulp Company, eight plots containing a total of 800 trees were laid out in the North Carolina Coastal Plain. These were in a mixed 5-year-old slash and loblolly plantation. Two plots of each species were heavily thinned to about 15' x 15' spacing and the other two were left unthinned as check plots to determine the difference in predictability caused by thinning. Each tree on these plots is tagged, and careful records made of its bole straightness, limb size, crown size, natural pruning characteristics, diameter, height and other characters. In future years,

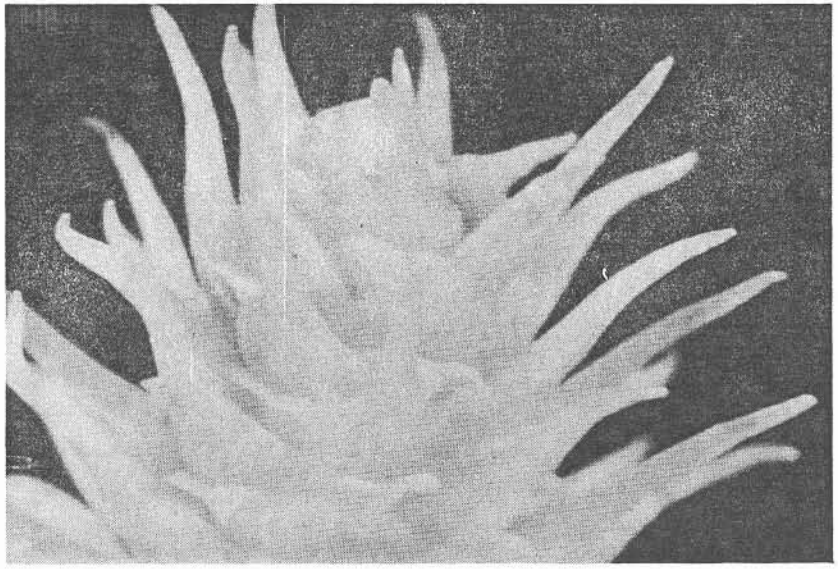
similar measurements will be made to see if the crooked trees are still crooked, the tallest trees still the tallest, etc. In addition to this Coastal Plain study, similar plots were laid out during 1958 on the Piedmont of South Carolina. These plots, established with the cooperation of Gair Woodlands Corporation, were similarly designed as to size and replication, but they were not thinned.

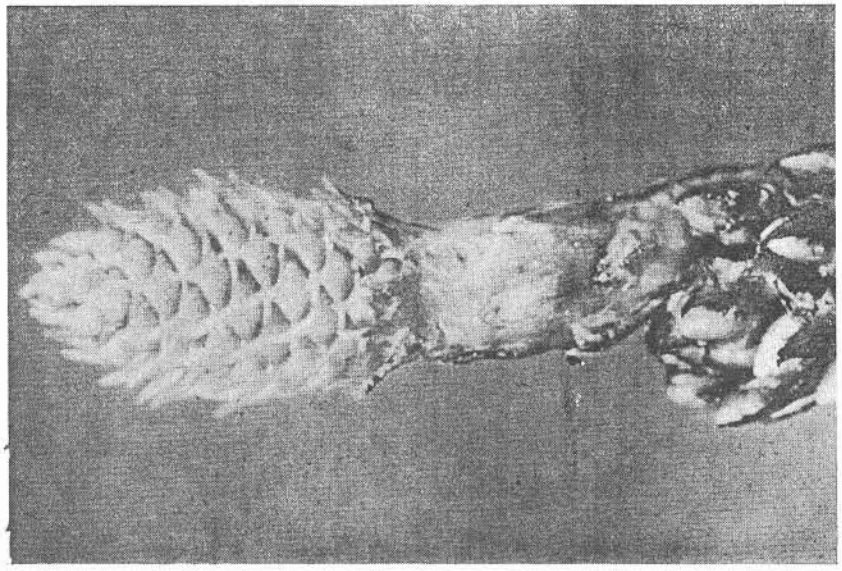
2. Studies on heritability and influence of parent on seedling. Early in 1959, a joint project was started with the International Paper Company Southlands Experiment Forest Group at Bainbridge, Georgia, to make intensive studies on the heritability of various characteristics in loblolly pine, how these characteristics are passed on from parent tree to seedling, and how much prediction of mature characters can be made from seedling characters. This is an extremely ambitious research job, requiring a large area of suitable timber, a very large number of controlled crosses and large acreage of suitable test sites. All these requirements were available at the Southlands Experiment Forest and all field work is being undertaken there, the majority of which is being done by International Paper Company research personnel.

This project is dependent on a complex statistical approach, a half-sib method that will tell what portion of a certain character is the result of environment and what proportion is due to heredity. This extremely complicated study is vitally needed for forest genetics studies; yet, due to its nature and the work involved, we do not know of any other study of this type attempted on loblolly pine.









The study of heritability being made jointly with the International Paper Company, Southlands Experiment Forest, means much controlled pollination needs to be done. These photographs represent various stages in loblolly pine "flower" development: (a) female "flowers" just beginning to break out of buds, (b) in maximum receptivity, (c) enlargement of "flower" at maximum receptivity, (d) conelet following pollination.

Such a project is a mixture of long-term and short-term studies and opens up many new research possibilities. Certain characters will be analyzable within relatively few years, but some characteristics, such as volume growth, will not be known for a number of years. Results obtained from this project will enable construction of a "selection index" which will take much of the guesswork out of our present selection systems.

This project is well underway. Trees on which crosses will be made have been selected and Dr. Cech, at the Southlands Experiment Forest, has already made a number of the needed pollinations.

3. Cytogenetics in Pinus. - Mr. LeRoy Saylor, a graduate student working cooperatively with the School of Forestry and Genetics Department at North Carolina State College, has initiated a study of the chromosomes of pines. He has spent considerable time on techniques and has worked out methods whereby he can accurately count and determine the morphology of the chromosomes of pines.

Basic studies of this type are absolutely necessary for an understanding of an individual species and relationships among species. Such studies will enable us to better know what takes place when two trees are crossed and possibly give hints as to why certain species fail to cross successfully.

4. Pollen flight characteristics. - In the First and Second Annual Reports, mention was made of a study involving pollen flight characteristics. Mr. Robert McElwee is conducting this work as part of the

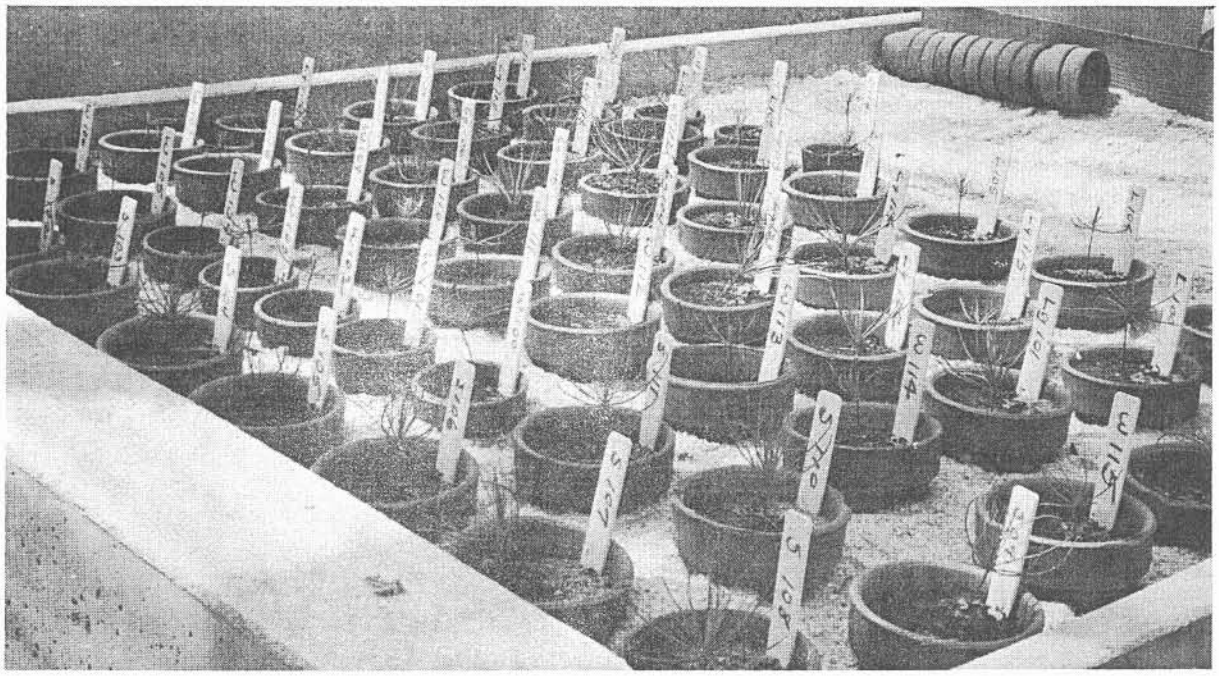
requirement for the advanced degree in Forest Genetics.

McElwee has completed preliminary stages of the study and will soon go into an intensive analysis of pollen flight. This analysis will be done by using radio-active pollen. Because of some hazardous aspects of this type of work, it will be necessary for him to spend one month next year at a special school at Oak Ridge to qualify him for handling certain radio-active substances. After overcoming this hurdle, he will be ready to take his research into the field.

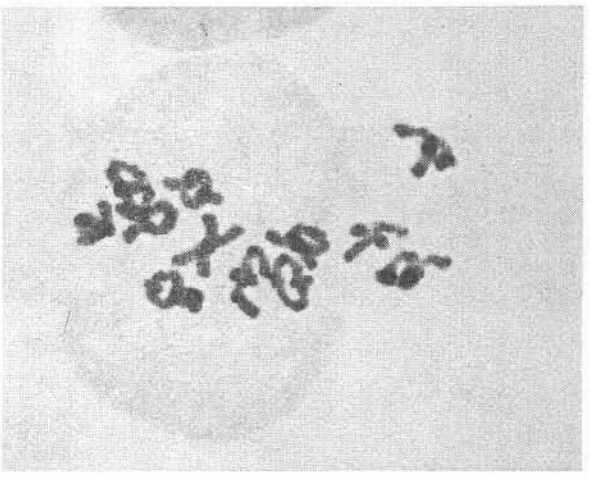
Studies of pollination are essential to understanding the pattern among trees and the evolutionary significance of pollen spread. Of immediate practical importance will be the information obtained on requirements for isolation of seed orchards and seed production areas and on degree of contamination to be expected in our current seed orchards.

5. Variation in loblolly pine. - This May, Mr. Eyvind Thorbjornsen completed his research work for the Ph. D. degree. His studies deal with variation in loblolly pine, especially as to morphological characteristics of seeds, cones, needles and seedlings. Seed physiological characteristics and other characters, such as wood anatomy, are also included. His research will be presented as his Ph. D. dissertation, after which all or portions of it will be published. Thor has found an extreme amount of individual variation in most characteristics, and also regional trends in others.

Studies of this type are essential to our understanding of the species with which we work. His findings will give an indication of



These pines are being grown in the greenhouse to make chromosome studies. They include several species and hybrids. Chromosome studies will be made on the roots by Mr. Saylor.



These are photographs of pine chromosomes. The one showing the long chromosomes are from the loblolly-longleaf pine hybrid (Sonderegger pine). They are termed mitotic chromosomes and are from root tips. There are a total of 24 chromosomes shown. The short chromosomes show the 12 pairs that are present in meiotic divisions. These were taken during pollen formation of shortleaf pine.

what variation we can expect, what possible evolutionary trends have been operating and what usable genetic variation might be present.

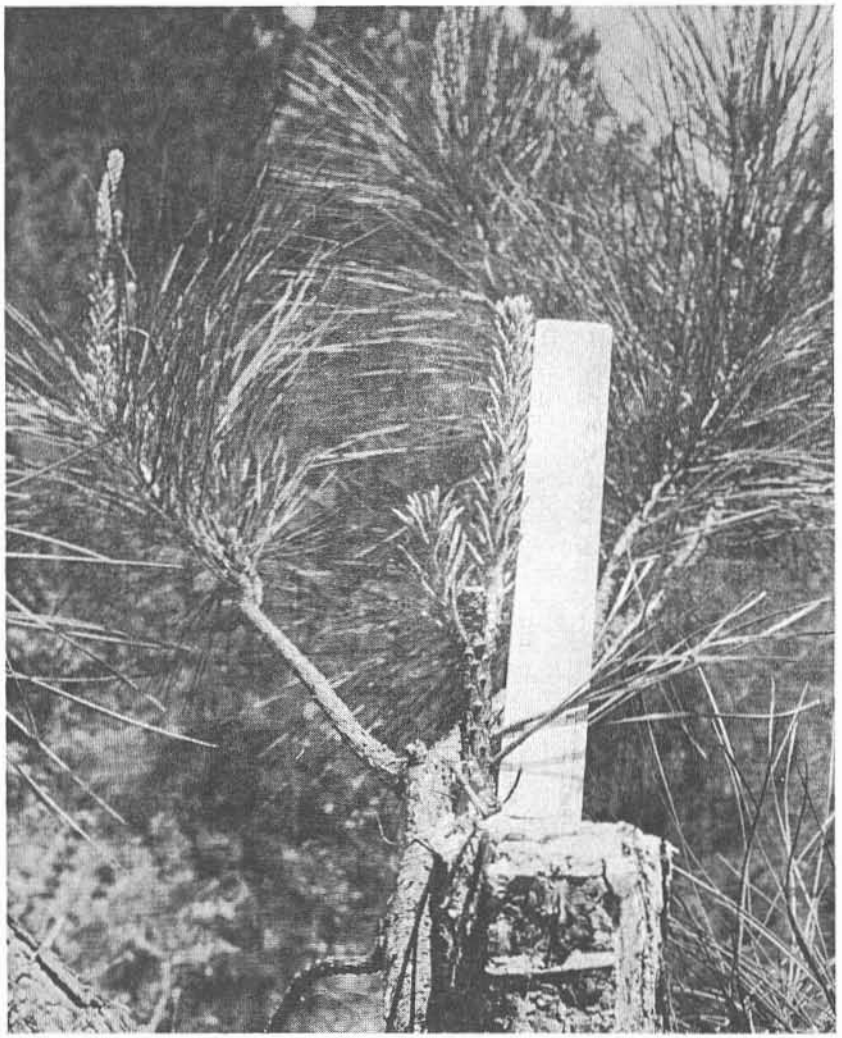
6. Variation of loblolly pine in North Carolina. - In 1958, $550.00 were made available through the Faculty Research and Professional Development Fund of North Carolina State College for a study of natural variation in loblolly pine within the state of North Carolina. Seed were collected on a transect from the coast due west through the sand hills to the western range of this species in North Carolina. Seed and seedlings of this material have already been analyzed by Mr. Thorbjornsen and will soon be reported. Additional seed are now in the Riegel Nursery and next year long-term outplantings will be made at several areas. This study will yield information as to the feasibility of using coastal seed in the piedmont or sand hills and vice versa, and will give an estimate of local variation present in North Carolina. Such information on local variations is essential to proper seed orchard establishment and to future breeding studies.

7. Characteristics of loblolly pine affecting seed yield. - In 1957, Thor became interested in reported results that the "superior" trees produced less seed than ordinary trees. This led into a study of factors affecting the seed-producing ability of loblolly pine. This research project, aided significantly by labor and equipment plus financial assistance from the North Carolina Pulp Company, is now completed. Thor has submitted the manuscript for early publication.

8. Effect of fertilizer on wood properties of loblolly pine. - The current upsurge of interest in the use of fertilizers in forestry and the development of "strains" of trees with special wood properties has prompted a study on the effect of fertilizer on specific gravity, cellulose yields and fiber length. In cooperation with Dr. T. E. Maki, of the School of Forestry at North Carolina State College, research is nearly complete on the effects of various levels of fertilizers on wood eight years following the first of three consecutive annual fertilizer applications. Results of this study will be reported in 1960.

Information on influence of edaphic changes on wood properties is essential to the geneticist. Maximum efficiency may not be achieved by breeding strains of trees for better wood properties if these better properties can be easily achieved by fertilizer applications or if they might be partially offset by the effects of fertilizer. The use of the trees in Dr. Maki's study will allow an early estimate of possible fertilizer effects on wood quality.

9. Best methods of field grafting. - While we have been recommending the use of field grafting in seed orchard establishment, we do not know which of the several recommended methods are best. Therefore, Mr. Charles Webb has begun an intensive study in a four-year-old nearby Halifax Paper Company loblolly pine plantation. He is analyzing several methods of handling field grafts, including evaluation of covers and time of year best suited to make the graft. He is determining temperature



Different types of field grafting are being tried by Mr. Webb. The photo on the left shows one of his test plants where four different covers are being tried. The other photo shows a graft on the stem of an older loblolly pine which had been cut off and grafted in a manner similar to a walnut.

and moisture relations as they affect grafting success, as well as variations due to differential growth rate of the stock plant. Charlie's findings plus results already achieved in field grafting should result in recommendations for field grafting that will consistently raise the graft survival percentage.

10. Methods of controlled crossing in pines. - As time goes on, a great amount of controlled pollination, both between and within pine species, will be required. Mr. Brooks Polk has chosen for his doctoral thesis problem the techniques and physiology of pine hybridization. This work, begun during the current year, has been initiated in North Carolina but will be completed in Missouri, where Brooks is a member of the staff of the School of Forestry. His results should allow us to obtain larger yields of better seeds when crossing pines, as well as obtaining for us a fuller understanding of the environmental factors conducive to higher seed yields. He will also deal with phases of work concerning the reasons why certain species will not cross with each other.

11. Silvicultural relationships. - While obtaining information on selected trees for use in the seed orchard, each tree is classified rather intensively as to a number of its characteristics. Information is obtained on tree form, limb characters, soil characteristics, competition, wood properties and a number of other things. Each tree is classified by county and company lands. All of this information is then put on IBM cards for easy future use.

Some 550 trees have presently been catalogued in the six-south-eastern-state area. A literal "gold mine" of information is being built up that can be drawn on extensively. For example, if one wanted the volumes of the fastest grown 12 to 14-inch trees (or 30-year-old trees, or trees on Site Index 80, etc., etc.) in the Coastal Plain compared to those in the Piedmont, we are in a position to supply them. If one wants to compare wood properties of loblolly and pond pine growing under similar sites, it can be obtained; or, the differences between Virginia pine and loblolly pine growing on the same area. If it is desired to find the effect of deep sands versus clay soils on growth or wood properties, this information can be extracted from our data. Also, much additional related information will be available from data amassed in tree selection and other studies.

Since the trees sampled are the best for each stand, they would not yield average figures, but would indicate what might be expected from "superior" phenotypes under good management.

12. Establishment of a breeding arboretum. - During the past two years, plantations of pine hybrids, exotics and select trees have been established on the school forest in the Piedmont, near Raleigh, as well as on the lands of North Carolina Pulp Company in the Coastal Plain. Although these plantations do not represent a research project as such, they contain material essential for future studies and contain parents of what may in the future be valuable pine hybrids.

Fundamental Research (Wood Studies). - The bulk of basic research time of staff members has been devoted to research on wood properties. All such research has a genetic objective; yet many of the studies deal with nongenetic phases necessary to make the genetic wood studies feasible. Some of the projects on wood are listed below:

1. Variability in specific gravity, fiber length and cellulose yields of loblolly pine. - Several papers have previously been published on findings to date. Field work has just been completed on an intensive and well-designed study which will indicate the geographic and site variability, as well as individual tree differences in several wood characteristics. An analysis will be made of the interrelationships among specific gravity, cellulose yield and fiber length that might be present. These findings will be supplemented by the mass of data previously obtained in the tree selection program discussed under silvicultural relationships.

This paper will be completed early in 1960. In addition, as a service to the individual cooperating companies, it is planned to report to each the variability in specific gravity, and also possibly in cellulose, that occurs on their holdings, broken down by counties when feasible. These individual company reports will not be for general distribution.

2. Presence and properties of core (juvenile) wood. - Early in our studies it became clear that some gross method must be developed to recognize the variation in wood, from center to outside, and from bottom to top, of any individual tree. Accordingly, a study of core wood,

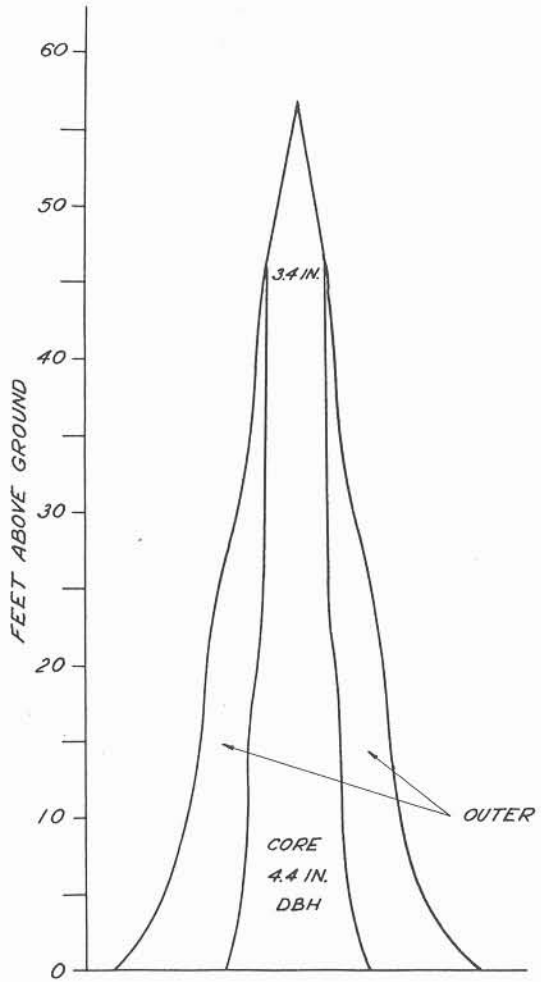
its properties, presence, characteristics and variabilities was undertaken on a wide scale. The information from our own studies plus the information available in the literature, was prepared as a "monograph" on core wood and was presented to the Biology group of TAPPI in New York in February, 1959. This paper will appear in "Tappi" magazine.

No further intensive studies of loblolly core wood will be made. The information obtained is complete enough so that in the future core wood presence can be recognized and taken into account in studies on loblolly pine wood genetic research.

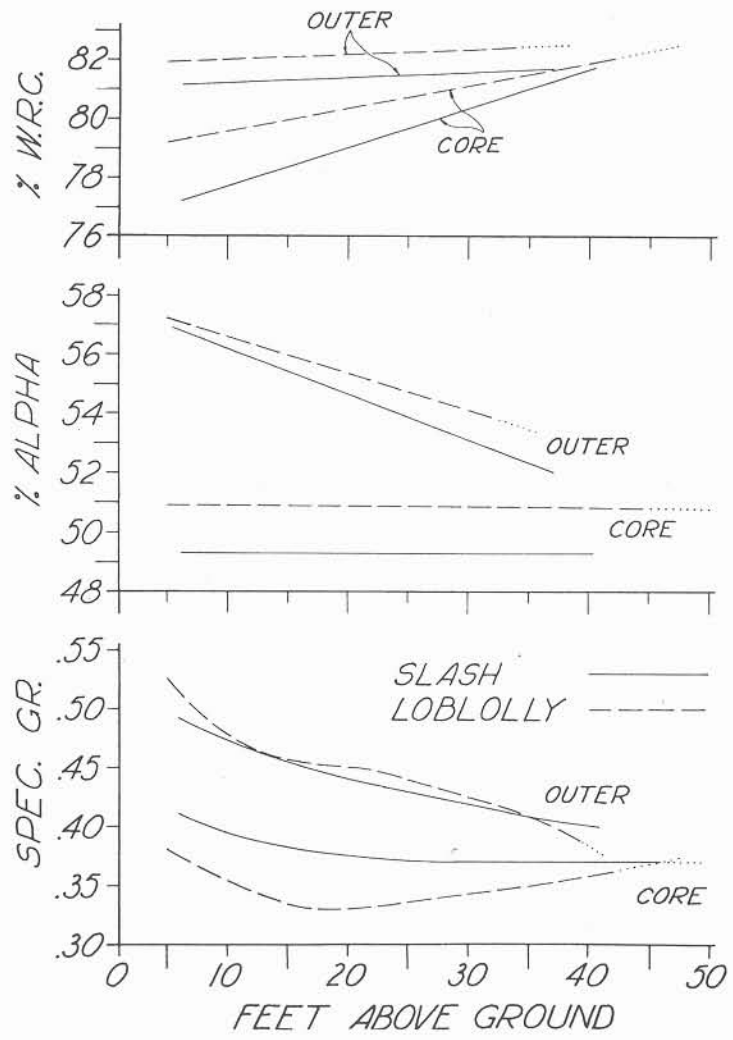
3. Predictive value of breast height increment core samples. -For genetic studies of wood, it is necessary to take small samples from many trees at a standard location in the tree. In the past the standard location has been assumed to be breast height, i.e., 4.5 feet. But do the wood properties at breast height have significance as to the wood properties of the whole merchantable tree bole? If so, then the simple procedure of sampling at breast height is sufficient; if not, a new sampling system must be worked out.

In order to answer this question to our satisfaction, 47 slash pines and 14 loblolly pines were cut down and sectioned. From these dissections, various relationships were worked out. Our data show that the method of sampling at breast height is satisfactory for specific gravity and WRC, 1/ but not as accurate for alpha-cellulose. Other researchers

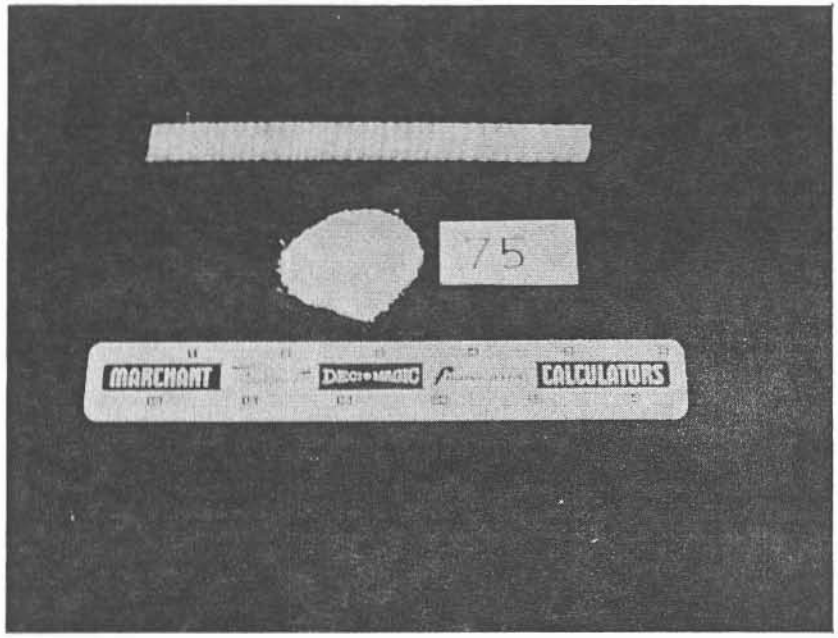
1/ Water-resistant carbohydrates, similar to hollocellulose.

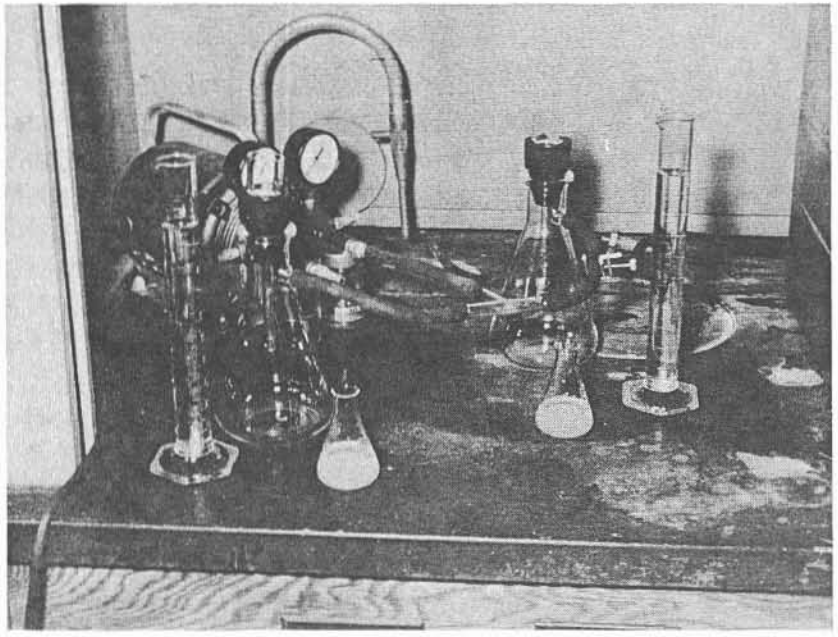


In order to make genetic studies on wood properties, it was necessary to study variations within a tree. This diagram shows the actual diameter of core wood from base to top of tree. Data was based on sampling of 14 loblolly pines every 2 feet from stump up.



Much of the basic research done has dealt with variation in wood properties. These graphs, reproduced in one of our publications, shows the change in wood properties from base to top of tree for both core and outer wood for slash and loblolly pine.





This series of pictures show three steps in the "micro" analysis of cellulose:(a) An over-size (11 mm) increment core is ground and put through a 20-mesh sieve; .75 gm. of this material is used. (b) Thirty samples are chlorited at one time under exactly the same conditions. (c)After the chlorite treatment, the samples are filtered and dried to determine the cellulose content. It takes approximately 7 hours to determine this step of cellulose determinations for 30 specimens.

working on the same species have reported similar results for specific gravity and fiber length.

The manuscript for the paper reporting our results is complete and has been submitted for publication.

4. Variations and inheritance of fiber characteristics of loblolly pine. - During the past year, Mr. Floyd Goggans has started work on his Ph. D. degree. His research problem will deal with the variability and inheritance pattern of fiber characteristics, chiefly fiber length and tracheid wall thickness. His study will show the tree-to-tree differences, the differences due to site and the geographic differences, if any. From trees of known parentage he hopes to get some estimate of the inheritance pattern of these wood characters.

Such a study will be invaluable as a guide to the selection of trees with desired wood. It will be of a great deal of interest to the pulp industries and may serve as a guide for their operations. This information on fiber characteristics, correlated with data already available on specific gravity and cellulose, should make our understanding of wood qualities and breeding for wood qualities much clearer.

5. Effect of bole straightness and knots on compression wood. -Mr. Earl Haught completed the thesis for the Master's degree in 1958. His preliminary findings were indicated on page 7 of the Second Progress Report and final results are reported in his completed thesis. He found that spiral or crooked trees have significantly higher proportions of

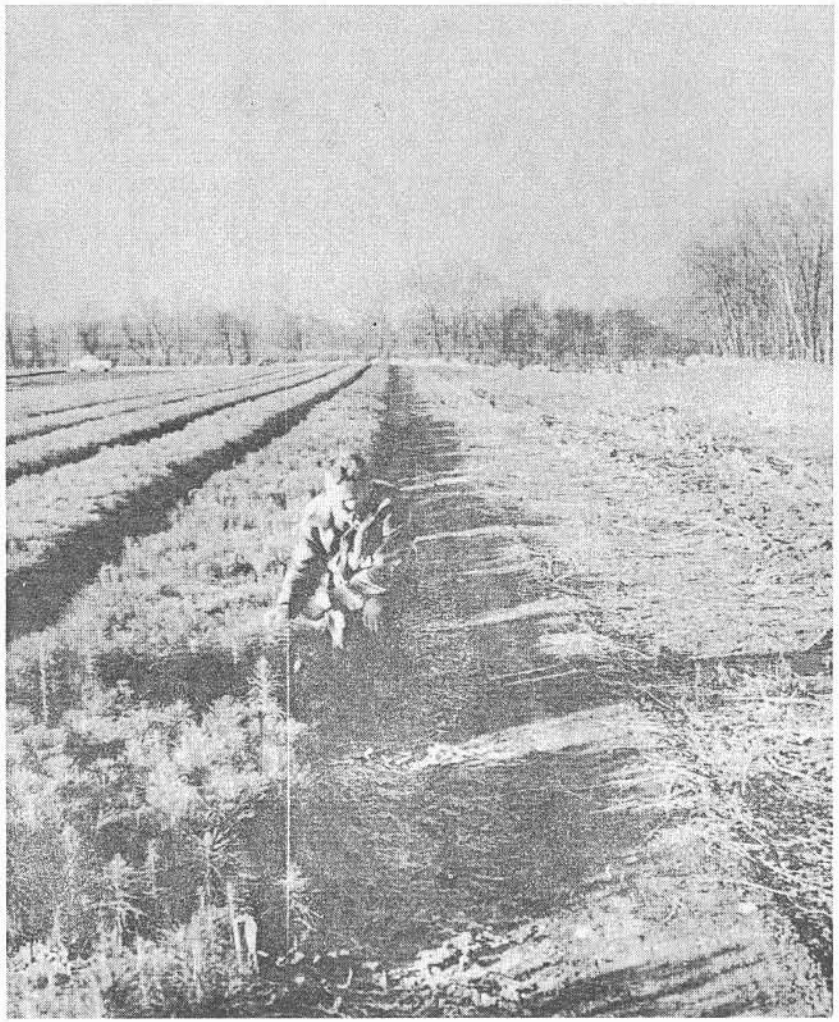
compression wood throughout their entire bole than do straighter trees. This information, plus a strong indication of considerable heritability of the spiral characteristic, has helped serve as a guide in the tree selection program.

6. Relationship of limb wood to bole wood. - Several studies, made to confirm results obtained while in Texas, were completed on the feasibility of using limb sections to predict the specific gravity of bole sections. Findings were similar to those we obtained in the Texas studies, so we have not planned to report the confirming information in formal publication. In both studies it was found that there is a good relationship between the specific gravity of wood of the limb and the bole from which the limb came.

Personnel

Announcement was made of the employment of Dr. Thomas O. Perry, formerly Head of the Forest Genetics program at the University of Florida. Tom is now doing post-doctoral studies at California Institute of Technology on a basic physiological and genetic study. He will take active part in the North Carolina State College program early in 1960 and will teach, guide graduate students and work on phases of research in the program. We are very pleased to have been able to obtain the services of this outstanding scientist.

Two personnel changes occurred during the year. In September, Bob McElwee, Liaison Geneticist, started a nine-month full-time course



A job becoming more important and time-consuming is the progeny testing of the trees selected for use in the seed orchard. The first nursery bed shown here is only a part of the progeny seedlings grown for outplanting the past year. These seedlings, grown in the Bowaters Nursery, are 9 months old. Note their seed orchard in the background.

One phase of basic research of wood is studying fiber length variations and inheritance. This photograph shows Mrs. Henson and Mr. Thorbjornsen working with the "Ray-O-Scope," measuring lengths of loblolly pine tracheids.

of study towards the Ph. D. degree. Eyvind Thorbjornsen (Thor) replaced McElwee in the liaison work until June 1, 1959, when Bob returned to full-time work. Thor will complete his research work prior to taking a position at the University of Tennessee to direct a research program in forest genetics there. Mrs. Virginia Bunn has taken over the part-time secretarial job for the program. We were fortunate to obtain such a competent person for this job.

Below are listed the personnel connected with the North Carolina State College - Industry Cooperative Genetics Program:

Name	Position & Status	Comments
Dr. B. J. Zobel	Geneticist in Charge of Program	Concerned with industrial, basic & student training phases of the program.
Dr. T. O. Perry	Geneticist & Physiologist	Work with graduate students, teach a course and do basic genetic research.
Dr. T. E. Maki	Head, Dept. of Forest Management & Prof. of Forest Management	Student adviser and consultant on soil and other silvicultural problems.
Dr. H. F. Robinson	Head, Genetics Dept. & Prof. of Genetics & Exp. Statistics.	Advisor in statistical and genetic probblems relating to the program.
R. L. McElwee	Liaison Geneticist	Back on the staff after 9 months' study for advanced degree.

Name	Position & status	Comments
E. Thorbjornsen	Graduate Student, Interim Liaison Geneticist	Capably filled the liaison geneticist job for 9 months, completed Ph. D requirements, goes to head genetic research program at U. of Tennessee.
Mrs. Faye Henson	Laboratory Assistant	Does the bulk of laboratory wood analyses and other key jobs.
Mrs. Virginia Bunn	Secretary	Part-time secretarial, filing and other office jobs.
Floyd Goggans	Graduate Student for Ph. D.	Member staff Alabama Polytechnic Institute; works on loblolly tracheid characteristics.
Brooks Polk	Graduate Student for Ph. D.	Member staff U. of Missouri; works on control pollination.
LeRoy Saylor	Graduate Student for M. S. Ph. D. (jointly with Genetics Department)	From Iowa State; works on pine cytogenetics.
Charles Webb	Graduate Student for M. S., Ph. D.	From N. C. State College; works on field grafting.
Donald Smith	Graduate Student for M. S.	From Alabama Polytechnic Institute; begins studies in Sept., 1959.
M. T. Conkle	Graduate Student for M. S., Ph. D.	From Michigan State College; begins studies Sept., 1959.

Name	Position & status	Comments
Roy Stonecypher	Graduate Student for M.S., Ph. D.	From N. C. State College; begins studies Sept., 1959.
K. O. Summerville	Senior Forestry Student	Semi-skilled labor for project.

Physical Facilities

A section of the greenhouse was completed during the past year and is now in full use. Its value will become even greater as soon as the cooling system is installed.

An attempt is being made to air-condition the laboratory so that it can be used more efficiently for cellulose analyses.

Because of expansion of the Athletic Department's playing fields, which absorbed the half-acre research nursery site, no nursery facilities are available in Raleigh. However, during the past year all progeny test material was grown in the Bowaters nursery. Their season was very successful and fine progeny test plants were available to nine companies. The current progeny needs are considerably larger than last year, so planting has been done at the Riegel Nursery near Lumberton, as well as at the Bowaters Nursery. This help on nursery needs is greatly appreciated. The needs are so great that, even if a small research nursery were later developed near Raleigh, it would be difficult to handle the progeny stock. For example, for next year, approximately 1200 feet of nursery bed is needed.

Publications

The following publications have been made, or are comtemplated, since the Second Annual Report:

1. Zobel, B. J., and Maki, T. E. 1958. Comments on "Annual variation in the seed crops of loblolly pine" (with reply from K. F. Wenger, defending and modifying his original thesis). Jour. of For. 56(2): 144-146.

This was a "comments" discussion in the Journal pointing out that the so-called flowering cycles of loblolly pine may be due to other things than the physiological "flower-producing" condition of the tree and often a poor seed year is not the result of lack of "flowers" but what has happened to the flowers due to frost, insects, etc.

2. Zobel, B. J.; Webb, C.; and Henson, F. 1959. Core or juvenile wood of loblolly and slash pine trees. (Accepted for publication in "Tappi".)

This rather long article (25-page, single-spaced, typewritten material, including eight figures) is intended as a summary "monograph" on loblolly and slash pine core wood, both from what we have found in our research here and what has been discussed on other species in the literature.

3. Zobel, B. J. 1958. What's new in forest genetics. The Unit, No. 74, pp. 26-27.

A short published version of a talk given to the SPCA is contained in their publication, the Unit. It stresses needs.

4. Zobel, B. J. 1959. Progress in forest genetics. Sent to American Forest Products Industries.

At the request of Mr. Franklin Bradford, this article was prepared to be used as a release by the American Forest Products Industries. It has, and will, appear in several publications.

5. Zobel, B. J.; Barber, J. C.; Brown, C. L.; and Perry, T. O. 1958. Seed orchards--their concept and management. Jour. of For. 56(11): 815-825.

This article was prepared by the four authors named for the special issue of the Journal of Forestry on forest genetics.

6. Zobel, B. J. 1959. Forest Genetics. Carolina Tips, 22(2):5-6.

This is another generalized request article prepared for the "lay" reader.

7. Zobel, B. J. 1958. Tree improvement and genetics. Forest Farmer 23(2): 11-12 (Special Forest Research Edition)

At the request of Editor Walt Myers, our views on the needs for research in forest genetics were reviewed.

8. Thorbjornsen, E. 1959. A cone production study of loblolly pine on the Coastal Plain of North Carolina (publication pending).

Thor made a special study on seed production and seed yields from trees of various types. His work is summarized in an article to appear soon.

9. Zobel, B. J.; Henson, F.; and Webb, C. Estimation of wood properties of trees from breast height measurements. (To be published soon)

This study was to confirm the accuracy of using breast height wood samples to characterize the whole tree bole for wood specific gravity and cellulose yields.

10. Barber, J. C., and Zobel, B. J. 1959. Comments upon "Genetic variation within geographic ecotypes of forest trees and its role in tree improvement." (To appear in issue of the Jour. of For. soon)

These comments, prepared by the two authors, were made in an attempt to clarify and draw a more realistic view of factors at work, what we know about them and how they can be used.

In addition to the published papers outlined above, talks were given to various groups on the subject of forest genetics, though formal papers were not prepared. Among those were talks to the Twelfth Alkaline Pulping Conference at Hot Springs, Arkansas, and the Twelfth meeting of Southeastern TAPPI at Jacksonville, Florida.

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Company	Working Units
Bowaters Southern Paper Corp.	one
Champion Paper & Fibre Co.	one
Chesapeake Corp. of Virginia	one
Coosa River Newsprint Co.	one
Continental Can Co.	Gair Division
	Continental (Eastern)
Georgia Kraft Co.	one
Halifax Paper Co., Inc.	one
International Paper Co.	Coastal Plain
	Piedmont
North Carolina Pulp Co. (Weyerhaeuser)	one
Riegel Paper Corp.	one
Union Bag-Camp Mfg. Corp.	Georgia
	Virginia
West Virginia Pulp & Paper Corp.	South Carolina
	North Carolina