PROCEEDINGS OF THE FIFTH MEETING OF THE COMMITTEE ON FOREST TREE BREEDING IN CANADA

September 19 and 20, 1957

PART I

MINUTES AND DISCUSSIONS

PROCEEDINGS OF THE FIFTH MEETING OF THE COMMITTEE ON FOREST TREE BREEDING IN CANADA

Held at Petawawa Forest Experiment Station, Forestry Branch, Department of Northern Affairs and National Resources, Chalk River, Ontario, on September 19th and 20th, 1957.

Attendance

J.S. Ball	Dept. of Lands and Forests, Reforestation Division, Toronto, Ontario.
R.M. Belyea	Dept. Agriculture, Forest Insect Laboratory, Sault Ste. Marie, Ontario.
A. Bickerstaff	Forestry Branch, Ottawa, Ontario.
A.J. Carmichael	Dept. Lands and Forests, Tree Seed Plant, Angus, Ontario.
W.H. Cram	Dept. of Agriculture, Forest Nursery Station, Indian Head, Saskatchewan.
B.W. Dance	Dept. of Agriculture, Forest Biology Laboratory, Maple, Ontario.
J.L. Farrar	Faculty of Forestry, University of Toronto, Toronto, Ontario.
D.P. Fowler	Dept. of Lands and Forests, Southern Research Station, Maple, Ontario.
D.A. Fraser	Forestry Branch, Petawawa F.E.S., Chalk River, Ontario.
M.J. Holst	Forestry Branch, Petawawa F.E.S., Chalk River, Ontario.
R.G. Hitt	University of Wisconsin, Madison, Wisconsin, U.S.A.
A.P. Leslie (Chairman)	Dept. of Lands and Forests, Southern Research Station, Maple, Ontario.

A.W. Khan	Forestry Department, Government of East Pakistan.
H.G. MacGillivray	Forestry Branch, Fredericton, N.B.
F. Mergen	School of Forestry, Yale University, New Haven, Connecticut, U.S.A.
R.J. Moore	Dept. of Agriculture, Science Service, Ottawa, Ontario.
I.C.M. Place	Forestry Branch, Petawawa F.E.S., Chalk River, Ontario.
R. Pomerleau	Dept. of Agriculture, Forest Biology Laboratory, Quebec, P.Q.
M.L. Prebble	Dept. of Agriculture, Forest Biology Division, Ottawa, Ontario.
H.A. Senn	Dept. of Agriculture, Division of Botany and Plant Pathology, Ottawa, Ontario.
H.S.D. Swan	Pulp and Paper Research Institute of Canada, Montreal, P.Q.
C.W. Yeatman (Secretary)	Forestry Branch, Petawawa F.E.S., Chalk River, Ontario.

64. Welcome

Mr. Leslie welcomed the guests: Mr. R. G. Hitt, University of Wisconsin, Mr. A. W. Kahn, East Pakistan, and Dr. Francois Mergen, Yale University.

65. Minutes of the Last Meeting

The minutes of the last meeting had been prepared and distributed to members by the Department of Lands and Forests of Ontario under the direction of Mr. Leslie, Chairman of the meeting. The minutes were adopted with the following correction: the title and address of Dr. G. S. Allen, given in Appendix "P", Membership, should read "Dean, Faculty of Forestry, University of British Columbia, Vancouver, B.C.

66. Business Arising from the Minutes

(a) Membership - The following men were elected members of the Committee:

Dr. R. M. Belyea	Officer-in-Charge, Forest Insect Laboratory, Sault Ste. Marie, Ontario.

Mr. D. P. Fowler	Research Division, Dept. of Lands and Forests of Ontario, R.R. No. 2, Maple, Ontario.
Dr. I.C.M. Place	Officer-in-Charge, Petawawa F.E.S., Chalk River, Ontario.
Dr. L.T. White	Officer-in-Charge, Forest Pathology Laboratory, Southern Research Station, R.R. No. 2, Maple, Ontario.

Mr. Bickerstaff gave notice that Mr. J.D.B. Harrison wished to stand down from the Committee, and that Dr. D. R. Redmond, Chief, Forest Research Division, Forestry Branch, Ottawa, would take his place.

Dr. Farrar gave notice that Mr. K. A. Armson wished to resign from the Committee.

(b) Lectures on Tree Breeding

A list of the names of Committee members who were prepared to give lectures at universities was sent to the University of Toronto, Laval University and the University of New Brunswick. Only one lecture was given during the past year: Mr. Holst spoke at the University of New Brunswick.

(c) Tree Breeding Substations

Two hundred acres have been set aside at Turkey Point, near St. Williams, Southern Ontario, for the establishment of frost susceptible species and races of interest in the eastern Canadian tree breeding program. Twenty acres had been selected by Dr. Heimburger for clearing for planting in 1958.

(d) Distribution of Proceedings

A lengthy discussion was held concerning the form of publication of the Proceedings for distribution to non-members of the Committee.

The following motion, moved by Dr. Cram, seconded by Dr. Moore, was adopted:

"a) that the Proceedings should include the member reports in full,

b) that the minutes and the reports should be bound separately to form two parts to the Proceedings,

c) that the minutes be distributed to members only,

d) that the reports receive a general distribution to interested parties,

e) that the restriction "not for publication" be removed, and

f) that in future members should provide the secretary with the required number of copies of their reports, prepared on 8 1/2 x 11 inch paper to a standard format."

(e) Genetics Society of Canada

It was reported in a circular of 27th April, 1957, that Dr. Boyes, Chairman X International Genetics Congress, had replied that careful consideration would be given to a request by the Committee that a section on Forest Tree Genetics be formed within the Congress.

After some discussion of the complexities and responsibilities involved in organising such a section, the Committee concluded that a separate section on Forest Genetics in the X International Congress was not warranted. Participation in the Congress by members was encouraged by the Committee.

Mr. Leslie read a letter from Dr. A.W.S. Hunter concerning proposed exhibits at the X International Genetics Congress, Montreal, 1958. Dr. Hunter suggested that the Forest Tree Breeding Committee, or certain members of it, might wish to set up an exhibit on forest genetics. The exhibition is to be staged in the Winter Stadium of McGill University and will be open to the public. Members expressed interest in the project and noted its publicity value.

The following motion, moved by Dr. Senn, seconded by Mr. Swan, was carried:

"that the executive be authorised to explore, by means of a circular letter, the possibility of members setting up exhibits."

(f) Exchange of Observers

Mr. MacGillivray attended the Fifth Northeastern Forest Tree Improvement Conference held at Orono, Maine, 22-23 August, 1957.

Dr. Cram reported his visit to the meeting of the Lake States Tree Improvement Committee.

The report "The Lake States Forest Tree Improvement Committee, Its Purpose and Activities" was received from Dr. Paul O. Rudolf, and tabled by the Secretary for inclusion in the Proceedings.

67. New Business

(a) Co-operation with the Forest Insect Laboratory, Sault Ste. Marie

Mr. Holst reported that discussions had been held on the 18th September with Dr. Belyea, Dr. Prebble and Mr. Fowler concerning co-operation with the Department of Agriculture in the testing of hard pines for resistance to European shoot moth.

Dr. Prebble pointed out that it is not the function of the Forest Biology Division to take part in tree breeding as such, but that they would be glad to help in tests that are of specific interest to tree breeders for assessing disease or insect resistance.

(b) Fifth Northeastern Forest Tree Improvement Conference

Mr. MacGillivray read the following report of the conference which he attended.

Notes on the Fifth Northeastern Forest Tree Improvement Conference
(by H.G. MacGillivray)

The conference was held at the University of Maine, Orono, Maine, on the 22nd and morning of the 23rd August, 1957. The reports and technical papers as well as the discussions will be published at a later date.

22 August - Morning Session

The morning session, under the chairmanship of E.L. Giddings, consisted chiefly of brief outlines or summaries of the work being done in the (1) Northeast, (2) the Lake States, (3) the South, (4) in California, and (5) at Maple, Ontario. Reports for the Pacific Northwest and Canada will appear in the Proceedings.

R. I. Ashman, Professor of Forestry at the University of Maine, gave a talk on the possibilities of Norway spruce as a forest tree in Maine. Norway spruce, because of its good growth and adaptability to climatic and soil conditions in Maine, should do well in that area. Its growth generally exceeds that of native spruces. Damage to the leader by red squirrels and weevils is a limiting factor. Gall aphid damage is not serious in Maine.

Afternoon Session

A demonstration took place during the afternoon session on the Penobscot Experimental Forest of the Northeastern Forest Experiment Station. The possibilities and limitations of genetical mass selection in the spruce - fir type were discussed under the chairmanship of E. Schreiner.

The method demonstrated was referred to as "genetical improvement conversion". The object of this method is the continuous but possibly slow improvement of the genetical composition of the stand as a whole. To attain this aim the cutting is directed so as to remove the undesirable phenotypes leaving the best to supply seed for the regeneration. A further step is the introduction of "exotics" known to be of better genetical quality than any regeneration that would naturally be produced in the stand. These "exotics" could be turly exotic, such as Norway spruce which will grow faster than the local spruce or they could be the progeny of an elite strain of white spruce of quite local origin.

The possibilities of using several exotic species were discussed. Norway spruce seemed to be the most desirable species. A suggested measure to help eliminate weed species was to have the cutters drop the tops, during cutting operations, on undesirable regeneration thus crushing the weed species and not having the top occupy space that could be used in culturing desirable regeneration.

On the return to the campus, Professor Fay Hyland conducted a visit to the Botanical Plantation to examine the growth of several exotic species, some of which may have use in forestry in the northeast.

Evening Session

A picture session was held immediately after the banquet. Interesting slides were shown by various workers. These pictures covered a wide range of subjects such as vegetative propagation, maple sugar studies, differences in needle retention between individual Christmas trees from the same plantation, the selection of superior trees, nursery work, and differences between the seedlings of various races and strains.

23 August - Morning Session

The morning session, under the chairmanship of H.C. Buckingham, consisted of the presentation of several technical papers.

Francois Mergen of the Yale Forestry Research Center gave a very interesting paper on air-layering Norway spruce and blue spruce. The trees used in this work appeared to be quite young. However, Dr. Mergen indicated to me after the session that he had successfully rooted flowering branches. Some branches bear flowers after having been severed from the parent tree.

P.O. Rudolf, Lake States Forest Experiment Station, presented a report prepared by himself and Hans Nienstaedt on spruce improvement research at the above-mentioned Station. The increased scion growth brought about by exposing rootstock and grafted plants to a long day in comparison to the growth produced by grafted scions exposed to a short day was quite striking. The combination of long day and low temperatures gave best results. Long days were 20 hours and short days 13 hours. Ordinary fluorescent lamps were used.

Lindane was credited with giving partial control of cone insects.

A paper entitled, "Relation Between Growth and Unit Rate of Photosynthesis in Forest Trees" was presented by Philippe Bourdeau of Yale Forestry Research Center. It was shown that the greater the efficiency of the photosynthesis mechanism of the leaf the greater would be the growth potential of the plant. One practical use of this work in tree breeding might be to predict the growth potential of trees while they are still seedlings. Dr. Bourdeau pointed out that tolerant trees have a lower light requirement for photosynthesis than intolerant trees and that they can therefore continue to grow in the shade.

J. R. McWilliams, Yale Forestry Research Center, presented a paper dealing with (1) germination tests of Pinus pollen at different temperatures and (2) the temperatures of receptive female flowers (strobili) (a) isolated by different methods as well as (b) non-isolated flowers as control.

The best pollen germination and tube length development was obtained at 30 to 32°C but good results were obtained over a fairly wide range of temperatures. In the field, the flowers isolated by sausage casings having the more exposed parts painted with aluminium paint gave temperatures which more closely approached those of the control than did the plain sausage casings or combination of sausage casing and kraft paper bag.

J. D. Diller of the Northeastern Forest Experiment Station gave a brief account of a survey made by requesting people to report the locations of old (mature) American chestnuts. Numerous mistakes in identification of this species were made by co-operators who reported on trees which turned out to be horse-chestnut, oriental chestnut or immature trees. Slides were shown of some promising tree breeding material. Scions from chestnut tree breeding material are distributed to co-operators for trial in different regions.

Dr. Graves, involved in breeding for resistance to the chestnut blight, gave a brief account of the success that he had in inducing early flowering on immature chestnut hybrids by using Karl Sax's phloem block method. Here the method inverting bark rings was used on branches rather than on the main stem. The treated branches were the only ones that produced flowers.

F.V. Klaehn of the College of Forestry, Syracuse, presented a paper on flower morphology of some important Fraxinus and Acer forest trees. Slides were used to illustrate the mixture of sexes that occurs in the flowers of these genera. It was indicated that some species of these genera are still in the process of evolving from insect pollinated species to wind pollinated species.

C.A. Bickford, Northeastern Forest Experiment Station, gave some practical advice on some considerations in designing experiments in forest genetics research. He warned that the statistician could be of much greater help if approached before the experiment was designed than after it had been started, and that statistics were no substitute for good common sense.

Two papers not presented at this time "Blister Rust Resistance in Eastern White Pine" by R.F. Patton and A.J. Riker, University of Wisconsin, and "Some Practical and Biological Considerations in Designing Experiments in Forest Genetics Research", by E.J. Schreiner, Northeastern Forest Experiment Station, will likely be published in the Proceedings.

The conference terminated following the re-organization of the standing committees and the presentation of resolutions.

An informal discussion followed of techniques which may be used for the induction of flowering in trees.

(c) Letter from Dr. N.H. Grace, Director, Research Council of Alberta.

The following message from Dr. Grace was read to the Committee:

> " Will you please convey my congratulations to the Committee members for their diligence, for the excellent work and the fine work spirit which they display".

(d) International Co-operation for the Establishment of Test Plantings of Important Tree Species in Several Continents, with regard to Resistance to Disease and Pests.

A copy of a letter from Mr. J.D.B. Harrison, Forestry Branch, to Dr. J. E. Bier, Forest Biology Division, was received by the Chairman. The letter commented on a paper with the above title which had been prepared by Dr. Bier. However, no specific proposals were presented to the committee. Mr. Holst commented that he had reviewed the paper, but that he felt the program was too general and that particular problems should be taken up as they become evident.

(e) International Botanical Congress, 1959

Dr. Senn brought to the attention of the Committee that the International Botanical Congress would be held in Montreal, August 19-29, 1959. The Congress would cover almost every aspect of plant science. No action was required by the Committee, but there were certain matters which were of interest:

(i) At the last meeting of the Congress held in Paris it was recommended that the section on Forest Botany be discontinued at future meetings, and that papers should be heard in the appropriate sections of plant science such as physiology, ecology, etc. The program committee was looking for further guidance in this matter, the current impression being that a separate section on Forest Botany was still desired by many. Members were asked for their comments.

(ii) The field trips constituted an important part of the Congress. At present the field trip subcommittee was considering the organisation of a forest botany trip in Quebec, and possibly another centering on Petawawa Forest Experiment Station. A third trip was being planned dealing primarily with the boreal forest in northern Ontario and Quebec. Other trips not of specific reference to forest botany were being planned.

The co-operation of everyone involved in forest botany was requested, including the forest industries.

The following resolution, proposed by Dr. D.A. Fraser, seconded by R. Pomerleau, was adopted:

"The Tree Breeding Committee is in favour of a Forest Botany Section at the 9th International Botanical Congress to be held in Montreal, August, 1959".

(f) Agenda

The following motion, proposed by W.H. Cram, seconded by M.J. Holst, was carried:

"That a formal agenda should be distributed in advance of future meetings of the Committee."

(g) Organisation of Committee Meetings

The following motion, proposed by J.L. Farrar, seconded by R. Pomerleau, was carried:

"That in future a business meeting of the Committee be held prior to and distinct from the conference, at which technical papers would be delivered and discussions held".

68. Location of Next Meeting and Election of Officers

The Committee decided that the Sixth Meeting should be held in British Columbia in 1958, tentatively in September.

Dr. A.L. Orr-Ewing was elected Chairman for the 6th Meeting, Mr. Yeatman to continue as Secretary.

69. Discussion Arising from Members' Progress Reports

Active members had distributed their annual reports in advance of the meeting. The following notes from the discussions arising from the reports are included in the minutes of the meeting in accordance with the motion proposed by Dr. Cram, seconded by Mr. Swan.

Reports were tabled as listed below, and are to be published as Part II of the Proceedings.

Index	Name	
A.	A.J. Carmichael	Angus, Ontario.
B.	W.H. Cram	Indian Head, Saskatchewan.
C.	B.W. Dance	Maple, Ontario.
D.	J.L. Farrar	Toronto, Ontario.
E.	D.A. Fraser	Chalk River, Ontario.
F.	C.C. Heimburger	Maple, Ontario.

Index	Name (cont'd)	
G.	M.J. Holst	Chalk River, Ontario.
H.	A.H. Hutchinson	Vancouver, B.C.
I.	H.G. MacGillivray	Fredericton, N.B.
J.	R.J. Moore	Ottawa, Ontario.
K.	A.L. Orr-Ewing (in absentia)	Victoria, B.C.
L.	R. Pomerleau	Quebec, P.Q.
M.	W.A. Porter (in absentia)	Victoria, B.C.
N.	P.O. Rudolf (in absentia)	St. Paul, Minnesota, U.S.A.
O.	H.A. Senn	Ottawa, Ontario.
P.	W.H. Cram	Paper: Spruce Cone and Insect Problems
Q.	R.G. Hitt	Madison, Wisconsin, U.S.A.
	F. Mergen	Yale Forest Research Center, Valhalla, N.Y., U.S.A.
	M.J. Holst	Talk: Breeding of Spruce and Hard Pines.

A. A.J. Carmichael

Dr. Farrar congratulated Mr. Carmichael on the maps contained in his report. These showed clearly the layout and design of the field experiments, and the geographic locations.

A discussion arose concerning the arrangement of clones in seed orchards. Mr. Carmichael said that his original plan had been to plant clones in alternate rows, but this was now thought to be unsuitable because of the liklihood of self-pollination. It was now the intention to use the more elaborate systematic arrangements which have been developed in Germany. Dr. Mergen suggested that the 'knights jump' system might be useful. This was illustrated as follows:

A B C D E F G H I J ..... Row 1.

D E F G H I J A B C ..... Row 2.

G H I J A B C D E F ..... Row 3.

J A B C D E F G H I ..... Row 4.

C D E etc.

where each letter stands for a clone, whose members are scattered systematically throughout the seed orchard. Mr. Holst advocated the use of a wide distance between plants at the time of planting. This should allow adequate space for crown development and thinning should not be necessary.

It was suggested that 10 clones were too few to have in a seed orchard. Dr. Mergen said that 12 clones were commonly considered to be a minimum.

Dr. Cram introduced the question of the number of plants per plot and the number of replications which should be employed in provenance experiments. He stated that in a recent discussion at the Lake States meeting the feeling was for few plants and many replications. Mr. Holst pointed out that in Europe the approach was flexible. Mr. Fowler said that Dr. Heimburger preferred larger plots, 1) to simulate stand conditions, and 2) to provide greater possibilities for the selection of individual trees within the plots. Mr. Holst commented that at Petawawa two types of plantations were established with provenances, 1) designed experiments in which statistical principles were followed, and 2) observation plots, which consisted of large plots within which selections could be made. It was generally agreed that the details of design must vary with the objectives of the particular experiment, and with the environment in which it is to be established.

B. W.H. Cram

Questions were raised on the problem of spruce provenances in Saskatchewan, cross compatibility in Caragana, and the rooting capacity of aspens. No work had been done on the last matter.

Mr. Carmichael and Dr. Cram discussed seed germination tests with respect to the period of time taken to determine the germination capacity of a seed sample. Dr. Cram had used 30 days for his standard, while Mr. Carmichael claimed that at Angus 12 - 15 days gave results more in line with the results obtained in the nursery seed beds.

In answer to Dr. Farrar's question on the need for stratifying black spruce seed, Mr. Carmichael said that after two or three years of cold storage germination was commonly 90 - 95 per cent without stratification.

C. B.W. Dance

On the question of vegetative propogation of aspens, Mr. Holst suggested that the constant mist propogation chamber may be effective for the promotion of roots.

In answer to a question by Dr. Pomerleau, Mr. Dance discussed the perfect and imperfect stages of poplar pathogens.

Mr. Holst mentioned the susceptibility of the Populus tremula x tremuloides hybrid to attack by Valsa nivea. It appears

that the triploid hybrid from a tetraploid P. tremula and diploid P. tremuloides was more resistant to the disease. The question was of great concern in Sweden where the diploid hybrids had been mass produced for sale. The disease does not become apparent in these hybrids until they are about 12 years of age.

A discussion was held of the pathogens which are to be found on Populus species and hybrids in Ontario.

D. J. L. Farrar

Dr. Farrar commented that he had been impressed by the variability of growth response of individual seedlings under the long day treatments. The question of forcing the growth of seedlings by extending the day length with artificial light was discussed at greater length. Dr. Mergen commented that attempts had been made to overcome the mutual shading effect of foliage by hanging bright metal streamers over the seed beds. These reflected a portion of the incident light at various angles into the foliage. Dr. Senn discussed the problem of separating the effects of temperature and light.

Mr. Holst introduced a discussion by asking how dormancy in trees might be overcome quickly. Dr. Senn referred to the work of Helmer in California who has been working on this problem.

E. D. A. Fraser

Replying to a question by Dr. Farrar, Dr. Fraser said that flower primordia in spruce are laid down in August, and that the female flower primordia preceded the male flower primordia. More flower primordia are laid down when both day and night temperatures are high, but with a difference between them.

F. C.C. Heimburger

Mr. Fowler offered to answer questions concerning Dr. Heimburger's report. In reply to a question by Mr. Holst, Mr. Fowler said that needle fascicles with shoot buds had been successfully bud grafted. He pointed out that after the top of a shoot is cut off to induce the formation of buds in the needle fascicles, the needles below the cut should be thinned. The thinning promotes bud formation along the length of the shoot. With no thinning, buds form only in the needles close to the cut, which results in crowding and makes it difficult to collect the fascicles with a little bark attached.

Mention was made of Dr. Slankis' success in rooting needle fascicles at Maple, but no buds were formed and hence no shoot growth could occur. Mr. Fowler had attempted to root needle fascicles with buds but so far without success. A discussion followed of techniques for propagating cuttings, including the use of hormones, constant mist chambers, time of collection, type of basal cut, etc.

On a question of stratification, it appeared that red pine seed from the south and from the north of the range of the species required a shorter period of stratification than did that from the middle of the range.

Mr. Fowler commented on other methods of overcoming seed dormancy. Cones were collected when still green and the seed excised, but embryo development was incomplete and the attempt failed. This year the seed coats were removed shortly after the seed was extracted from ripe cones and the naked seed germinated immediately.

Mr. Carmichael noted that it had been reported that asphalt emulsion when used for summer grafting had a depressing effect. Mr. Fowler outlined the procedure he had used for summer grafting. It was carried out in July when the current year's shoots were in a semi-succulent stage, buds beginning to form, the needles not fully elongated and the stem still quite soft. A cleft graft was employed, protected by a double bag, glassine inside, covered by a kraft paper bag. Asphalt emulsion was satisfactory with this combination of bags, but resulted in a lower survival when plastic protective bags were used. However, the effect was on survival only; the asphalt emulsion did not depress the growth of the successful grafts.

The question of field vs. greenhouse grafts for the establishment of seed orchards was debated. Mr. Carmichael suggested that if field grafts failed, significant gaps may occur in the seed orchard. Mr. Holst felt that it was cheaper and safer to graft in the greenhouse so that only healthy plants, which would be certain to survive, were planted in the seed orchard. However, the technique of grafting in the field is of value for rejuvinating mature material.

Mr. Fowler said he had grafted up to 40 scions of red pine into the crown of a single Scots pine, and in a relatively short time he expected to obtain a large crown of the grafted material.

Mr. Hitt preferred field grafting onto small stock for seed orchards. A number of scions may be grafted on each tree. Tests gave a satisfactory result with 65 per cent survival of the scions. He grafted red pine onto red pine. Further discussion ensued concerning methods of protecting grafts in the field, including bagging and dipping the scions in liquid latex.

G. M.J. Holst

Mr. Carmichael asked how much work was being done with birch at Petawawa. Mr. Holst said that little work was being done, beyond the acquisition and propagation of interesting lots of birch seed. The seedlings were transplanted to arboreta where he hoped that some day they would provide useful material for detailed study.

In response to a question by Dr. Cram, Mr. Holst replied that the results of control pollinations in spruce had been variable, but a few seedlings were obtained from most crosses, and some crosses yielded many seedlings. An important factor to be considered is the estimation of the crossing value of individual trees. This has yet to be worked out.

Mention was made of an attempt at Petawawa to isolate the top of the crown of a spruce with a specially constructed tent. This may be a very useful technique to facilitate self-pollination.

Dr. Farrar asked how seedlings were raised from hybrid seed. Mr. Holst said he preferred to sow in the fall, but this was not always practicable. More frequently the seed is stratified 8 - 10 days in slightly acid water, then sown in specially protected beds in the nursery, the soil of which had been steam sterilized shortly before sowing. This latter procedure practically eliminated damping off.

H. A.H. Hutchinson

As the author was not present at the meeting no discussion was held.

I. H.G. MacGillivray

In reply to a question by Mr. Carmichael, Mr. MacGillivray described the veneer graft, in which both the stock and scion are sliced on one side only; and the side graft, in which a slanting slit is made in the side of the stock, and the scion sliced on both sides to fit into the slit of the stock.

Dr. Prebble and Mr. MacGillivray discussed the selection of balsam fir for resistance to spruce budworm attack. Outstandingly green trees were selected, some may be misses or late flushing types.

J. R.J. Moore

Dr. Moore commented that since his report had been written he had obtained eight seeds from the polyploid branch Caragana arboresens, and now had two seedlings.

A discussion arose concerning the analysis of hybrids by the Anderson diagrams and other means.

Dr. Cram asked whether the polyploid branch was more vigorous than the normal diploid branches. This was not so. No practical advantages had been noted in the polyploid material which is only a curiosity so far. Dr. Cram commented that if genetic factors for vigour could be doubled in a tetraploid, which is then crossed with a diploid to obtain triploids, the sterile triploids may display outstanding vigour as they would not be subject to loss of production through flowering and seed formation. Difficulties often arose, however, with the viability of the tetraploids.

K. A.L. Orr-Ewing

As the author was not present at the meeting no discussion was held.

L. R. Pomerleau

A discussion arose concerning the introduction of exotic species of elm which may be resistant to the Dutch elm disease. Dr. Pomerleau explained that the Chinese elm, which is resistant to the disease, is not useful for breeding with the native species because it has a different chromosome complement. A number of resistant European elms have been imported. Methods of innoculation were discussed.

M. W.A. Porter

As the author was not present at the meeting no discussion was held.

N. P.O. Rudolf

The paper "The Lake States Forest Tree Improvement Committee, Its Purpose and Activities", was received from Prof. Rudolf and is included in Part II of the Proceedings for the information of members.

O. H.A. Senn

In response to a question by Dr. Cram, Dr. Senn discussed the results of field-planting the seedlings raised under controlled conditions in the greenhouse. The responses of individual seedlings to the day length and light intensity treatments vary considerably.

P. W.H. Cram

Spruce Cone and Insect Problems - Dr. Cram read his paper to the Committee. There followed a general discussion of the topic by Mr. Holst, Dr. Cram and Dr. Prebble.

Q. R.G. Hitt

Mr. Hitt outlined the tree breeding program at the University of Wisconsin, which includes individual tree selection, provenance trials and special studies. In response to a question from Dr. Farrar, Mr. Hitt said that attempts to air layer white pine had been unsuccessful so far. However, the work had had to be done late in the season. Bridging of the callous across the wound had frequently occurred.

A general discussion developed concerning the techniques of vegetative propagation.

F. Mergen

Dr. Mergen described the work being carried out and the facilities available at the Yale Forestry Research Center, Valhalla, New York. A number of slides depicting the buildings and plant material were shown. Dr. Mergen pointed out that emphasis was given to basic research not necessarily related to practical application.

M. J. Holst

What is Possible in the Breeding of Spruce and Hard Pines? -

Mr. Holst outlined to the Committee the approaches which he is making for the genetic improvement of the spruces and hard pines of eastern Canada.

In white spruce the basic question to be worked out is the racial variation within the species over its geographic range, i.e., the provenance problem. Within this framework, selection of superior genotypes for seed production could be expected to result in some improvement in the potential value of seedling stock for reforestation.

The red x black spruce hybrids held out interesting possibilities for obtaining heterosis on certain forest sites.

Little is to be expected from single tree selections made with red pine, particularly on botanical or form characteristics, as the species is peculiarly uniform in these respects. It seems possible that the red pine may be divided into separate uniform families, each of which is derived from a few parents which have escaped fires. The testing of red pine families is stressed in the breeding program with this species.

Little work has been done at Petawawa with the breeding of jack pine. Some hybrids have been established in the plantations and arboreta, and it is the intention to attempt to cross jack pine with the southern P. virginiana types. Hybrid vigour in the jack x lodgepole pine hybrid, such as reported at Placerville, has not been demonstrated at Petawawa.

A program of breeding of red pine resistant to the European shoot moth is being carried out in co-operation with Dr. Heimburger and the Forest Insect Laboratory. Attempts have been made to cross red pine with members of the P. nigra group and with P. thunbergii, so far without success.

Exotic Pinus species are introduced for inclusion in the arboretum.

Scots pine has been planted extensively in eastern Canada, often with disastrous results. This is because most of the seed bought from Europe was from the lowlands of southwestern Germany and proved to be quite unsuited to our climate. Introductions are being made of Siberian and Russian types which are expected to be better adapted to continental conditions.

In reply to a question, Mr. Holst commented that within-species hybrids may be expected to exhibit heterosis when the parents are taken from climatically distinct populations.

ROUND TABLE DISCUSSION OF PROVENANCE PROBLEMS IN TREE SPECIES

Chairman - J. L. Farrar

Dr. Farrar introduced the discussion by pointing out that the existance of racial differences within tree species owing to geographic location has been demonstrated clearly in Europe, and to a lesser extent within the native tree species in North America. Two or three decades ago some people were far sighted enough to collect seed from different places and establish plantations, for example, at Cloquet, Minnesota, where jack pine of differing origin was planted. The variation between them is tremendous, ranging from 'crawling serpents' to fine, straight trees. This variability is of both scientific and practical importance. Dr. Farrar asked Mr. Holst to lead off the discussion.

Mr. Holst commented that before the provenance problem could be discussed we must have some idea of the nature of the problem. He went on to outline his understanding of the problem in Canada and the results which may be expected from our provenance experiments, both those which have been established, and those yet to be made.

Commencing with white spruce, it is to be found from the Maritimes to the Yukon, south to the Lake States and north within the Boreal Forest Region. However, for the moment the area of distribution within the Great Lakes - St. Lawrence Forest Region is of greater economic importance, and therefore of greatest interest for tree improvement.

When Dr. Heimburger was at Petawawa he established plantations which included several provenances of white spruce. These provenances exhibit some very definite variation in youth, and the Petawawa strain is the best. However, Petawawa is in the southern part of the range of white spruce in comparison with some of the other areas of collection represented, for example, Grandview, Manitoba; Saskatchewan; Great Slave Lake, Alberta; and British Columbia. These areas are also far west of Petawawa. Other areas from Quebec and the Maritimes in the east are represented. When the growth data is plotted against the latitude or against the mean temperature of the three summer months of the place of origin, two curves of differing slope seem probable, the one includes the provenances to the east and the other the provenances to the west of Petawawa. The height growth of the lots east drops much more steeply with distance and decreasing mean summer temperature from Petawawa, probably due to a steeper moisture gradient, which increases sharply towards the east coast. The problem also appears to be related to probable centres of migration following the last glaciation, the one in the east and the other in the unglaciated far west. However, the evidence is inconclusive on this point so far. On the whole, the material established by Dr. Heimburger suggests that there is a decrease in growth at

Petawawa of about 10 per cent for every one to one and a half degrees ° decrease in the mean temperature of the three summer months at the place of origin.

The east - west distribution of white spruce may be compared with the predominantly north - south distribution of Norway spruce in Europe. In Sweden, Norway spruce had to migrate from the north to the south and thus the adaptability of the species to a southern climate was limited. Norway spruce came to Germany from the south, and it is found that spruce of German origin planted in southern Sweden grows about 20 per cent faster than local provenances. However, the German provenances are not hardy to the north of southern Sweden owing to their frost susceptibility, due to their reaction to the longer day length. Such marked differential day length reactions could not be found between eastern Canadian white spruce collected within the Great Lakes - St. Lawrence Forest Region. Phenological studies on the material planted by Dr. Heimburger have shown that the northern types commence growth a little earlier than southern provenances, and have a shorter growing season.

The problem of population genetics within white spruce remains to be studied in detail in order to discover the extent of the influence of the coastal type, and to determine whether there is a gradient of variation from east to west, or whether there are two major types of white spruce as some have claimed.

The more practical aspect of the provenance studies is to set up zones for seed collection based on suitable climatic indices. It is too early to be able to define these zones with any accuracy, but it is known that Quebec and Maritime seed should not be used too far to the west of the areas of collection.

With respect to red spruce, its area of distribution extends from North Carolina, up the coast to the Maritimes and inland to northern New York State, southern Quebec and eastern Ontario. The distribution of red spruce is limited to areas of relatively high summer moisture. For instance it is typical that it is not found at Petawawa, but occurs in the Algonquin Highlands in mixture with yellow birch and maple. Owing to its predominantly north - south distribution, it is thought that some hardy southern types might be found which would grow faster in southern Canada than red spruce of local origin.

So far the southern provenances have suffered considerably from frost damage in the nursery but a useful type may yet become evident. Red spruce from the mountains in the south also suffers in the foliage from sun scald from the sunlight reflected from the snow in winter.

Black spruce has a wide distribution from the highlands of northeastern States to the Maritimes and westward to the Lake States and throughout the Boreal Forest Region to Alaska. In the east introgression occurs where its range overlaps that of red spruce. Red spruce is found commonly on the upland slopes while black spruce is confined to the swamps. Hybrids and hybrid populations may commonly be found on intermediate sites, especially where the hardwood competition has been reduced by fire and felling, for example at Acadia in New Brunswick. It was remarked that high

quality black spruce is found on steep slopes in the Gaspe area which is within the Boreal Forest Region. Red spruce is not thought to extend farther north than Edmundston.

Most of the work with spruce is being done in co-operation with industry, who assist by making seed collections when requested, and a number of companies within the Great Lakes - St. Lawrence Forest Region have undertaken the establishment of provenance experiments with seed or seedlings supplied from Petawawa F.E.S. At a later date it is hoped to extend the study of the spruces to include detailed collections from the western and northern ranges.

Red pine presents quite a different problem. Its range of distribution is limited to the area from the Maritimes and northeastern states westward to the northern Lake States and central Ontario to the Manitoba border. Red pine is an extraordinarily uniform species. It is very difficult to find any significant variation in the botanical characteristics. It is the only representative in the northeast of the group Lariciones, which includes the Pinus nigra species in Europe, Pinus tropicalis which is found in the West Indies, and Japanese black pine. Although geographic racial differences in red pine cannot be recognised from botanical characteristics, there do appear to be definite physiological races. The whole red pine range has been sampled with seed collections and a number of provenance experiments have been established. This work has been done in co-operation with the Ontario Department of Lands and Forests which has supplied much of the seed from Ontario sources. In addition to the plantation experiments, nursery provenance experiments are conducted with the same seed lots, where careful measurements of height growth and phenology are made in early years of growth. Older experiments in the Lake States have provided some very interesting information, but they mainly concern provenances of Lake States origin, and although originally planted in several locations, most of them were lost to fire.

The objective is to determine whether there are any races within red pine which are particularly suitable for use in the reforestation of specific areas, and equally as important, whether there are certain races which should be avoided.

Provenance experiments with jack pine have been established at Petawawa. One of these was made in co-operation with the Lake States Forest Experiment Station with material supplied by them. Older plantations of jack pine were established by Dr. Heimburger and a more recent experiment was established in 1954. There is quite a wide variation in jack pine, for example, in cone shape, which may vary from typically hooked to practically straight. The provenances represented to date are limited to Ontario and the Lake States with a few from Quebec, and it is hoped to make wider collections later on.

A number of graft population samples have been made, where one scion from each of 100 trees in a stand is collected.

These are intended for provenance hybridisation experiments as they will provide early flowering material, and they also form a type of provenance experiment.

It is probable that the same type of variation exists in jack pine as has been found in Scots pine. Both species are limited to the poorer sites and form relatively isolated stands. For example, jack pine has a very wide distribution but it does not form a continuum across northern Canada. It is found on the warm, sandy areas and separated by stands of spruce on the wetter sites.

In conclusion, it is expected that the seed collection zones which may be set up will be narrow for jack pine, somewhat wider for red pine and possibly wider again for white spruce.

Dr. Hitt described the red and jack pine provenance studies in which he is interested at the University of Wisconsin, and which include seed and scion collections made throughout the Lake States and from Ontario and Quebec. The scions are intended for controlled provenance hybridisation studies. Lack of personnel has prevented the carrying out of provenance studies in the nursery. The co-operation between the Lake States and Canada is valuable and of mutual interest. The initial effort of the program has concentrated on the assembly of provenance material, but in the future more effort is to be spent on the breeding aspects of tree improvement. Investigation is being made into the I.B.M. methods of data analysis.

Dr. Mergen discussed some provenance problems in southern pines. One provenance study was made with slash pine and also one with loblolly pine, and, as commonly occurs, the large size of the plantations necessary presented a problem. For instance, one year's out planting required about 68 acres. Dr. Mergen was therefore concerned with points of interest in the planning of provenance studies. First, the variation within an area must be considered so that the best method of obtaining samples can be arrived at. Secondly, if specific environmental factors are of interest, such as the effect of light or temperature, for example, the effect of photoperiod, over a north - south range, then small scale experiments might be carried out under controlled environments in the nursery or greenhouse. Such differences as are exhibited between provenances may then be investigated through more refined experiments. Through the co-operation of foresters in the field, extensive collections of seed may readily be made which may be very difficult to evaluate in later years when extensive plantations have been established.

The question of clinal as opposed to ecotypic variation was discussed. Demonstration of the former requires a rather intensive sampling of the geographic or climatic range under test. For example, in slash pine it was found that seedlings of western, continental origin flushed at an earlier date than those of eastern, maritime origin, relative to the same rise in daily maximum and minimum temperature in the spring. It is not known

whether this variation is clinal, that is, continuous, or ecotypic, with discontinuous population differences. Both ecotypic and clinal variation have been demonstrated in Scots pine in Europe. Mr. Holst commented that Langlet considers that Norway spruce exhibits clinal variation over parts of its natural range.

In an investigation of provenance material a combination of characters should be evaluated so that the factors subject to clinal and ecotypic variation may be separated. This does not rule out the advisability of observing variation under conditions of controlled environment where one environmental factor is varied while the remainder are held constant.

Dr. Mergen, citing the reported uniformity within red pine, again emphasized the need to determine the approximate areas of variation within a species by means of small scale experiments, which may then be followed by intensive sampling from the ranges of interest.

Mr. Fowler noted that it seemed likely that white spruce spread from two main refuges following the last glaciation. If this were so, then it might be expected that white spruce will correspondingly exhibit two variation clines. Mr. Holst agreed that such may be the case but that much more data is required than it has been possible to collect to date.

It was pointed out that in setting up seed collection zones for a species, it is important to know whether variations in productive capacity are clinal or ecotypic. In the former case, a rate of drop in productive capacity may be predicted with distance of seed movement, whereas, if the variation is ecotypic, specific zones may be delimited within which seed may be moved freely, and beyond which some loss will be incurred.

Dr. Farrar asked whether Anderson's method of multiple factor analysis of population variation could be applied equally well in the natural stands and in plantations. Mr. Holst replied that it could be used in both instances, and cited the example of his study of black spruce - red spruce introgression for which branch and cone samples were made in the forests, and also in provenance plantations. Dr. Senn commented that for certain species Anderson's methods of analysis is practicable, while for other groups of species it is of little help for the definition of populations. Dr. Mergen said the method had worked well in slash pine in which anatomical characters of the needles were used. Mr. Holst pointed out that the selection of characters to be studied is critical for the success of the method, for they must be well defined, and the variations within any one character must be clearly recognisable.

Dr. Place raised the question of uniformity of sampling for provenance seed collection. Mr. Holst replied that the problem arose in connection with the extensive provenance seed collections organised at Petawawa. Most of the seed collections are made by co-operators so that practical considerations placed a limit on

the specifications which could be laid down for seed collection. A minimum of 10 trees for one seed collection was set, and it was requested that they be chosen from a good, average spruce stand for the area of collection. The details are recorded on a standard seed collection form. Dr. Mergen suggested that an additional precaution would be to specify that the seed trees be spaced a minimum distance from each other of, say, 100 yards.

Mr. Fowler suggested that both ecotypic and clinal variation may be found within a specified range of a species, and may be defined by different sets of characters. He questioned whether such a situation would confuse the variation pattern as defined by Anderson's multiple factor analysis. Mr. Holst replied that the two types of variation may be found quite commonly, but that with adequate measurement of unrelated characteristics, the groups of characters which define the two types of variation may be separated.

Dr. Fraser referred to the paper of Mirov concerning biochemical variation of the terpines within Pinus species and species hybrids. This type of study may provide another tool for the study of variation.

Mr. Holst referred to Dr. Schmucker in Germany who has conducted tests on provenance material using the paper chromotography technique of biochemical analysis. This presents some interesting possibilities but the biochemical relationships have not yet been worked out.

Dr. Mergen referred to the work of Zobel who used the analysis of terpines successfully in a modified Anderson hybrid index to study natural populations of Jeffrey and Coulter pines, and to show the relationship between the two species.

Dr. Farrar asked Dr. Senn to comment on the scientific aspects of variation. Dr. Senn considered that more fundamental work should be done to discover the type of variation which exists, especially with reference to that within a population, and the relation of the within and between provenance variation.

Dr. Farrar asked Dr. Senn whether he considered the provenance concept valid. Dr. Senn remarked that he felt that foresters in general often take too much for granted with respect to genetic uniformity within a limited area. Comparisons between provenances would be on a sounder basis if enough were known to be able to select in the field the required type of material for comparison. However, much genetic variation is not recognisably distinct from that resulting from environmental influences. Mr. Holst agreed that little is known of the variation within limited areas, but that much of this information should become evident in the provenance experiment itself. The genetic nature may only be inferred for the populations beyond those sampled for provenance study.

Dr. Farrar questioned whether too much emphasis has been placed on the selection of superior trees, and too little attention

paid to the complete range of variation within populations.

Dr. Mergen referred to an ecotypic study which he had made in slash pine. Seed was collected from populations on wet and dry sites in the same locality. The seedlings were planted out on wet and dry sites in two locations. Differences were found between the two populations. This example serves to emphasize the need to take into account variations of local ecological conditions which may exert a sufficiently strong selection pressure and give rise to genetic differences between local populations of a genetically variable species.

Dr. Senn noted that most of the provenance studies were concerned primarily with growth characteristics as they affected the total volume yield of timber. He asked how much was being done to investigate specific characteristics of wood quality as related to the ultimate wood utilisation.

Dr. Mergen referred to the study of genetic variation in wood characteristics in red pine from different sources by the U.S. Forest Products Laboratory in co-operation with Forest Service Experiment Stations. Dr. Place referred to the discovery by the U.S. Forest Service of striking differences in wood density of apparent genetic origin in the southern pines. Outstanding trees are preserved, particularly in the lower Mississippi Valley.

Mr. Holst commented that his selections of superior trees have been made in virgin forests where environmental changes throughout the life of a tree may induce a considerable variation of wood density within a tree trunk. He felt that for the Canadian species this type of study must wait until there is material available of known origin which has been grown under uniform conditions. The possibility remains that any improvement in wood density might be much more important than a possible improvement in volume or tree form.

Mr. Swan remarked that advice to breeders from industry concerning the quality of wood to be preferred is a tough problem. High density wood does give a higher yield of pulp, but high density is commonly associated with slow growth. Where trees are used for both lumber and pulp, there may be a conflict of interests. However, it is not known whether individual trees may combine a capacity for fast growth and high wood density. Possibly the best criteria for selection would be to produce the maximum weight of wood per acre per annum.

Dr. Mergen, in further answer to Dr. Senn's question, referred to the Ph.D. dissertation at Yale by Dr. Bob Eckels, entitled 'Genetic Variation in the Wood Characteristics of Scots Pine'. Dr. Echels used the International Union of Forest Research Organisation Scots pine provenance plantation at Fox Forest. Wood samples were taken with an oversize Swedish increment borer, and determinations were made of wood density and fibre length of the summer wood and spring wood. Considerable differences were found between the southern and northern strains and some information was gained on the variation within a population.

Dr. Fraser noted that the Institute of Forest Genetics at Placerville send a lot of their material to the Madison Forest Products Laboratory for determination of cellulose content and fibre length. Another point of interest is that the International Paper Company, using elm for pulp production, find that some lots are uniform in quality while others exhibit considerable variation. It is not known to what extent this is due to site as opposed to inherent causes. This serves to emphasize the importance of having uniform growth conditions for comparisons of genetically determined variation in wood quality. Mr. Swan commented that he would like to see a study made to determine the effect of spacing in plantations on pulp yield per acre per annum. A relatively wide spacing may lead to a maximum volume production, which may or may mot coincide with the maximum pulp production.

Dr. Place said it was his impression that there was more variation in fibre length with the position in the tree rather than the width of the growth ring and that this would substantiate a program of thinning. Too much emphasis has been placed on the width of the ring rather than the age of the tree.

Mr. Swan agreed that variations in pulping quality occurred from the pith to the bark, and from the base to the crown of the tree, but considered that the amount of growing space afforded the tree also had some effect on this quality. Dr. Mergen noted that Dr. Phil Larsen in his dissertation dealt with the effects of spacing and location on the wood characteristics of slash pine in natural stands. He related wood characteristics to spacing, soil characteristics and moisture.

Mr. Carmichael asked Dr. Mergen what system of sampling he would advocate to sample the geographic range of a forest species, such as red pine, in order to set up seed collection zones. Would sampling a few cones from a great many trees be preferred, or many cones from a relatively few trees?

In reply, Dr. Mergen said it would depend, first, on whether certain stands were more prolific cone bearers than others and, secondly, on the time and facilities available for cone collection. Dr. Mergen's recommendations were that, 1. collections should be made in good seed producing stands, and 2. that the range of phenotypic variation within the climatic area to be sampled should be determined, and that collections should be made to cover this range. It would be to further advantage if collections could be made in successive years, and also that test plantations be established in different years.

Dr. Prebble enquired whether sufficient detailed information concerning the circumstances of cone collections was available in the records. Mr. Carmichael replied that generally there was not enough and that he would like to repeat many collections under closer control.

Dr. Prebble further asked if the distribution of seedlings from the nurseries was regulated. Mr. Carmichael stated that such

control is administratively difficult and not easy to enforce beyond rather wide limits. Mr. Ball commented that it would be of great assistance if it were known that seedlings of a specified origin could receive a wide distribution for planting out.

Mr. Holst mentioned that the results of a single tree progeny test from open pollinated Petawawa red pine indicated that one family was strikingly superior to the remainder. Climatic data for the comparison of geographic areas is difficult to obtain for on one hillside, for example, there may be considerable variation in important climatic factors.

Mr. Carmichael suggested that if the concern is primarily with broad changes of a heritable nature, then sampling should be on a broad scale.

For the work at Petawawa, Mr. Holst said that Mr. George Brown had provided a map of climatic sections within the range of red pine which provided the initial sampling units. The results of the provenance experiments at a later date may indicate that these sections should be grouped to form larger units for the purposes of seed collection and seedling distribution.

The question of racial differences in susceptibility to pathogens was raised. Dr. Pomerleau said that some work had been done in Europe and in America. Dr. Boyce has dealt with the question. It is probable that differences in resistance to pathogens exist but these are difficult to assess. In native species wood rotting fungi are important mainly in over-mature trees and the rusts are not too serious. Most differences appear to be associated with the environment.

Mr. Holst stated that every encouragement would be given to other workers to study the relationship of seed origin to diseases, stand density and similar specialised problems.

Dr. Place remarked that Dr. Baxter had made observations of the incidence of disease in different stands in Michigan but that no formal investigation related to seed origin had been carried out.

Mr. Dance referred to the incidence of Hypoxlon cankers in Ontario. It is open to question whether this may be due to changes in the host due to the difference in climate and site or whether the conditions are less favourable to the pathogen. No formal work concerning the relative susceptibility of provenance material has been carried out.

Dr. Pomerleau remarked that Douglas fir in Europe is subject to severe attack by pathogens which are of little significance on the west coast and concluded that this indicated that the relative susceptibility was a function of climatic differences.

In concluding the discussion of provenance problems, Dr. Farrar thanked the members for their interest and contributions.

Mr. Leslie resumed the chair, and called for the adjournment of the 5th Meeting of the Committee.

Mr. Holst conducted the members and guests of the Committee on a field tour of the tree breeding facilities at Petawawa Forest Experiment Station. This tour included the greenhouse, seed extraction plant, nursery and certain of the plantations and arboreta.

Informal talks were given by other Petawawa staff members on research activities in forest ecology, physiology and silviculture being carried on at the Station.

On Saturday morning, 21st September, Dr. Place conducted a tour of the new laboratory and some of the field establishments of the research program.