POPLAR CULTURE

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I am honored and priviledged to attend this Conference, and I want to express my thanks to Pete Garrett for calling this Conference to my attention and inviting me here. I am not so sure that I expressed my thanks also for putting me on the program. I left New Zealand in mid-May and was not prepared to present a formal talk. I haven't prepared any remarks, and my slides unfortunately will not show you what I would have liked; but I am pleased to be able to give you a brief account of New Zealand and particularly of poplar culture and its problems "down under."

I brought a map to show you where New Zealand really is located. Some people think it is part of Australia and that there is a bridge across the Tasman Sea - that is not true. I can tell you, seeing that there are no Australians present, that Australia is just a rather large island - some people call it a continent - just off the coast of New Zealand.

We confess to being a peculiar country with 3 million people of which some 250,000 are Maoris. We live at the bottom of the World, Christmas falls in the hottest part of the year and is spent at the beaches, we drive on the left side of the road, we have a Queen who lives in London, and we have as yet no unemployment. We have some national vices like many other countries - football, horse racing, and beer.

Originally, New Zealand had no native mammals except two species of bats and a rare Maori rat, but there were many kinds of birds of which the flightless kiwi is the best known hence New Zealanders are called Kiwi's. At present we share the country with some 60 million sheep and 10 million dairy and beef cattle and also many millions of non-domestic introduced mammals which are now regarded as serious pests. Included in this category

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are rabbits, nine kinds of deer including the wapiti, a small herd of moose, and the Australian opossum.

New Zealand is a mountainous country consisting of two main islands "North and South Island. Its nearest continent is 1200 miles away - Australia. The country lies between latitudes 34.5 and 47.5 degrees. It is over 1000 miles in length and only 200 miles wide at its widest point. The total area covers some 66 million acres - almost the same size as Italy. Throughout the length of both Islands runs a high mountain range with several peaks of 10,000 feet About 50 percent of the country consists of steep slopes, 20 percent moderately steep while only 30 percent is classified as flat or rolling. Because of its mountainous nature, rivers are short with many rapids running directly to the ocean,

The climate runs from subtropical in the North to cool temperate in the South with a small semi-arid region in the rain shadow of the southern Alps. The climate is oceanic with rainfall of 40 to 100 inches per year evenly distributed throughout the year although some short summer droughts do occur. High intensity rain storms can occur any time of the year and result in flash flooding.

Geologically the country is mainly sedimentary in origin - mudstones and sandstones, the former highly erodible. The mountain ranges consist mainly of fractured graywacke while the central volcanic plateau of the North Island is covered by deep erosive volcanic ash.

When the first white settlers arrived about 1840, 75 percent of the country was heavily forested; but rapid exploitation of forest resources and a conversion to farm land by burning and over-sowing with grass seed on the ashes in 100 years has brought about a wide expanse of grass covering 14 million acres. This transformation of forest cover to agriculture land has, in a country with steep slopes, erodible soil, and high intensity rainfall, aggravated by repeated burning and over-grazing, resulted in an increased runoff and erosion which in some districts is of alarming proportions, We managed in New Zealand to do in 150 years what they did in Greece and Turkey in about 2000 years, and we are not proud of it.

The New Zealand Forest Service and private companies began a large scale aforestation program in the 1920's and by 1935 some 700,000 acres were planted, mostly on the volcanic plateau. These plantations include one of the largest man-made forests of the world - the Kaingaroa State Forest which covers more than 370,000 acres. Planting is continuing at the rate of 70,000 acres a year to cope with the record expansion of forest based industries. The main species is radiata pine which in New Zealand grows up to 3 times faster than in Monterey, California. The rotation is about 30 years.

All aspects of forestry research is undertaken by the Forestry Research Institute in Rotorua which is part of the New Zealand Forest Service; and not being in the Forest Service, I can say that it is "world standard" and well known to many of you.

The seriousness of the erosion problem required urgent action in the steeper country, and in 1941 an act was passed setting up a national body, The National Water and Soil Conservation Authority, to make provisions for the conservation of soil resources, prevent erosion damage, and to control flooding. In all of the main river systems, local cathment authorities - something comparable to your soil conservation districts - were constituted to administer and actively organize a program of river control in the flood plains and erosion control in the hills and steep land headwaters. For erosion control a series of soil conservation techniques furrows, banks, regulating dams and established techniques using improved plant materials including grasses legumes and trees were adapted to meet the special conditions of the hill country of New Zealand.

In 1954, the National Plant Materials Centre was established as part of the Ministry of Works and Development. This Ministry has a special Water and Soil Division of which the Plant Materials Centre is a part. It is situated in Palmerston North, and I happen to be in charge. This Station was established for the breeding and selection of plant materials for erosion control. Its functions are similar to but wider than the American plant material centers. We have on the staff also physiologists, pathologists, and specialists who work on establishment problems - in total we have a staff of 9 professional people and 16 technical and assisting staff.

The poplar and willow breeding and selecting work in New Zealand is undertaken by the National Plant Materials Centre while all other breeding and selection with other species is undertaken by the Forest Service. We work in close cooperation with them, particularly the Genetics Section. Many of the staff of that unit are well known to your group including Dr. Thulin who is in charge. Many of them received training or advanced degrees here in the United States.

On the steep and unstable slopes and gullies, tree planting occupies an important position and poplars and willows in New Zealand play a unique role in erosion control. Looking for fast-growing trees to replace the slower-growing native species on the most susceptible areas, it was quickly realized that poplars and willows could play an important part. They grow rapidly, they are easy to plant, they bind the soil with the root system, and they improve absorption and drainage so that soils will not become saturated so readily and consequently are less liable to slip and slump.

Since about 1900 poplars and willows have been widely used in river control and roadside stabilization and our high country roads hang literally on the roots of poplars, these trees have prevented the widening and deepening of gullies and wide-spaced trees in key positions have stopped the movement of unstable hill country thereby anchoring the capret of grass on many slopes. After 1950 the planting of poplars and willows received new impetus, and they are now a major tool in the prevention and control of erosion. This rapid increase in the number of willows and poplars planted in the last 20 years can be illustrated by some figures: in 1950 we planted 40,000; in 1967 400,000; and in 1972 1.2 million.

Poplars and willows have proved to be the most suitable trees to plant on unstable hillsides for the following reasons; propagation by cuttings is simple and easy in nurseries and large numbers of identical material can be built up rapidly - with the consequent mono-culture

results, 2, The ease of establishment of poles one of the most important features, Poplars and willows are the only species that can be established from 9-12 foot unrooted poles, thus they can be planted in the presence of stock which is important in a nation with 60 million sheep which are unable to reach the new growth. Poles of poplar and willow are able to root readily under suitable conditions because root primordia are performed in the bark of these big poles, Poles are quite easy to transplant and plant out, 3. The rapid growth rate is another reason. We have selected faster-growing varieties in the last 15 years - mainly the Italian hybrid poplars. The rapid development of an extensive root system with strong tensil and sheer strength. 4. The high evapotranspiration rates of poplars in particular are known to have dried up swampy soils. 5. Poplars and willows, in particular the suckering poplars, are able to recover from mechanical damage. When the roots are broken by shifting soil, new shoots are sent up and when parts of the stem are buried, new roots develop on the buried portion. 6. Shade and shelter for pasture stock without unduly shading the ground cover is desirable. Foliage will not foul the pasture in autumn, 7, Well managed trees will have an ultimate timber value for which there is an increasing demand. The match industry is establishing its own poplar plantations and the pulp and paper industry has also shown an interest in poplars to be added to fibers of P. radiata for finer quality papers.

The poplar and willow breeding program at the National Plant Materials Centre includes breeding of clones which are resistant to disease, better adapted to New Zealand's longer growing season, adapted to less favorable sites, less attractive to stock; and, of course, we do the normal investigations on form, habit, growth rate, rooting capacity and propagation, and establishment methods.

One of our very serious pests is the Australian opossum which feeds on smooth bark of young trees and leaves. We are looking for trees that form rough bark at an early age and trying to increase salicylic acid levels in foliage of our new selections. This has been proven to make the leaves bitter and consequently less palatable to the opossum. Clonal selection alone has produced a number with higher salicylic acid.

In 1972 we discovered the poplar leaf rust Melampsora medusae Thüm which we call the American leaf rust. From the point of first outbreak in Australia, it moved about 450 miles to the Northeast in less than six weeks and knowing that we receive from time to time other offensive materials from Australia - dust from the central deserts, ash from furnaces, insects and even small birds that blow over - we expected to find the leaf rust in New Zeland shortly and we were not disappointed. By 1973 the first reports confirming its arrival were received. We soon discovered that there was not one but two rusts, Marssonina populi and Melampsora medusae, and they were attacking different clones. As a result, we got defoliation very early in the year, not like here where it usally starts in mid- to late-August. Our defoliation occurs by the middle of May and early June, which means by the middle of the growing period the leaves are gone and as a consequence the trees are dying.

We compound this a bit by trying to get clones that retain their leaves longer to make better use of our longer growing season; and as a result, we now have some poplars that never loose their leaves even in our winters. Consequently, the life cycle just does not require the alternate host and it goes right through with uredia spores from poplar to poplar. By early spring there is a high enough concentration of inoculum in the air to infect the other poplars which do loose their leaves.

In closing, I would again like to thank you for permitting me to participate in this Conference and for your patience in listening to my talk which was rather unprepared. For Dr. Schreiner, I would like to show slide of what has to be the most southern planting of his hybrid poplars - the Androscoggin at 47 degrees South Latitude.

Fig. 1.--Soaking increases strike percentage of unrooted poles. Ten feet long poles are placed in a soak bay for at least 14 days prior to planting out.

Fig. 2.--Poplar poles are grown in special stool nurseries on a 2-year rotation. These stools are 1-78 with 1-year-old regrowth.

Fig. 3.--Poplars are planted for hill country stabilization as 10 foot long poles so that the tops are out of the reach of cattle and sheep.

Fig. 4.--View of the poplar pole trial area (clonal trials) at the Tangoio Soil Conservation Reserve near Napier (Hawkes Bay).

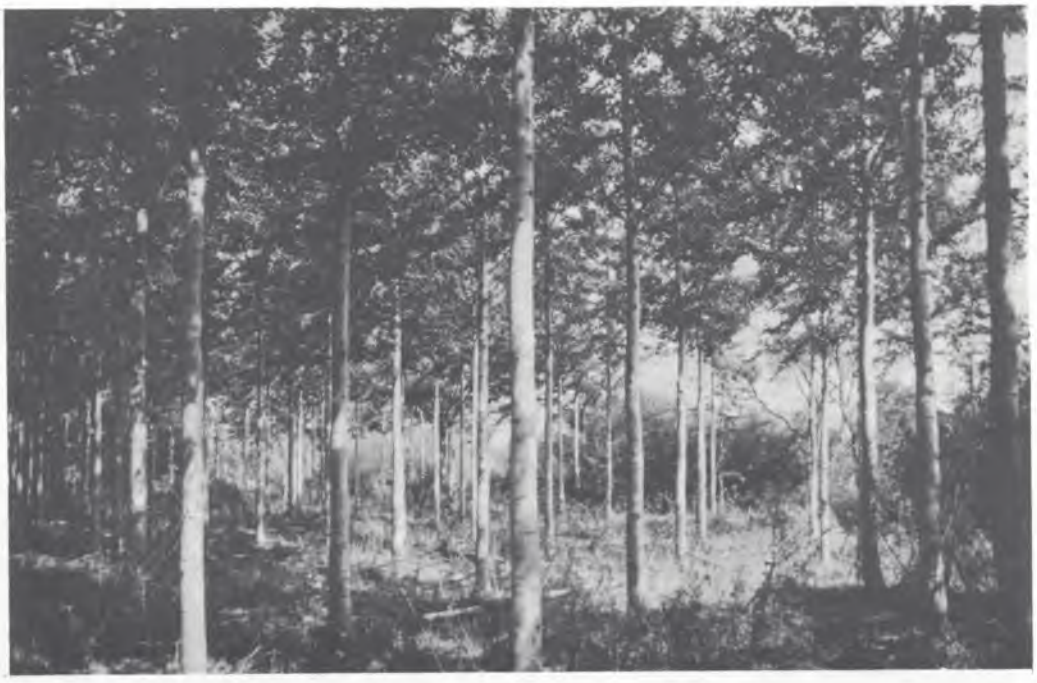

Fig. 5.--P. x "Androscoggin" age 7 at Pebbly Hill Forest, Southland. Thinned and pruned to 20 feet after 5 years. Spacing now 150/acre. DBH 8" - 9". At 46°15' southern latitude this must be one of the most southerly plantations of Schreiner hybrids in the world.

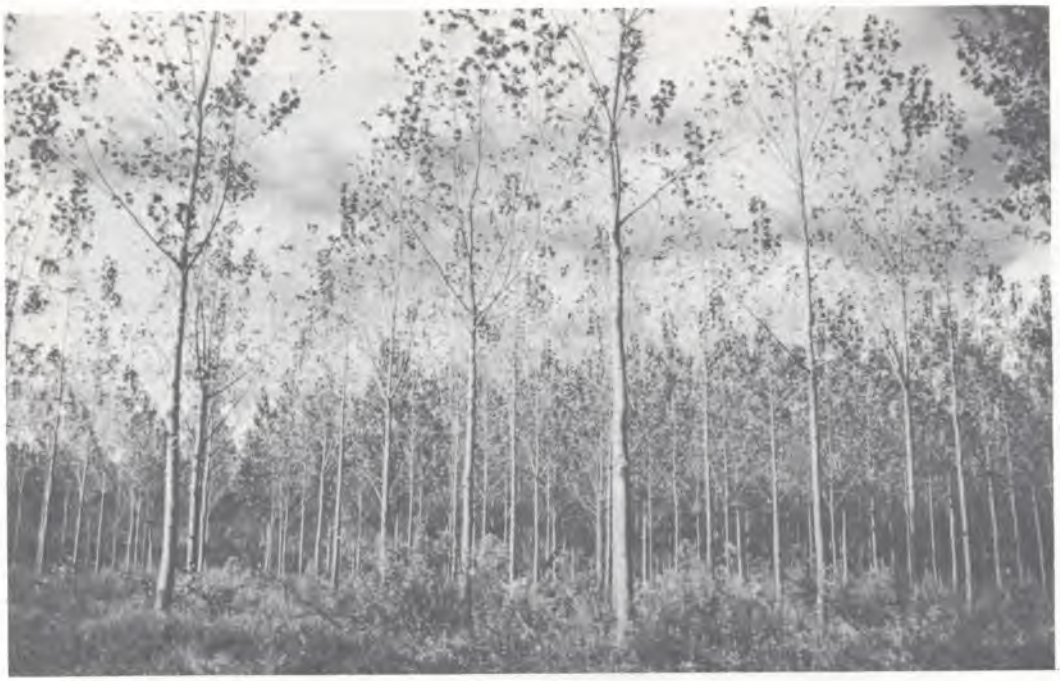

Fig. 6.--Premature defoliation of P. x "Robusta" by Melampsora larici-populina in mid-summer.

Fig. 7.--Dead stand of P. x "Strathglass" after 2 years of M. larici-populina attack. On right P. x Androscoggin less seriously affected.

Fig. 8.--Part of a 15-acre nursery for pole production.

Fig. 9.--Poplars for erosion control on hill country.

Fig. 10.--Trees protected by plastic "netlon" sleeves. Sleeves last 5 years and expand with the tree.

DISCUSSION

Gerhold - I have a comment related to a question that was raised by Jaynes. Lorenzo Mittempurgher told me that in Italy a hyporivulent strain of Endothia parasitica has been injected into active chestnut cankers. The cankers have healed over and there has been natural spread to other cankered trees in the same plantation leading to a remission of the disease. He is very excited about this.

Jaynes - Let me comment on the European situation. There have been some good observations made in France and Italy but publication of data is scant. Published information is often presented in rather obscure publications and details of experiments and data are not presented. Hence it is frustrating for us to evaluate fully the state and fate of chestnut and the chestnut blight fungus in Europe. The information we have is encouraging and we are excited by the prospects for our situation.

Gerhold - French research indicates the presence of a virus that is apparently associated with the hypovirulent strain.

Jaynes - Grente has speculated that a virus is responsible for the "hypovirulent" characteristic. Some attempts have been made to confirm this but the results are inconclusive. One can at least think in terms of virus-like particle being transfered from the hypovirulent to the virulent strain and converting it to hypovirulence.

Schreiner - In one of the early IUFRO reports an Italian pathologist reported that apparently the chestnut trees were developing resistance and were coming back.

Jaynes - I assume that is Biraghi.

Schreiner - Yes, that is right (11th IUFRO Congress, Rome, 1953, pp. 643-645).

Hunt - I wonder if perhaps we could omit branching characteristics in a chestnut selection program, The walnut growers are willing to prune to improve stem quality and there are quite a few nut growers who would be just as happy to have full crowns and increased nut production in lieu of a modest improvement in stem straightness.

Keys - It would be much more desirable to have a naturally pruned tree. However, I think we could drop the branching characteristic and concentrate more on resistance and form. And, as you say, for nut production branchiness is desired.

Hunt - How much would we lose if we avoided that? The branchiness from our selection. How many trees per hundred or how many individuals would you have to throw out on that basis?

Keys - I have my figures somewhere. It is a very high percentage. At least 25 percent would be thrown out.

Wargo - One comment on the branching - another thing that should be considered is that first trees were planted on a 10 x 10 spacing and many of them died along the way. So in terms of taking advantage of mutual shading we are not looking at a typical forest stand, so that should enhance the branching and discourage branch shedding because of wider spacing among the trees.

Keys - Now, I don't think so. Like I say, when we went in, this was overgrown with sprouts of original stands which had overtaken the chestnut and shaded many out.

Santamour - First of all, I would like to say that Dick Jaynes' talk was better than going to church. It has really given me a new outlook on this whole business. The geneticists beat their heads up against the wall for a long time and then along comes a sneaky pathologist - I guess it gives you two options, especially with the propagation possibilities and this probably always was there. You could root sprout material of all of them, and you have some very fine hybrid chestnuts. What direction do you

see your program or would you suggest other programs to go? You could take chestnut seedlings of any origin, plant them out, and inoculate with this hypovirulent strain. Or, to still utilize your hybrids, chop them down, let them sprout, propagate them and sort of give yourself double protection by reforestation with the hybrid and non-resistant materials, plus the hypovirulent strain. You have a chance, I think, to go both ways and which way would you choose?

Jaynes - I really think that it is too early to say. We have to learn a little bit about the spread of the hypovirulent in the fields, from tree to tree, before we put any money down. We should begin to get that information within the next year. I would not suggest going out with hybrids, or asexual propagules at this point. I would think it would be worthwhile setting up test plantings of individual clones, which we haven't done in the past. Trees such as the hybrid Clapper chestnut or large surviving Americans from scattered points within the range are candidates for asexual propagation. If this rooting technique can be somewhat further refined and put into commercial use, I think the first place we are going to see it go is with selected chestnuts for back yards, for the homeowners. I know that we have the trees and the public is interested in them (named selections: Namking, Crane, Sleeping Giant, or Eaton chestnut). I don't see why Stark Borthers or somebody else couldn't really go with them, assuming that they could put that asexual propagation technique on the line. Until you can economically produce trees for the homeowner market there is little chance you can do it economically for forest plantings.

Wargo - Do they take the spore suspensions and inoculate or did you use mycelium?

Jaynes - We inoculate by removing a 4 inch plug of bark with a cork borer, place an agar plug of the same size with the fungus growing on it in the hole, and then tape it to prevent drying.

Wargo - Is it a prolific sporer?

Jaynes - Oh, yes, many hundreds of thousands of spore are produced by a canker. The hypovirulent produces fewer spores than the virulent material.

Wargo - That is what I mean. You haven't been able to or you haven't done it yet? Like spraying the canker with spores?

Jaynes - We have not done that yet.

Holmes - I wanted to ask that too - something about using an atomizer on the wounds? What can we recommend to the arborist and municipal tree warden for practical use this coming season?

Jaynes - Well, I was told that the fungus could be grown in wooden plugs or blanks that could then be shot from a gun. A mechanized way to shoot the hypovirulent strain into virulent cankers.

Holmes - You asked inducing resistance with hypovirulent cultures - I want to reassure you that some ways some of us already are trying this. We got such cultures by crossing cultures of distant origin (Massachusetts and

Netherlands) and growing single ascopores from the resulting perithecia, Then, in the infected trees some of these cultures caused almost no disease symptoms but others caused far more severe disease than in nature. We left these cultures in the Centralbureau voor Schimmelcultures, Baarn, Netherlands because we were not able to bring any cultures into America, But we also got hypovirulence through storage of cultures in test tubes through many years under sterile mineral oil. They lost various characters, including compatibility and sometimes ability to sporulate, and they also lost a lot of their virulence. So at the request of the USDA-ARS Cooperative Regional Research Project NE-25 (now NE-99) Technical Committee, this year I took a number of cultures that had been kept in oil for many years and put them into about a hundred elm trees in our nursery in Hadley, Massachusetts. We got some mild symptoms in some trees and in others no symptoms at all. Then, a month later, we inoculated the same trees (plus control trees) with fresh isolates of C. ulmi. Again, this is in the middle of being done and final readings haven't been made, but we seem to have had no protection from the hypovirulent cultures.

Jaynes - The loss of virulence is a constant problem and worry to us and because of that we seldom inoculate with any laboratory culture more than three months old.

Holmes - I might say that Dr. Wells found that C. ulmi lost virulence many years ago at Cornell, but among other things it also lost its ability to form spores, so all he had left was mycelial growth and he couldn't get it to invade through the tree. To get protection with low virulence, you must get the fungus through the tree.

Ledig - Some of the chestnut hybrids inhibit growth of the virulent fungus, do they also inhibit the growth of the hypovirulent?

Jaynes - I don't think we know that now. We have had the hypovirulent strain under quarantine and it only has been in the last year that we have gone out into the field with it, We are checking that out.

Schreiner - In the forties, the late Dr. Gravatt, at Beltsville, told me they thought they had isolated the chestnut blight from post oak.

Keys - Maybe it wasn't a post oak. It may have been live oak.

Hicks - In east Texas we don't have American chestnut, but we do have allegheny chinkapin (Castanea pumila) and there are numerous chestnut blight cankers on the stems of chinkapin and a few on neighboring post oaks, so it does affect post oak. I haven't seen it on white oak, but it may infect white oak as well.

Santamour - I'm not sure if this is terribly apropos, but Jay Stipes of VPI has been doing a lot of work on it - Endothia gyrosa - the common name is pin oak blight, for want of a better name, but he is finding it through Virginia, I'm sure it occurs in Maryland, on oaks other than pin oaks. It is suspected on live oak, also, but it is culturely and anatomically different than Endothia parasitica. Just recently he got a paper out in Mycologia comparing various species of Endothia.

Schreiner - Gravatt was a very good pathologist; I would assume that he was right.

Santamour - Indeed he was. But the taxonomy of Endothia was not well understood at the time he did his work. It is possible that both E. parasitica and E. gyrosa could be involved in live oak cankers.

Schreiner - Perhaps we are dealing with a variant.

Santamour - A different species?

Schreiner - Well, who can define a species?

Jaynes - No, we are dealing with the same species. Using biochemical markers we have transferred hypovirulence into nuclear marked virulent strains.

Schreiner - In other words, these variants on the oaks are not hypovirulents.

Jaynes - Oh, I don't think so, I would be surprised if there were.

Larsson - I was interested in just ont point on Si Little's paper. Did he see any pronounced differences in the reciprocal crosses between the two species?

Little - We have some, but they are too young to show differences. However, I will say that in the planting that we will see on the field trip on Thursday, the tallest stock in average height at the present time had a loblolly female parent. Loblolly seeds for the information of those who may wonder about seed-size effects may be about 16,000 to the pound, while pitch pine seeds may be about 48,000 to the pound. There should be some initial advantage.

Hunt - I'd like to ask Si if the young plantations anywhere are beginning to bear seed and do you anticipate this seed to be somewhat equal quality with your controlled crosses?

Little - The oldest plantings are only in their fifth growing season.

Hicks - I would like to ask Si a question. I didn't get what the parentage of your loblolly pine checks was. Were they selected loblolly pine?

Little - They varied. For one of the western Kentucky plantings certain check stocks came from selected clones in Virginia. In most cases, one check was regular loblolly nursery stock. In some of the plantings checks included regular loblolly from the Maryland nursery, regular loblolly from seed supplied by the Virginia Division of Forestry, and loblolly seedlings from wind pollination of certain clones in our New Lisbon orchard.

Cech - Do you have any one seed that is common to all of your test plantings?

Little In the test plantings most of the hybrid stocks are different--with only an occasional one repeating, For example, in the four plantings in West Virginia most of the hybrid stocks in each planting are only in that one planting, There are some duplicates - checks plus occasional crosses, In other words if we have four plantings of 60 stocks each within a geographic area, in any planting there are probably 50 that are not in any of the other three.

Cech - Do you have one of the control lots that is present in all plantations?

Little - The seed-orchard pitch pine stock and usually the Korean pitch x loblolly stock are - and usually there are several - between 2 and 10, that provide comparisons among plantings. Some crosses are duplicated in other geographic areas as well: especially in the plantings that were established in a given year. For example, the same crosses that went in in western Kentucky appeared in the West Virginia plantings of those years. Many of the eight test plantings that went in this year contain the same crosses.

Genys - As a point of information I wish to make a comment that I am interested in Dr. Santamour's work. To pursue this interest I have collected scionwood from the two trees which he has described as not having strobic acid - one is Pinus strobus cult. "pendula" and the other is Pinus strobus cult. "fastigiata", - some grafted seedlings of these trees will be planted in western Maryland where we have plenty of Pissodes strobi. This will help us to find out how these trees react in such sites, heavily infested by insects.

Santamour - John has rather carte blanch treatment at the National Arboretum and has some rather interesting things going but the business of testing grafted stock against the weevil bothers me a little. It's one way of approaching it, but I always have that sneaky feeling about what a graft does to the overall system, especially on a young tree. When the thing is up around 20 or 30 feet, okay - but if you are working on a 3-foot grafted specimen, that portion of the two-parted tree which is of unknown root stock origin is a substantial portion of the tissue in the whole system. I just do not know what to expect. But any propagation is better than none at all and any testing is better than none.

Davidson - I tried some pitch x loblolly pine crosses in central Pennsylvania in 1969, these suffered from winter kill. If there are any sources that are winter hardy, I would like to test them on Pennsylvania coal-mine spoils.

Little - I expect that many of our crosses will be cold-hardy in many sections of the Northeast, Westvaco personnel estimate the length of the growing season at the 1972 planting site in West Virginia as only 100 to 110 days,