MODERATOR'S SUMMARY

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When Dr. Schreiner asked me to act as moderator and to review these papers, I was a little bit hesitant because I had heard of some possible differences between silviculturists and geneticists. It is unfortunate that this feeling, that the silviculturists and the geneticists were at odds, should ever have arisen. Actually, if you think back some of the most promising tests were started by early silviculturists. They nay not have been designed in the manner in which we would approve of today. In fact, very few agricultural experiments were well designed a quarter or half a century ago. But when you recall the seed source studies started by hunger, Weidman, Bates, Rudolph, and Wakeley, all silviculturists, I suspect that there isn't too much to the contention that silviculturists and geneticists are at odds.

To sum up the papers of the two speakers, I think that geneticists would agree that, as Dr. Heiberg pointed out, there isn't much we can do in extensive forestry aside from leaving the phenotypically best trees for seed trees. Were passing the stage of extensive forestry in this country hope. As forestry becomes more intensive I think that, as Dr. Heiber pointed out, it will be possible to make improvements by thinning and by planting. He pointed out that we could do this by selecting the best trees' for the crop trees so that they would be the parents of the future stand. When Forestry becomes even more intensive with general planting, we can select the best seed provenance. He pointed out the possibility of developing seed orchards so that we'll always have a source of good seed and he pointed out the possibilities of mass selection in the nursery both at the seed and seedling level. There may not be too much possibility of selecting at the seed level. I think the work of Righter suggested that there as little relationship between seed size and vigor of the seedling. Dr. Heiberg indicated also the possibility of plus tree selection with later development of elite trees and then he suggested that hybridization was a powerful tool but that because of the long period of testing required this technique may not be as important as selection. It's true that the period of testing is long but the interplanting method Righter, who incidentally was a graduate of this University, and is in charge of the Forest Genetics Institute in California, is a possible solution. The interplanting system can be a way of hedging with hybrids. You plant one hybrid to five regular trees, or one to four or some other ratio; and if the superior trees are superior, they take over the stand. If they lose out, you haven't lost much. One point Dr. Heiberg made that the geneticists might disagree with is that the character of a scion, its form or position in

the crown, may determine its future form. I suspect this hoe been true with some species, spruce I believe has a rather peculiar growth habit for a while but it certainly isn't true for poplar and is not true at least for some pines.

Dr. Mergen's caner could well have been rewritten in genetical terms from Dr. Heiberg's. They follow each other closely. Dr. Mergen pointed out the three methods that are applicable from a genetic approach. First is the multiplication of our existing superior trees by mass selection in which we would select for disease resistance, growth rate, or form. These things that the forester can do and is doing. A second technique is hybridization and, as he pointed out, there is a great deal of possibility in such genera as pine which has a great range and a great number of species. The possibility of getting a number of characters combined in one tree is very good. Mergen's third point was the possibility of mutation. I think that's a field that has not been explored as much as it might be. I am not a geneticist but I believe that it is true that through the ages there have been mutations from cosmic radiation. There's no reason to believe that we couldn't hurry the rate of mutation with all the possibilities we have in radioactive isotopes now. Some of you are using the facilities of the Brookhaven laboratory's gamma radiation field and maybe more genetics ought to be working in the field.

I believe that just about summarizes the two papers. We have about a half an hour for discussion from the floor.

DISCUSSION

Ehrhart Some mention has been made of the difference between the geneticist and the silviculturist. I think what comes from either source has to go through the mill of the forest manager. Let me try to illustrate. We hear of the work that's done in the south from the genetical standpoint on selecting seed trees, seed sources and that sort of thing. That's fine where you have conditions as in the south, where you have tremendous barren areas that require planting;. But if you are in a region where you have essentially complete stocking with very little necessity for planting then I think perhaps the emphasis would have to be on the silvicultural side. To think of completely converting an existing forest by replanting with genetically superior stock, excepting on a minor scale under unusual conditions, would be absurd, so it would be up to the forest manager to decide under what circumstances the emphasis should be on silvicultural or on the genetical side.

Zabel I wish to comment on Mr. Mergens paper. The paper is very fine and very nicely analizes genetical approaches to improving the forest. But getting back to his very interesting analogy, there's the distinct possibility that nature will turn that faucet back on about the time he has his floor all mopped up. The insects and fungi are not static, they're changing. Their short life cycles give them tremendous capacity to change, so in these tree improvement programs we may develop a stable, resistant type but find that ou.r fungi and insects are changing.

Bramble I have a question for both the gentlemen. Is it possible to increase the cubic feet volume yield per acre of a given species through any of these methods. I gather it's not, and that the only thing we can do is to produce larger trees rather than more volume per acre.

Heiberg I don't know. It has been the general thought for the last fifty years that we can do that, it seems that we are finding out now that we can't, but I don't know. You're thinking of the org- anic substance the amount of organic material.

Bramble In a forest stand we often have a large number of small trees, can we genetically increase the volume per acre? In other words can we utilize the soil and the air to better advantage with improved trees. What we do with thinning is just put more volume on fewer trees and I'd like to know whether the geneticists is thinking in the same way. Is he thinking of bigger and fewer trees or a higher volume per acre?

Bergen One possible way to increase the total yield and obtain a higher volume per acre per year, is to increase the growth of the young seedlings and maintain the rapid growth, as they mature. A good example of this can be found in a young longleaf pine forest where most of the carbo hydrates are stored in the grasses and lower vegetation. Hardly any growth is added to the longleaf pine seedlings as long as they are in the grass stage. If we can divert these carbohydrates to the trees at an early age by forcing these longleaf pine trees out of the grass stage, we certainly will increase the yield per acre on a. yearly basis. Also, there is the question of efficiency. Two trees having the same volume of foliage and roots do not grow at the same rates. There is some indication that there are differences in efficiency between individual trees of the same species.

Hamilton Concerning this apparent diversity of opinion by Dr. Bergen and Professor Heiberg as to the influence of position on the tree on the growth habit of the scion, I would like to point out that Professor Heiberg emphasized juvenile development of the scion. I recall a few months ago seeing some pictures he brought back from Europe, illustrating that the growth of young beech was influenced by the crown position from which they were taken. Perhaps Professor Heiberg could amplify this.

Heiberg What I was referring to was some testing areas that I had seen in Europe recently and where they were testing the plus trees that have been selected under different environmental conditions. I saw it with spruce, I saw it with beech, I saw it with douglas fir, that the scions that had been grafted were behaving very markedly according to the position of the tree that they were taking from. Side branches were behaving like a side branch for a number of years. Now what is going to happen later on we do not know. Top shoots were behaving like top shoots. The thought I threw out here was proposed testing of the growth capacity of the older in contrast to the younger top shoots to see whether they would behave in the same way when grafted, as they behave on the tree.

Hamilton I'm under the impression that the ornamental horticulture people take advantage of this influence in propagating certain desirable habits of growth. Is this not the case?

Mergen A German scientist by the name of Molish published on the effect of original position of the branch on the subsequent development of the propagules. He had some illustrations which showed that a branch from the lower part of a tree grew parallel to the ground after it was outplanted, and propagules from the upper part of the crown showed a normal growth pattern. In subsequent studies this type of creeping growth was found to persist only in some of the spruces. Very often, when one induces root formation on a cutting one or two small roots are formed at the base. Then these rooted cuttings are outplanted in the forest or in a test garden they do not have an adequate root system to keep them upright. Sometimes the slightest wind movement bends them over. When we used guy wires to stabilize slash pine cuttings we obtained well formed, erect trees. If, however, they were allowed to become established without any support, they appeared to have a semi-prostrate growth pattern. The general consensus of opinion at present seems to be that trees in general have short memories; cuttings don't remember for too long a period from which position on the tree they come.

Schreiner There is evidence for what might be called "cytoplasmic condition ing" that may last for some time. For example, about 30 years ago I felled a 25-year-old Chinese poplar and took cuttings from all branches from the top to the bottom of the tree. The cuttings from lower branches produced prostrate trees in which even the leaders bent toward the ground. After about 4 years however an erect trunk began to develop. There was a temporary conditioning which obviously was not genetic. Furthermore, when we took cuttings from the new wood developed on a prostrate 1-year-old tree from such a lower branch of the old tree, they immediately produced normal trees. I think I've seen some of the things that Svend was mentioning. At Edkebo, Sweden, they had a very good example of a grafted spruce which at 12 years looked just like the top of an old tree stuck into the ground.

Heiberg Two very interesting things have been published by Schaffalitzky de Muckadell. Line thing was that he took branches of old and young beech trees and grafted them in the same hedge. The younger beeches kept their leaves on just as we see our younger beeches out in the forest here, and many of us think that the wind has not removed them, while the older trees lose their leaves. Exactly the same thing was done by grafting on the older tree. Another thing, I saw was connected with western red cedar. They had a disease that makes it very difficult to raise red cedar in the nursery and what they then have done is take a nursery bed that has been producing in the ordinary manner by seeds and then they have brought in from older parts of the western red cedar small branches and rooted them and they were completely resistant. There was not one that had been attacked while the ordinary nursery produced western red cedar were all killed. Again an example of this juvenile characteristic contrasted with senile characteristics.

Baldwin I have a question I'd like to throw out chiefly in comment on Prof. Heiberg's paper. I believe I have made as cruel attacks on wolf trees as anyone, both with the axe and the pen, but when he was reading the paper I was wondering if some wolf trees became so because of superior growth. If a wolf tree is larger than the other trees is there a possibility that this was genetically controlled? Rapid growth is one of the very things

we're trying to get and if we want to get greater production per acre it can be obtained chiefly by growing larger trees faster. Should we not examine the genetic makeup of some of these wolf trees which all foresters have been taught to eliminate for the good of the stand as a whole. The other point that I'd like to make is related to the first. I can't resist the impulse to decry again the overworked term "selective cutting" chiefly as practiced in white pine. This is an intolerant species which normally grows in even-aged stands; yet it seems to be the accepted custom to advise, the private owner to cut the largest trees in a partial cutting. Now those large trees may be plus trees. I don't know. They probably are not in all cases, but we don't know. What we do know is that they are rapidly growing trees. Certainly we should examine our silviculture in the light of the remarks Professor Heiberg has made.

Heimburger. I think Dr. Baldwin is right, that we should not completely ignore the fact that some wolf trees are there because of their superior growth. Another thing which I would like to emphasize for instance with white pine, is that within a species there may perhaps be differences in tolerance. So for instance in an old field, the first trees which invade are usually white pine that are able to establish themselves in an old field and therefore are more or less of a pioneer nature, and because they have room to grow they develop into big cabbage heads and wolf trees. Yet, if treated properly some of them, not all of them, may be just what we want in intensive forestry to produce a stand with the least possible cost, and it is certainly cheaper to just plant the stuff instead of growing a nurse crop and then underplant. And if we can select within an intermediate tolerant species like white pine, a strain which will be able to grow on an open field and with reasonable care produce good trees, so much the better, and some wolf trees may under certain conditions become quite acceptable.

In respect to the type of growth we get from grafts, I don't think that grafts are suitable for testing. It is the offspring of the graft which we want to test in the bush. The grafts grow crooked and in many cases it is desirable to grow crooked grafts, otherwise people steal them for Christmas trees. It is useful that they are crooked and in fact in some of the white pine grafts I out the tops off to make them bushy and undesirable for Christmas trees, in order to assure that we can retain them.

Hutchinson I do not wish to enter into the discussion so far as this area and this association is concerned but I would like to say something with regard to the general problem of seed certification as it effects British Columbia. At the same time I am going to make an apology for. British Columbia regarding some of the things that we have not been doing. I would like to subscribe very strongly to what has been said regarding the germ test for seeds, this would seem to indicate that we should know more, by means of the germ test, about the genetics of the parent, if we are going to provide for forest improvement.

Now, British Columbia has distributed Douglas fir seed throughout the world and in many cases there has been good success with these seeds but the result has not always been satisfactory. Too often the seeds have been collected from those trees which were the most easily climbed scrubs. Too often they have been collected from areas which have been denuded, largely,

of their superior forests or have been taken from non managed second growth; and our natural, second growth in some cases is not equal to our original growth. In other words, we have not subjected these trees to the germ test or these seeds to the progeny test. The result is this, several years ago representatives from Denmark came over to British Columbia and suggested that we improve our methods. Well we have not done very much about it so now we have in British Columbia representatives from Denmark who are collecting the seeds for themselves on a more scientific basis.

Something has been done however, we have several graduate students, who are in the employ in some cases of the Dominion Government and in another case the Provincial Government, who started their experiments at the University in the first place and who are carrying, out progeny tests with Douglas fir and with pines, particularly in the case of pries, for rust resistance. Seed is being selected from superior stands and from superior individuals and germination tests are applied. Pore general genetic tests are planned which undoubtedly will result in better seed and ultimately, improved forests. Extensions of these selective, genetic procedures are being recommended, with a view to the development of disease resistant, structurally superior, vigorous, ecologically adapted, fruitful forest trees, in order to compensate for the increased rate of current utilization.

Ashworth Has anyone here working on the subject of induced mutations used virus disease as a source of variation? I've noticed it in apple trees and potatoes. I was wondering if anyone had used it in trees?

Hansbrough I wouldn't want to say authoritatively that the method has never been used. I just don't know of any such use.