DEVELOPMENT OF SEED ORCHARDS AND SEED PRODUCTION AREAS AT THE PENNSYLVANIA STATE UNIVERSITY

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Our research program in forest genetics is designed to serve three main functions,? The foremost of these is to provide educational experience for graduate students who specialize in silviculture, including forest genetics Nearly equal in importance is the expansion and dissemination of knowledge, both basic and applied, which is needed for effective tree improvement. The third function is to make available to tree growers the elite trees and improved varieties that result from the selection and breeding activities which are vital ingredients in our genetic experiments. Thus we consider seed orchards to be by-products of our program, the main product being knowledge imparted to our graduates, to the profession, and to practitioners.

Although our experiments include several species, only the work with Scotch pine has progressed to the point of seed orchard establishment. It was actively initiated in June, 1956, Earlier seed source trials established by W. C. Bramble and W. R. Byrnes were precursors of the present program. This report will describe three approaches to the production of genetically improved Scotch pine seed intended for growing Christmas trees. The need for improvement is greatest in winter foliage color, crown shape and density, and stem form,

COMBINATION PROGENY TEST--SEED ORCHARDS

This cooperative project involves R, F West of Rutgers and L. S. Hamilton of Cornell, in addition to the author.. It was designed to provide genetic information concerning a dozen characteristics, to select trees for breeding, and to enable the conversion of progeny tests into seed orchards.

Seed was collected in the autumn of 1956 and planted in the New Jersey State Nursery at Washington Crossing. Most of the parent trees were selected in 15- to 40-year-old plantations, for which no seed-source information was available, This was unfortunate but unavoidable, and was not considered to be a serious flaw. The selection criteria specified that selected female parents were to be greatly superior in one to several characteristics, in comparison with Scotch pines being produced by Christmas-tree growers, Measurements were taken on selected trees and on surrounding probable male parents.

In the spring of 1959, plantations were established at nine locations representing widely differing environments in New Jersey, New York, and Pennsylvania. Each is approximately one acre in size, consisting of 30 blocks each of which contains 31 half-sib families plus one commercial variety in one-tree plots: Two-year-old seedlings were planted by hand at a six-foot spacing. Subsequently, the plantations received intensive care, including chemical weed control combined with mowing, spraying for protection against insects, rodent and deer control, and periodic inspections. The trees have not been sheared, so that normal branching characteristics could be measured..

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Measurements have been made in each of three successive years, and will be completed in December, 1964, representing the end of the commercial Christmas tree rotation. Needle color and needle length are determined in December, flowering is observed in June, and stem form, branching characteristics, height, needle retention, and presence of laminas growth are recorded in August or September. Analysis of the data will include parent-progeny regressions, nursery-plantation regressions, variance analysis, and heritability estimates. These will provide a basis for further selection and breeding. In addition, we expect to learn the earliest age at which selections can be made effectively, roughly how much can be accomplished through selection and breeding, and how extensively trees will need to be tested in order to grow well in different regions.

It is already apparent that in this locality, the seedling progeny test--seed orchard combination approach is entirely feasible for Scotch pine that is to be used for Christmas trees. Our conclusion is contrary to that of Johnsson (1964) in Sweden, where the same species is being improved for use as timber. However, this does not imply that the two different conclusions are in conflict. Under our conditions, selection in any generation may be completed by age six, or possibly sooner. Obviously, the need for thinning is precluded, even if close spacing is employed. Prolific flowering, both male and female, has occurred in many families. The heritabilities of several characteristics appear to be quite high, at least within a plantation. All of the members of one family in particular can be identified infallibly, both by appearance and by the degree of pain inflicted by the needles. For these reasons, both objectives may be accommodated in a single plantation.

Our design, representing the pilot-plant stage in seed orchards, will need to be modified for large-scale production. The one-acre size has been quite satisfactory for the experiment, but, of course, is much too small for production orchards. The one-tree plots were instructive, but too small even for the experiment, not because they were inefficient or yielded unreliable data, but because even with very high survival, there were too many missing plots, Three to four tree plots might be considered a practical minimum, and could very well be employed if the effectiveness of within-family selection for traits having low heritabilities is unimportant. Other recommendations must wait upon the analyses and their interpretation.

An historical footnote may be in order. Our decision to use seedlings in very small plots for the dual purpose of progeny testing and seed orchard establishment was made in 1956. It was a radical departure from the grafted clonal approach which was then, and still is, very much in vogue, At that time we were not aware that long ago, combined progeny test--seed orchards had been proposed by Fabricius (1922), and established by von Lochow (1929). It is also noteworthy that von Lochow's progeny tests were replicated in time as well as in space. More recently, the advantages of seedling seed orchards have been pointed out by Wright (1959, 196o), Goddard and Brown (1961), and Schreiner (1962, 1963). The relative merits of clonal and seedling seed orchards have been debated by several authors in Silvae Genetica 13 (1 and 2). Many of the issues have been clarified, but several points will remain controversial for some time to come.

INTRASPECIFIC HYBRIDS

Scotch pine trees of Spanish origin have been crossed with selected trees of non-Spanish origin. Both controlled, full-sib crosses and semi-controlled., pollen-mix crosses were made The latter were possible because in one seven-year-old Spanish Scotch pine plantation, there were no male flowers on any trees, but about half of the trees produced female flowers (On a different site, flowers of both sexes were present.) This is an attempt to combine the most desirable features into a single variety that may also be heterotic.

If the study is successful, it could lead to the rapid establishment of early yielding intraspecific hybrid seed orchards. Their design could specify from two to many clones, or else, non-hybrid seedlings. Progeny tests can provide pre liminary information in the nursery at age two; they will yield more useful data in three or four-year-old plantations; and they can be completed by age five or six. Seed orchards could be established at any stage of this testing, the time depending upon the degree of risk that can be tolerated. The production of useful quantities of seed should begin between the ages of eight and twelve

SEED PRODUCTION AREAS

About two-thirds of a ten-acre Scotch pine plantation established in 1950 has been converted into a seed-production area The remainder, which is partially isolated by distance, topographic position, and intervening hardwoods, has been left untreated for comparison, No information is available about the seed source. The quality and variability of the trees were considered sufficient to provide a good opportunity for selection The plantation will be utilized to study the relative usefulness of this approach, and to experiment with various cultural treatments.

The conversion began in December,1957, with the selection of seed trees. Many of them had cones at that time. Those with the most desirable combination of Christmas tree characteristics were marked to be left at spacings of 12 to 24 feet. The intensity of selection was low, and is estimated to range from .25 to 0.06 for the composite rating. The cutting of unmarked trees required about l'man-days during the winter. Students equipped with a powersaw, bowsaws, and axes were employed to fell the trees plus lop and scatter the branches. The stumps on a portion of the area were sprayed with a mixture of one quart dieldrin in 50 gallons of fuel oil to guard against damage by pales and approximatus weevils. However, in this instance the treatment was superfluous, as little damage occurred in the untreated area.

A pruning experiment was installed in June, 1961, to develop a method for promoting low, wide crowns and to study its effect on flower and seed production. At that time the trees were about 16 feet tall, with live branches almost to the ground. Sixteen groups of four trees each received the following treatments:

H - control, no treatment;
.75 H - topped at 3/4 of its total height;
.50 H - topped at 1/2 of its total height;
.25 H - topped at 1/4 of its total height.

The cut was made with a pruning saw just above a whorl of branches, and required about 1.5 minutes per tree. In 1962, a reduction in female flowers was observed in all treatments as expected, due to the removal of the upper part of the crown. A severe frost in 1963 destroyed most flowers, so again no measurements were taken.. In June, 1964, the following data were obtained:

	H	.75H	.50H	.25H
Female conelets, average number per tree	180	209	83	17
Average height, feet	17.0	16.6	13.3	8.5

These treatment effects are statistically significant. The results suggest that roughly the upper quarter of the living crown may be removed without lowering conelet production three years later. It appears further that at least that much crown must be removed, probably repeatedly, in order to reduce height growth to the desired extent. The experiment will be continued by pruning back each terminal leader several more times, One to three internodes will be removed after each cone harvest which might occur at two- to four-year intervals.

Seeds have been collected from the most distant parts of both the untreated portion of the plantation, and from the rogued portion. Seedlings issuing from these will be compared to estimate the degree of improvement that may be expected from this method. It is anticipated that the effect of selection will be quite small, and that seed production areas will be useful chiefly for the efficient production of seed from varieties that already exist, rather than for the genetic improvement of these varieties.

CONCLUSION

The production of genetically improved Scotch pine seed for Christmas tree purposes is without a question feasible. Several approaches in addition to the three that have been described are possible. At the present time, choices may be made among them on the basis of theoretical genetic considerations; of rather limited empirical observations; and of practical considerations concerning facilities, personnel, travel distances, and so forth. Within a few years, a great deal more practical genetic information will be available to clarify these decisions, especially as to how much gain may be expected, and as to the adaptability of improved varieties.

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JACIW Here's a question for Dr. Stairs. When selections are made in plantations, what age are these plantations and at what age can it be determined that these trees can be expected to be of superior quality at maturity?

STAIRS I don't have any absolute criterion as to age, but most of my selections are in about40-year-old plantations. In some fast-growing larch plantations I have selected trees at about twenty years of age. Intuitively, I feel that a tree which has grown well for twenty to forty years will continue to perform satisfactorily, In addition, I believe the decision should be made in relation to rotation age; since we are trending toward shorter rotations I feel we can similarly select trees at younger ages.

I have a question for Dr. Gerhold, Do you think the heritability values reported are inflated because of full sibbing or is this an environmental factor?

GERHOLD Well, we really havent looked at these figures critically yet. I hope none of you will go out and use this figure now and say that we can just go ahead and select for needle length and have it breed entirely true. I don't want to leave that impression at all. I wanted to mention the diversity of results were getting so far. I think the lowest estimate was just over two tenths, so that we have a wide range of estimates. I think perhaps this is very common when estimates are made in half-sib progeny tests.

STAIRS I asked the question basically because I feel it would be of interest if anyone had data on the selective pollination of open pollinated seed. The problem of estimating the amount of full-sibbing, halfsibbing, and selfing among open pollinated seed is a difficult one.

CALLAHAN One observation from Placerville ties in here. Cones collected in the lower part of the crown of a Coulter pine is heterozygous for albinism, produced exactly the expected 3-1 ratio of albinos. This means that every seed on the lower part of the crown probably was selfed. Those on the top of the crown showed about 710 outcrossing. I believe Squillace and Kraus have similar results from Olustee. The evidence begins to accumulate that anybody who collects cones from the lower part of the crown is going to collect a high proportion of selfs and that if you want a high proportion of outcrosses you better get high up in the tree.

PITCHER I have a comment and a question for Dr. Stairs. In our selection prog ram in the Lake States we've gone through a transition period where we started out selecting first for quality characteristics such as branch angle and so forth. I was very much interested to hear your comment on selecting for groi rate first and then, within that group, selecting for quality characteristics. This is the approach that we are now taking. I have a question on the number of acres that you set up in the seed orchard and in the seed production area. What is your basis for this estimate? How did you figure out how much acreage you would need to have under management to meet your future requirements?

STAIRS I was not directly involved in the early stages of the New York planning, but I believe the study was based on a plan similar to that presented in a paper by Paul Rudolf of the U.S.F.S. The projection was made on the number of acres needed to produce the amount of seed desired and then a safety factor of two was added.

WINIESKI - One other factor I might mention to Jack (Pitcher) that was used in Pennsylvania and also in New York to estimate the area of seed orchards. Besides the nurseries production, estimated production of seed orchards and other factors, there was the actual shippable seedlings that we could count on from a pound of seed--which would reflect nursery handling and practices.

STAIRS - That's right, the projection is made in terms of nursery production. Working backwards from that figure one computes the average seed yield per tree over an arbitrary period, the number of trees per acre, and then the number of acres needed, I believe there is still a lot of room for conjecture here and we need additional data on expected flowering in seed orchards.

GABRIEL - What I have to say is related to Dr. Callaham's remarks on stratifica tion of pollen sources, I am wondering what the effect of creating one level of flowering for male and females will be on incidence of selfing. Would this be a detrimental practice in seed orchards?

STAIRS - We have found this to be somewhat true in red pine, and a good deal of our topping work is still on an experimental basis. Certainly we must be concerned here with the re-distribution of male and female flowering& Dr. Callaham has pointed out the increase in selfing found in the lower crown portions. There is a possibility that the normal distribution of male and female flowers will reoccur after topping with the result of a lower, more workable seed source,

HUNT - Dr. Stairs, regarding your comment on early seed production in white spruce, do you expect this seed production at perhaps five years of age, to result in depressed growth rates for those trees due to a photosynthate depletion? This is one reason I rogued the tree in West Virginia.. Many of the cones were persistent and became ingrown in the stem and branches. I termed it oversexed. It looked like a case of slow growth due to extra cones.

STAIRS - I mentioned that white spruce is an early flowering species., but we are not selecting for early flowering peper se. I believe Stern's work with birch pointed out the extreme depression of vegetative growth obtained when selec-tion is based on early flowering alone.

HUNT - On that basis, you would select mainly for vigorous growth within the early flowering trees so that no apparent depression resulted.

STAIRS That is correct, we are not selecting for early flowering, the fastest growing trees remain our principal interest.

ALLISON – I'd like to direct this question to the speakers. What is their thinking in regard to developing seed orchards that will produce seed that is capable of producing seedlings under direct seeding conditions rather than nursery conditions?

GERHOLD - It seems to me that it might be necessary to follow two different progeny test procedures to find out if a seed source could be used both for direct seeding and for use in the nursery. This is certainly a question that should be explored. I don't think there's any answer to that yet.

ALLISON The reason I was asking is that we are getting into direct seeding, especially of Virginia pine. Last year, which was our first, we distributed thirty-two pounds. We are also getting inquiries in regard to pitch and white pine, as well as yellow poplar. I feel that we may have some difference on survival in the field from different seed sources, growing under conditions that are similar to nursery seed beds

GERHOLD - Directly after direct seeding at the time of germination, there can be very intensive natural selection by certain factors which ordinarily would not be effective in the nursery. This is what prompted me to voice that opinion.

HOCKER I think that if someone were to come up with a nursery seedling which would outgrow a direct seeded seedling that the silviculturist is going to find a way to utilize that in his management program, but Pd like to echo what Gerhold says that probably two types of progeny testing will be necessary for these trees. Now in the initial selection, these trees were naturally produced so that at some time in their life they were subject to the rigors of initial germination and establishment under natural conditions, so were not selecting against these characters in the initial selection of plus trees.

LARSSON - Theres one point which has come to my mind and that is, rather than pruning the trees down to size and running into problems, perhaps we should take a leaf out of the book of the horticulturist and use dwarfing stock for grafting purposes, so that seed collection could be simplified by collecting the seed easily and economically from the ground and avoid the problems of extreme heights.

STAIRS I believe it would be a good idea, if we knew of a good dwarfing rootstock for conifers. I tried the combination of ponderosa pine on Mugo pine when working with Dr. Richard Dingle at Washington State University. After several years there did not appear to be a dwarfing effect; The subject requires additional testing along with the possibilities of root pruning, phloem inversion, and phloem restriction. There are several reports of the latter methods in the literature.

SCHREINER I'd like to point out that it took the Malling people many years to select their dwarfing rootstocks, so I think time foresters began to look for dwarfing rootstocks. If you go out on the field trip tomorrow you will see some possible dwarfing stocks in the Norway spruce IUFRO test; trees 22 years old and less than 5-6 feet in height. If we want dwarfing rootstocks we should select dwarf phenotypes and test their clonal ramets for their dwarfing effect.

JACIW Its a question to Dr. Genys. In selecting superior phenotypes, what co nsideration is given superior individuals versus whole stands of plus trees?

GENYS On this question I expressed skepticism in my report. Far more research is needed before we could predict the value of different methods of phenotypic selection. By testing different geographic seed sources we may gather some data that may lead us to stands offering a better bet for selection of individual trees. Again, within a stand of outstanding trees, three foresters may select three different plus trees. This choice depends strongly on the objectives of the selection (superior growth, form, branching habits, pest resistance, etc.). Some traits are hard to express in mathematical terms and it is still harder to predict their heritability. Mr. John Winieski works extensively on selection of superior phenotypes in Pennsylvania I think John could tell us more about his experiences

WINIESKI - All I can say is that selection always brings up problems, as John (Genys) stated, different people will look at the same stands of trees and select different trees in them. I think a lot of it goes back to the fact that in the actual selection process there are a lot of subjective appraisals made. In my work I try to measure anything that is measurable, and apply a numerical rating to such things as bole straightness, branching habit, etc. Very often, however, after rating two trees numerically, the one that appears to be more desirable ends up with a lower numerical rating than the one which appears less desirable. So I think the confusion in selection, mentioned by John, boils down to the subjective part of the selection process. I don't know what the answer is; we just do the best we can, measuring what we can and making subjective appraisals of the other desirable characters.

JACIW - You're mentioning these superior trees, and speaking of them as individuals, I was wondering whether when you are selecting your superior trees any consideration is given to the stand, general conditions of the stand that they are growing in, In other words, to the quality variation between the superior trees and the general stand.

GENYS - Our provenance studies are directed toward learning about the genetic values of different stands including some half-sib progenies from selected trees. Unfortunately, the early results indicate that the seedlings from an "average" stand may have a better growth potential than the seedlings from our selections, If these results hold, it will be unwise to conduct a phenotypic selection within a stand that gave us a 10 percent slower growing progeny. It appears more promising to select the "best" phenotypes in the stands that offered seed yielding better than average seedlings.

SCHREINER - John, you mentioned that perhaps we should select for our seed orchards some of the best individuals of the best progenies that have shown up in the nursery provenance test. Now this may mean selecting individuals from provenances a long way out of the locality where we're going to plant them To me, this "crash program" they talk about for seed orchards requires caution; so for "insurance" we shouldn't go too far beyond the climatic limits of our planting areas. I don't think I would establish an extensive "crash program" seed orchard for white pine to be grown in Maine with the best trees from Georgia.

GENYS - I appreciate your valuable comment. It would be a risk to use any provenance for seed production before learning if it is adapted to the local environment, It takes a long time to learn what provenances are most desirable under field conditions. The longer the test the more we learn about different progenies, Certain traits can be identified in the replicated nursery experiments such as the differences in the juvenile growth rate and the juvenile cold-resistance We are planning to select several white pine provenances in the nursery on the basis of their two-year performance. Each selected source will be planted in a separate location assuming that in the future they may be used for seed collections, if the same seed sources in the replicated field tests prove to be desirable. In other words, we intend to (1) conduct the long-term field tests; and (2) grow the selected provenances separately to insure that we will have these trees for seed collection if the designed experiments prove that they meet the qualifications for production of superior seed.

STAIRS In relation to this question, we have an interesting provenance test of Norway spruce established from three local plantations and three commercial seed lots. The local seed lots were from goodgrowing, forty-year-old plantations; at the present time they are far superior to the three commercial lots. I feel these results add weight to the desirability of using seed locally unless one has a good reference to the growth potential of the imported seed.

CLAUSEN My comment ties directly in with what you are talking about here. I have been trying to get this said earlier but it fits in very nicely now. Some years ago the Lake States Station started a seed source study in white spruce. To their surprise they found that an Ontario source outgrew the local source. You have all heard "To be safe use local sources". Well, now we have a range-wide study of white spruce seed sources and again we find the same thing. The Ontario source in this test came from approximately the same area as the original source, and at Rhine -lander it outgrows any of our local stock. I believe the Region is interested enough in this that they feel that they should get seed from Ontario rather than from the Lake States for use in the forest. Jack Pitcher can comment on that So you **see**, in this case we are finding local seed is not always the best. Jack, have you got anything to say?

PITCHER Our program at the present time is the development of seed production areas in stands of white spruce. Our program also includes the selection of superior trees on an individual tree basis. This again is local seed source or trees from which we will be developing our seed orchards. In addition to this, we are also establishing progeny tests with seed from our selected trees and the Ontario seed source which Dr. Clausen mentioned. For general nursery operation we still use local seed sources.

DOUGLASS As a soil scientist, I am a little confused here. You are taking a superior tree, that you feel is genetically superior, from a given site in a State Park in Maryland The tree is approximately 80 years old. You are then transferring the seed to an orchard in ideal growing conditions within the nursery, and there you are judging the tree for its characteristics after its grown two or three or four years. Now I realize that this probably has been proven to have some correlation, However, isn't it possible that if after you select a tree and plant the seed you find out that these seedlings are not superior by your new standards? Perhaps under certain site conditions; soil, aspect, and so on, the superior height could be a genetic condition or a factor causing the tree to be rated as superior,, But then you're changing the site and you're judging the tree again under nursery conditions. Is this a fair assumption?

GENYS I would hesitate to predict that the nursery results would give us the final answers. However, the replicated experiments with many provenances grown under similar conditions may give us a guide on their performance. We may want to **use** this guide in choosing the stands for further selective work. For instance, a progeny from a stand in Allegheny County, Maryland, was one of the best among other progenies from Maryland.We may use this stand to conduct further research.

ROLLINS The point of an earlier discussion on site, which I think Dr. Genys clarified, was simply that provenance tests are a means of eliminating the influence of site. I think this point might have been overlooked in the present discussion.

GABRIEL Referring to environmental influences, the duration of the effect of nursery on the phenotype is pretty well known. You can find one case after another in the literature where nursery effects are known to extend into the teenage stage of the outplanted stocks If selections are made at too early an age, without any knowledge of the correlation between juvenile and mature performance, you may be getting yourself into hot water.

GERHOLD Perhaps the point should be made here that, so far as I know, no one has advocated making final selections in the nursery, even though nursery measurements do have usefulness in several ways, some of which have been mentioned. In addition, they also permit one to gain some insight as to how these comparative measurements may change in the future. For example, in our work here with Douglas-fir--if we had made our final selections in the nursery, we might have chosen the coastal (green) variety of Douglas fir. However, there was some evidence of winter injury So to be conservative, a final decision was postponed until quite a bit later. As it turned out, the slowest of the three varieties growing in the nursery, which originated from Colorado, turned out to be the most useful one near rotation age with respect to Christmas trees.

GENYS We should be concerned whether or not the early results are applicable in predicting the future performance of different provenances. I recall a few cases where the growth of different provenances at the early age showed a similar trend at the more advanced age., For instance, in European larch provenances, the 4-year heights were very significantly correlated to 12-year heights In Virginia pine 3-year heights were correlated to 7-year heights. These early measurements could have been used to predict the comparative growth values of different provenances in the future More data along this line can be found in the literature. However, each species may react differently and nursery results should be taken with caution.

SCHREINER - I also have had some experience with juvenile selection. In 1928, on the basis of nursery performance, we selected fifty poplar hybrids, of a total of some 14,000 seedlings, for clonal propagation, Of those fifty clones all but about ten had to be discarded primarily because of disease susceptibility after 15 years of clonal tests; diseases and insects that were not present in the brief nursery stage., Of the selections made in the 18-year old hybrid seedling plantations the proportion of disease resistant hybrids (on the basis of field and inoculation tests) was much higher. Those of you who were at the NEFTIC meeting at Beltsville will remember the selfed silver maple progenies When these progenies were eight to ten years old I would have predicted that you could safely self silver maple. But after 22 years there isn't a selfed seedling left.

True, this problem of juvenile selection differs with the species and with the characters or qualities toward which selection is directed; but were not going to know the final answer until the end of the rotation. I'm willing to take a chance on half-rotation but believe me, gentlemen, I "got a bellyful" of nursery selection many years ago. Unfortunately, it's often difficult to correct a misleading earlier publication; the people who might have been encouraged by such a report to " sail-on" in the direction indicated in spite of the author's words of caution might have invested considerable time and money.Can we just say should have been more cautious?

FARNSWORTH Id like to make a brief comment in relation to the development of seed for direct seeding. As you specialize in the production of seed you also materially increase its cost, and because larger amounts of seed are required for direct seeding, as the cost increases, there is a possibility that its use in direct seeding would be somewhat decreased. This would favor planting the seed in the nursery and outplanting the seedlings or transplants. I'd also like to raise a question referring to Jerry Stairs remarks that both the grafting of material for seed orchards and the development of seedling stock for seed orchards have problems. What is the possibility for using rooted cuttings in a greater degree in the future than in the past?

STAIRS - I believe the use of rooting cuttings for seed orchards depends fundamentally upon two points (1) the most desirable method of vegetative propagation for a given species and (2) the question of physiological age. The larches, for instance, are difficult to root, but you can graft them quite easily. Norway spruce, on the other hand, has been more difficult to graft, yet it does root relatively easy. The question of dedifferentiation of tissue may be important here; if rooting does reinduce juvenility then one would want to avoid the method. I would like to see more data reported on the comparison of flowering following vegetative propagation by rooting and by grafting.

HEIMBURGER We have some data on information on rooting of white pine. It is quite possible to root young white pine in late August and early September, but, of course, the material is juvenile. We cannot root all the materials. And that is promising, for instance, in our work with blister rust resistance of white pine. We are using it chiefly to test individual seedlings; to produce more ramets so that we can lay them out statistically and then give them a better test than we can with one single plant.

In connection with grafted white pine seed orchards, we had experience the same as you have when you state that potted grafts are difficult to establish in the field. We have very encouraging results with field grafting of white pine on planted stock. We use that in our weevil resistance tests. We take a plant that is about four feet tall and graft it in the leader in early April or late March. And that gets very good results, rapid growth and high success, and I would certainly recommend that instead of potted stock. Potted stock is useful for production of special plantations for scion production because scions from old trees are rather difficult to graft; they can be grafted in the greenhouse with proper attention and establish materials in the nursery that can be pruned repeatedly for scion production for field grafting.

Now another problem which comes up is in our Scotch pine. The Scotch pine is very heavily attacked by mice. There is one chap in the Northeastern Station who has reported differences in resistance to mice, and the question is can we not graft Scotch pine on red pine, because in Ontario red pine is resistant to all the mice anyway.

JACIW I have a general question. My impression is that the selection of superior quality trees seems to be centered on conifers rather than hardwoods; or that there seems to be an imbalance between the two types of trees. I was wondering why it is so.

GABRIEL We will answer that, at least for sugar maple, in the Committee report on Hardwood Tree Improvement.

CHAIRMAN - We have time for a brief statement at this time.

GABRIEL - We have been doing selection work in sugar maple for superior sap production for several years; the first two years being spent in ironing out our technique. Using this technique we like to think that our selections are based primarily on genotypic rather than phenotypic variation. In essence our method tends to minimize environmental influences. Regarding the extent of our work to date, I would say we have visited between 50 and 75 sugar bushes and have tested about four or five thousand trees. I'll give you the exact figures on this later in the hardwood committee report. Someone asked John a question about group selection of trees. Some while back I had the same question asked me with reference to sugar production. Our present knowledge of environmental effects on sugar production is quite poor so consequently we steer clear of group selections and concentrate on single tree selections. Here we can compare them with standards which immediately surround them, which allows us to make an assessment of the environmental influences on the phenotypic expression. Naturally we intend to run progeny tests and perhaps clonal tests on these selections, Selections must be based on genotypic superiority or else you might just as well save your efforts,

WINIESKI - Was your question, "Why is everybody working with conifers and not with hardwoods?", is that it?

JACIW - Well, I didn't say everybody. There seems to be a predominance; most of the reports today were about conifers with some exceptions such as black locust, black cherry, and black walnut. Right now, we had a case of hard maple which is a highly valuable species, Then there is poplar, but there are a great many other species involved, and I was wondering why this trend persists,

WINIESKI - I think the answer is obvious to most of us. Most of the tree improvement programs are based on nursery production (conifers) and very little success has been reported with hardwood plantations or direct seedings. There seems to be very little demand for hardwood seed at this time, although I think there is a trend towards more work with the hardwoods now to work out the problems of the establishment of hardwood plantations with seedlings and through direct seeding in the meantime.

JACIW - I didn't have in mind the difficulty of establishment. I was just wondering whether the quality, the selection for quality, may not be just as important for conifers as for hardwoods.

SCHREINER - It would be my personal opinion that the primary reason for emphasis on conifers has been economic rather than genetic.

HUNT - Eli, could you give us some figures on the red pine seed yields per acre from the red pine seed production area established in 1958? I'd be interested to hear how trees of seedling origin are doing at this older age.

ELIASON - In our oldest seed production area of red pine started in 1959, planted in 1949, we have not had much production of cones as yet. It is hoped that the opening of the stand and the application of fertilizer will stimulate flower production. There have been some cones for several years, and some test collections have been made, but not sufficient for a commercial collection. A converted Scotch pine area planted in 1950 produced 92 bushels of cones on 6 acres in 1964.