a. P. Leslie

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PROCEEDINGS OF THE FOURTH MEETING OF THE COMMITTEE ON FOREST TREE BREEDING

March 1 and 2, 1956

(Not for Publication)

PROCEEDINGS OF THE FOURTH MEETING OF THE COMMITTEE ON FOREST TREE BREEDING

Held in the Biology Building, Department of Lands & Forests, Maple, Ontario, on March 1 and 2, 1956.

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Attendance:

K. A. Armson	Faculty of Forestry, University of Toronto
A. F. Beckwith	Division of Research, Ontario Department of Lands and Forests
A. Bickerstaff	Forestry Branch, Department Northern Affairs and National Resources, Ottawa.
A. L. Bowen	208 Rockingham Street, Rochester 20, N.Y.
A. J. Carmichael	Ontario Tree Seed Plant, Angus, Ontario
W. H. Cram	Forest Nursery Station, Indian Head, Sask.
B. W. Dance	Division of Forest Biology, Department Agriculture, Laboratory of Forest Pathology, Maple, Ont.
J. Halpenny	Division of Reforestation, Department of Lands and Forests, Ontario
C. C. Heimburger	Division of Research, Ontario Department of Lands and Forests
M. J. Holst	Petawawa Forest Experiment Station, Chalk River, Ont.
A. H. Hutchinson	Department Biology and Botany, University of B.C. Vancouver, B.C.
J. L. Farrar	Forestry Branch, Department Northern Affairs and National Resources, Ottawa. Now of Faculty of Forestry, University of Toronto
A. P. Leslie (Chairman)	Division of Research, Ontario Department of Lands and Forests
R. J. Moore	Science Service, Department of Agriculture, Ottawa
W. E. Nodwell	Courtland, Ontario
E. T. Owens	Woodlands Section, Canadian Pulp & Paper Association, Montreal
S. S. Pauley	School of Forestry, University of Minnesota, St. Paul 1, Minn.
V. H. Phelps	Forestry Branch, Department Northern Affairs and National Resources, Ottawa
E. J. Schreiner	Forest Genetics Research, Northeastern Forest Experiment Station, Forest Service, U.S.D.A. Upper Darby, Pa.
H. A. Senn	Botany and Plant Pathology Division, Science Service, Department Agriculture, Ottawa
C. R. Sullivan	Division of Forest Biology, Department Agriculture, Forest Insect Laboratory, Sault Ste. Marie, Ont.
H. S. D. Swan	Woodlands Research Division, Pulp & Paper Research Institute of Canada, Montreal
C. W. Yeatman (Secretary)	Petawawa Forest Experiment Station, Chalk River, Ontario

Note: Listing of full membership - Appendix "B"

59. Welcome

Mr. Leslie welcomed the guests and new members. Guests: Mr. V. H. Phelps, Department of Northern Affairs and National Resources, Ottawa; Dr. S. S. Pauley, University of Minnesota; Dr. E. J. Schreiner, Northeastern Forest Experiment Station, Upper Darby, Pa. New members: Mr. K. A. Armson, University of Toronto; Mr. E. T. Owens, Canadian Pulp and Paper Association, Montreal; Dr. A. H. Hutchinson, University of British Columbia.

60. Minutes of Last Meeting

Dr. R. J. Moore moved a vote of thanks to last year's secretary, Dr. C. C. Heimburger.

The minutes of the last meeting, which had been mimeographed by the Forestry Branch, were distributed beforehand. The following correction was suggested:

Minute 56 Should read: "Dr. Cram cited the work of Dr. WILNER .."

Minute 44 Mr. Sullivan stated that the Forest Insect Laboratory at Sault Ste. Marie is not chiefly concerned with resistance to shoot moth.

Minute 41 Mr. Swan made the following statement concerning the P.P.R.I.C. - "The Pulp and Paper Research Institute of Canada (P.P.R.I.C.) was reorganized in 1950 and at that time Dr. L. R. Thiesmeyer became its President. The Institute is supported by the Canadian pulp and paper industry, McGill University and the Federal Government. Mr. H. S. D. Swan became the Acting Supervisor of the Institute's Woodlands Research Division on the retirement of Mr. A. Koroleff at the end of June 1954. Attention is paid to all aspects of the growing, harvesting and utilization of pulpwood species."

Dr. W. H. Cram suggested that the proceedings be distributed as early as possible after meetings.

61. Business Arising from Minutes

(a) Membership

Invitations were issued by the Director, Forestry Branch to: Dr. L. R. Thiesmeyer, P.P.R.I.C., who was represented by Mr. H. S. D. Swan; Dr. H. Hill, Horticulture Division, Department of Agriculture, who was represented by Dr. H. A. Senn; Dr. A. H. Hutchinson, University of British Columbia, who attended. Mr. W. J. LeClair, Secretary of the Canadian Lumbermen's Association, was invited but did not attend. Mr. E. T. Owens attended the meeting as a representative member for the Canadian Pulp and Paper Association; Mr. K. A. Armson has taken over Mr. Grant's work at Glendon Hall and attended as an active member of the committee.

(b) Lectures on Tree Breeding

(1) An invitation was written to the Deans of the Forestry Schools in Canada asking them to submit concrete requests for special lectures on tree breeding to the committee for consideration. Replies were received from Deans L. Z. Rousseau, T. Miles Gibson and J. W. B. Sisam, all of whom expressed interest in having one or two lectures on tree breeding. A list of names was prepared of men who might be able to present lectures. In reply to a circular, the following men have indicated that they are prepared to accept invitations to lecture:

Name	Location	Field of Work
C. C. Heimburger	Maple, Ontario	Breeding of white pine, poplar and hard pines.
M. J. Holst	Chalk River, Ont.	Breeding of spruce, hard pines and larch.
W. H. Cram	Indian Head, Sask.	Breeding of Caragana and spruce.
L. Chouinard	Laval University, P. Q.	Vegetative propagation and tree breeding lectures.
A. J. Carmichael	Angus, Ont.	Seed orchards and provance tests.
A. L. Orr-Ewing	Victoria, B.C.	Douglas fir provenance and genetics studies.

Dr. Heimburger suggested that the lectures be divided into three groups: (1) general subjects, (2) more specialized, (3) particular field. Mr. H. S. D. Swan suggested that a list be prepared of the names of those people prepared to give lectures, together with the subject of the lectures, and this should be sent to the Deans who could then make their own arrangements. Mr. A. P. Leslie stated that he would undertake to contact the Ontario Research Foundation regarding travelling expenses for these lectures.

(2) In reply to a letter regarding the publication of lectures on tree breeding, Dr. C. Syrach Larsen stated he expected the book to appear in print shortly, consisting of 12 chapters, the titles of which are:

I Aim and possibilities
II Retrospect
III Progeny trials
IV Controlled pollination
V Vegetative propagation
VI Seed gardens
VII Tree Shows
VIII Breeding and diseases
IX Hybrids
X Genetics
XI Breeding of larch
XII Breeding and mechanisation

(Note: Larsen, C. S. Genetics in Silviculture. Oliver and Boyd, Ltd., Edinburgh. Published September 1956)

(c) Tree Breeding Substations

Dr. C. C. Heimburger stated that a trip had been made last summer on which two areas were located - one at Turkey Point near St. Williams, and one at Point Pelee. He added that 200 acres could be obtained at Turkey Point if the costs of clearing and erecting fences could be met.

Mr. A. Bickerstaff stated that the Forestry Branch had contacted the Parks Branch in connection with obtaining an area at Point Pelee, but the reply seemed to indicate that there would be some difficulty in obtaining this area because it is a so-called natural park area. Dr. Heimburger felt that steps should be taken to get another area in the same climate. Rondeau Park was suggested, but he felt this area was unsatisfactory because of people and deer. Mr. Leslie suggested it might be possible to obtain private land. Dr. Heimburger stated that efforts had been concentrated in southern Ontario as this was the most important, and no attempt had been made to locate substations in the north.

(d) Wood Density Studies

Mr. Leslie stated that some Paper Companies had shown an interest in this subject. Letters had been written to the Forest Products Laboratory and P. P. R. I. C. re wood density studies. Mr. Hale of the Forest Products Laboratory had replied stating they would be willing to enter into some arrangement to study species for density. Mr. Leslie regretted time had been too short to invite Mr. Hale to the meeting. The Forest Products Laboratories and the P. P. R. I. C. gave an indication of the information available, together with a number of references. Interested members may contact the secretary for further information. A further detailed reference may be found in the report "Breeding for High Quality Wood" by Harold L. Mitchell in the Proceedings of the Lake States Forest Tree Improvement Conference, August 30-31, 1955, pp. 89-99.

Dr. E. J. Schreiner pointed out that the Forest Products Research Society will meet at Asheville in June, and this subject will be discussed there. Dr. Zobel of Texas had been working on rapid growth combined with high density. Dr. Zobel believes you can have a rapid growing pine which is as dense as a slow growing pine.

(e) Distribution of Proceedings

Mr. A. Bickerstaff suggested that people other than those on the membership list should receive the Proceedings. It was also suggested that all universities should receive copies of the Proceedings, and Dr. Schreiner added that he thought that all genetic centres should be included on the list. Dr. Heimburger felt that because of the data included in these Proceedings, they should be marked "not for publication". Mr. C. W. Yeatman agreed that this would be done. It was suggested

that when members are preparing their reports, they should endeavour to put them out in a finished form on standard 8 1/2 x 11" paper, and distribute them for criticism. The stencils should then be forwarded to the secretary for inclusion in the proceedings. Dr. Cram moved that next year detailed reports should be mimeographed and distributed among members, and a standardized size abstract report should be included in the Proceedings. Stencils should be forwarded to the secretary. Proposal carried.

Dr. Schreiner suggested that the Proceedings and reports be published as one volume with a cover. This would more or less ensure that they would be indexed by libraries. Mr. Bickerstaff asked if the present Proceedings were to be published in this manner. Dr. Heimburger suggested that appendices of reports for this year should be summarized before distribution. Members should make their own abstracts and forward them to the secretary for this year. Dr. Cram moved that the secretary contact all those who presented papers at the present meeting and press them to submit an abstract to him in preparation for the 1956 Proceedings. Seconded by Dr. Heimburger. Carried.

(f) Genetics Society of Canada

Dr. S. S. Pauley stated that at the last meeting of the committee on Forest Tree Improvement of the S. A. F., the suggestion was made that a section on forest tree genetics be created at the next International Genetics Congress which will be held in 1958 at McGill University. Motion by Dr. Heimburger that the Committee approach Dr. Chouinard with the request to form a section on Forest Tree Genetics within the International Genetics Congress, and that this be open to international membership. Seconded by Dr. Schreiner. Carried. Dr. A. H. Hutchinson commented that this may encourage many forest genetists, including those in Europe, to attend the Congress, and we would benefit from these contacts.

(g) Exchange of Observers

A report on the "Third Northeastern Forest Tree Improvement Conference", August 30 and 31, 1955, by Dr. Heimburger, is found in Appendix "G". A report on the "Lake States Forest Tree Improvement Conference", August 30 and 31, 1955, by Mr. M. J. Holst, is found in Appendix "I".

Dr. Schreiner, N.E. Forest Experiment Station, Upper Darby, and Dr. S. S. Pauley, University of Minnesota, had been invited to the meeting. Dr. Schreiner thanked the committee for this invitation. He stated frankly that if he had not been invited he would not have thought to attend as this was not an open meeting. He pointed out that the N.E. Forest Tree Improvement Committee is not a closed meeting. He further stated that the N.E. Tree Improvement Conference had set up an Executive Committee which represents forestry organizations in the North East, and that it was not a Forest Service function. Members of this Executive

Committee are appointed by the organizations. Anyone may be invited to the meetings. The next meeting is to be held in August in Pennsylvania, and will be entirely a field meeting. The objective of the N. E. Forest Tree Improvement Committee is to reach the practicing foresters and get them to attend the meetings. They were not just meetings of people involved in forest genetics research. He said that over 600 invitations to the meeting were sent out, and that a paper company handled all the secretarial work and publication free of charge.

Dr. Schreiner also pointed out that the committee was kept distinct from government to encourage private participation, and to get company support for the operation of the committee.

Dr. Pauley gave a review of the Lake States Tree Improvement Conference. Their principal interest at the present time is centered on the seed source study of jack pine, which was initiated through co-operative efforts of the Lake States Forest Experiment Station and the University of Minnesota. He stated that he intends to take the seed source study to finer limits - he suspects more diversity within the stand than between the stands, with one or two exceptions. The last meeting of the L. S. T. I. C. was held in August 1955 and copies of the proceedings are available. The Lake States Forest Experiment Station is now in the process of establishing a research station at Rhinelander. Offices have been constructed and greenhouses are to be erected. Most of the laboratory work will be carried out there.

During a recent collection of white spruce cones, a member of the staff found what he thought were cones from a white spruce tree, but they were different from normal white spruce cones. They were thought to be F_1 hybrids. The cones were smaller than white spruce and larger than black spruce. They were of a blackish colour, open on the tree. The cones were exhibited at the meeting. Mr. M. J. Holst suggested they might be hybrids between red and black spruce.

62. New Business

(a) Tree Breeding in Ontario

Dr. Heimburger stated that he and Mr. Carmichael had met at an earlier date to discuss tree breeding in Ontario. Mr. Carmichael had wanted an overall plan for tree breeding in Ontario but Dr. Heimburger had objected. He thought that plans on policy should come from above, and details worked out later.

Mr. Carmichael stated that reforestation was being carried out on a large scale in the north on crown lands, and that help was being received from the Federal Government. The lands in which they were particularly interested are those which have been cut over and which are not regenerating properly. Mr. Bickerstaff stated that regeneration problems show a

shortage of seed, and there should be co-ordination on the work of tree breeding and seed orchards. Mr. Carmichael stated that one important point to decide is what is the most important species in Ontario for reforestation and for industry. A group of people from this committee should be asked to carry out an economic study for various species in Ontario, and the most important species should be studied first. Any study has problems, because what is important today may not be so tomorrow. Concentration should be on two or three of the most important species with respect to seed production and the establishment of seed orchards. A suggestion was made that such a study might be carried on by one of the sub-committees of the Ontario Research Foundation.

Mr. Leslie stated that he had sat in at this meeting between Dr. Heimburger and Mr. Carmichael, and he thought that the proposals made then were valuable to policy makers. It was suggested that perhaps the Research Foundation of Ontario may be able to help by providing funds through the universities to extend this work.

Mr. Holst pointed out that this was a local affair, and Mr. Carmichael replied that if it were successful in Ontario it would set an example for the rest of Canada.

Mr. Leslie asked if the committee was in favour of forming a sub-committee to approach the Ontario Research Foundation for funds.

Mr. Bickerstaff made the motion that the committee members consider it would be desirable for Ontario to make a general study of the tree breeding situation in Ontario with a view to putting it on a broad basis and securing adequate funds. Carried.

Mr. Armson stated that the Research Foundation was at present supporting work being carried on at Glendon Hall.

Mr. Sullivan stated that Dr. Belyea was interested in white pine weevil and shoot moth and would like to offer his full co-operation. This offer was accepted by Mr. Holst and Dr. Heimburger.

(b) Location of Next Meeting

Mr. Bickerstaff extended an invitation on behalf of the Forestry Branch to hold the next meeting at Petawawa. Accommodation should be available by that time. Dr. Cram moved a vote of thanks and accepted. Carried. The date of the next meeting was set at 19th and 20th September, 1957.

(c) Election of New Members

Dr. Cram suggested Mr. J. Walker, Superintendent Indian Head, as his sponsoring member.

Dr. Heimburger suggested Mr. R. N. Johnston, Chief, Division of Research, to be made a corresponding member.

Dr. Heimburger nominated his assistant, Mr. A. Beckwith.

It was suggested that Mr. M. Wilson of International Paper Company may be interested.

Mr. Leslie suggested that Mr. Mills, Manager, Ontario Forest Industries Association should be asked to nominate a member.

Dr. Heimburger again pointed out that we should ask Mr. LeClair to send a representative.

All were in favour of proposals.

(d) Further Business

Mr. Bickerstaff pointed out that the Forestry Branch has sponsored the appointment and invitations to members, but now that the committee is under way the Forestry Branch would have no objection to the committee functioning through the chairman and secretary, although the Forestry Branch would be happy to continue issuing invitations.

Mr. H. S. D. Swan made a motion that the present slate of officers be retained. Carried.

Dr. Cram suggested that a note of appreciation should be sent to the Director, Forestry Branch.

Mr. Carmichael suggested that the secretary should be retained, but that the chairman should be rotated according to the place of meeting. Mr. Yeatman stated that he would not be in Canada next year, but would be happy to continue as secretary. He would be returning to Canada before the next meeting in September, and Mr. Holst had agreed to take over the files for the period that he would be away. Mr. Leslie stated that he would be willing to carry on for another year as chairman.

(e) The Film "Developing Pedigree Trees" was secured on loan from the Mississippi Forestry Commission and shown to members in the evening of March 1st.

63. Discussion of Reports

Reports were tabled by the members listed below, and are to be found in the appendix.

Appendix	Name	Location
"A"	K. A. Armson	Glendon Hall, Ont.
"B"	A. J. Carmichael	Angus, Ont.
"C"	W. H. Cram	Indian Head, Sask.
"D"	B. W. Dance	Maple, Ont.
"E"	D. A. Fraser (in absentia)	Chalk River, Ont.
"F"	C. C. Heimburger	Maple, Ont.
"G"	C. C. Heimburger	Maple, Ont.
"H"	M. J. Holst	Chalk River, Ont.
"I"	M. J. Holst	Chalk River, Ont.
"J"	A. W. S. Hunter (in absentia)	Ottawa, Ont.
"K"	A. H. Hutchinson	Vancouver, B.C.
"L"	H. G. MacGillivray	Fredericton, N.B.
"M"	R. J. Moore	Ottawa, Ont.
"N"	A. L. Orr-Ewing (in absentia)	Victoria, B.C.
"O"	W. A. Porter	Victoria, B.C.
"P"	Membership list	

A resume of some of the discussion of the reports follows:

"A" K. A. Armson

In answer to a question, Mr. Armson said Fourdrinier wire was used to produce the conditions of 19% normal light given white spruce seedlings in the shading experiment. The questions of air circulation and temperature differences were raised, and it was pointed out that the results may give little information of the tolerance of the species in the bush as root competition was not considered.

In the photoperiod experiment with Norway spruce, fluorescent lights were used to provide the necessary additional illumination. The discussion centered on the questions of light intensity and quality. Dr. Pauley mentioned an experiment in which a light was placed at one end of a row of plants of a poplar clone. The point along the row at which

[illegible]	[illegible]	Location
"A"	W. [illegible]	Clardon Hall, Ont.
[illegible]	A. A. Carmichael	[illegible] Ont.
[illegible]	A. [illegible]	Indian Head, Sask.
[illegible]	T. [illegible]	[illegible], Ont.
[illegible]	[illegible] (Comments)	[illegible] River, Ont.
[illegible]	[illegible]	[illegible]
"C"	[illegible]	[illegible]
[illegible]	W. [illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	A. [illegible]	[illegible] Ont.
[illegible]	A. [illegible]	[illegible], B.C.
[illegible]	[illegible]	[illegible], P.Q.
[illegible]	[illegible]	[illegible] Ont.
[illegible]	[illegible] (Comments)	[illegible], P.Q.
[illegible]	[illegible]	[illegible] B.C.
[illegible]	[illegible]	[illegible]

[illegible] of the [illegible] were as follows:

[illegible] W. A. [illegible]

[illegible] wire was [illegible] the conditions of [illegible] natural light [illegible] in the shading [illegible]. The question [illegible] different [illegible], and it was [illegible] little information of the [illegible] was not considered.

[illegible] with Norway [illegible] necessary additional information. The [illegible] of the questions of light intensity and quality.

Dr. [illegible] an experiment in which a light was placed [illegible] of a row of plants of a poplar clone. The point [illegible] height growth ceased would be the point at which the light intensity would be limiting. The experiment was destroyed by a hurricane before completion, but it appeared to be working out up to that time.

Dr. Cram reported that some plants refused to break dormancy under continuous illumination.

Most of the work to date has been done on seedlings and cuttings, and the photoperiodic response of older material may be a worthwhile field of enquiry. Very little is known of the response in the flowering of trees to different photoperiods. Mr. Holst referred to recent work at Petawawa where long days had failed to induce flowering in two year old seedlings. Dr. Senn pointed out that the optimum light requirements for flower production and vegetative growth may not be the same. Photoperiods need not be restricted to 24 hour cycles, periods of darkness may be interrupted in order to simulate short nights. Dr. Pauley mentioned work being done on the effect of a flashing light source on algae. In order that experiments might be repeated, the quality, as well as the intensity and duration of the light must be known.

With respect to the break of dormancy, Dr. Pauley raised the question of the effect of temperature. This had been shown to be the operative mechanism for aspen and poplar. With regard to the light source used to examine such plants grown in the dark, it had been reported that yellow light was ineffective to induce flowering.

"B" A. J. Carmichael

The question of the reliability of seed source information was raised. Evidence appears to indicate informatinn from some seed collectors is unreliable and that care should be taken to verify the seed source given in as far as possible.

Birch grafting - the scions used were about pencil thickness and required a tight binding to hold the scion to the stock. Subsequently scions 1/2 to 1/3 this size were used, and were found to be more flexible and could be held to the stock with an ordinary budding band. The results were good.

Mr. Carmichael mentioned the problem of keeping grafts cool in the greenhouse into the early summer when they were planted out. At Angus, the south side of an east-west greenhouse had been filled with sheet aluminum so that there was full light from the north only. The plants looked healthy under this system.

Provenance tests - Dr. Heimburger said he considered 100 trees to be a minimum sample, but that the sample size should depend on the object of the experiment. Enough trees should be grown that stand conditions are simulated. The question of sample size v. s. number of replications was raised. Dr. Schreiner stated that more replications of fewer trees was a statistically better practice than the reverse.

Mr. Carmichael stated the reduction in size of the Scotch pine sample blocks from 196 to 100 (E.2) was for convenience only.

With respect to the comparison of shoot moth attack in two areas (E.3), a comparison of attack between Corsican pine and red pine is to be made at a later date.

Mr. Bickerstaff asked how far north Corsican pine could be grown. It is hardy at Maple, though killed in frost pockets in southern Ontario; it is damaged at Uxbridge; it is killed at Petawawa. The reason for the interest in this species is its relative resistance to shoot moth. It must be known where Corsican pine will survive throughout the area in which red pine suffers severely from shoot moth attack.

Mr. Sullivan referred to the control of shoot moth and reported that white pine weevil had become a pest on certain hard pines, and had been known to attack even red and jack pines.

Mr. Carmichael referred to a plough developed at Angus for dealing with heavy sod and roots. It had two coulters, one on each side of the furrow, which cut a clean furrow slice that did not tend to roll back into the furrow.

"C" W. H. Cram

Cross compatibility - Dr. Schreiner remarked that a male sterile factor could enter self and cross compatibility. Dr. Hutchinson pointed to correlations of morphological characteristics and compatibility.

Vigour potential estimate at 3 years - Dr. Heimburger referred to poplar, saying that such estimates were not always reliable at three years. Poplar is in a juvenile state for the first two years, and from three years acquired characteristics which are retained to six years. However, markedly inferior progeny may be eliminated at three years.

With respect to spruce pollinations, Dr. Cram referred to the necessity for the control of cone insects with D.D.T. or other means.

Dr. Pauley spoke of their work in forcing large tooth aspen to female flower receptivity by covering portions of the crown with black plastic bags in order to increase the temperature and thus accelerate flower development in order to coincide with the time of pollen production of trembling aspen. He suggested that this may be possible with spruce species, thus overcoming some problems with isolation bags mentioned by Dr. Cram.

It was mentioned that sausage casings have been used extensively for pollination work and may be obtained in the U. S. from the Visking Co., Chicago.

Dr. Schreiner remarked that polyethylene bags were very useful for the storage of cuttings, which he had kept for two years in this way. Mr. Holst mentioned the danger of shipping conifer scions in polyethylene bags. Dr. Schreiner had encountered no trouble in doing so with poplar scions.

Dr. Cram acknowledged assistance received from the Forest Pathology Section of the Department of Agriculture.

"D" B. W. Dance

Dr. Dance commented further on his report. Poplar is susceptible to pathogens for only brief periods, possibly three to four weeks each year. In order to prolong the "working time", plant material may be stored in a dormant condition, such as potted plants, in a cold room. At present space is restricted. Cuttings may possibly be used, but aspen shows resulting defects, black spots, which resemble some of the pathogens and leads to confusion. Balsam poplars however take root readily and present no problem. Greenhouses are to be constructed in which this work may be carried out, and continual testing may be put into effect. Environmental conditions are specific for inoculation and development of pathogens and must be correct for sound testing. The new facilities will aid in this matter.

Dr. Schreiner, in comment, pointed out that lack of precise knowledge of pathogens was not confined to this country. He referred to the spring die-back of European poplar and the widespread disagreement as to the cause.

Dr. Heimburger pointed out that in susceptibility tests, species known to be susceptible should be retained for testing purposes.

It was considered desirable to maintain a bank of tree diseases, but there may be a considerable chance of loss virulence. However, the bank would be valuable for taxanomic purposes.

"F" C. C. Heimburger

With respect to the method of using white pine grafts, as opposed to seedlings, for testing resistance to disease (blister rust), Dr. Heimburger said this had been ineffective.

Dr. Heimburger emphasized the current effectiveness of the Populus tremuloides x tremula hybrid since pollen of southern European origin had been employed.

In discussion, Dr. Heimburger pointed out that Himalayan white pine (P. Griffithii) was more susceptible to white pine weevil than the native P. strobus, but was resistant to blister rust. Western white pine (P. monticola) and Serbian white pine (P. peuce) are more resistant to

weevil. In weevil resistance there are two phases which may be considered: (1) resistance to weevil attack, and (2) recovery from attack. P. peuce is also resistant to blister rust and therefore may be the most useful species to deal with in a breeding program. Slenderness of leader seems to be the most important characteristic conducive to warding off weevil attack.

Dr. Schreiner stated that with respect to late field grafting, the current year's wood may be grafted on current year's wood (in white pine) up to the end of June.

Dr. Cram, commenting on the rooting capacity of Populus species, said silver poplar was good if stored over winter. European cottonwoods are good and more flexible, Populus alba varies from year to year and something easier to handle is desired.

Dr. Heimburger spoke of his efforts to introduce rooting capacity into poplar clones that were otherwise satisfactory. This is a desirable factor for the commercial application of poplar culture, for seedlings are more difficult to raise. It was pointed out that seedlings are used extensively in Scandinavia, and that improvements in nursery techniques might be made. The use of seedlings in plantations maintains a degree of variability in the stock which might be considered desirable, notably with respect to disease and insect resistance.

"H" M. J. Holst

With respect to the selection of plus white spruce trees, Mr. Holst pointed out that these selections were concentrated in the vicinity of Petawawa, for selection is best undertaken and tested in local areas. It is hoped to demonstrate that improvement may be gained by the selection of trees of outstanding appearance. These selections also provide sound material to be used in species hybrids.

Dr. Schreiner agreed that the mass production of rare hybrids of native species is not likely to be of great value.

Resistance of Norway spruce to the white pine weevil was discussed. Mr. Holst distinguished between resistance and the ability to recover from weevil attack. It appears that the "brush type" Norway spruce is superior in this respect than the "comb type". Resistance to weevil may not be bred into Norway spruce directly from white spruce, as no hybrids are known of these species. An intermediate species, a crossing bridge, must be employed.

A discussion developed of species hybridization and introgression in western Canada and the U.S. Valuable natural hybrids, for use in the west may be found there, but they would be of only special application in in the east, e.g. character carriers. The example of Japanese x European larch hybrid vigour was mentioned. European larch is characteristically

a highland species and was introduced to the lowlands of Europe where it proved difficult to handle. Japanese larch of southern and medium elevation was introduced and did not do well either. The hybrid of the two species, however, proved adaptable to lowland European conditions by a combination and compromise of ecological requirements.

Mr. Holst said, with this in mind, that the attempt was made to cross sitka spruce with a northern white spruce.

Comments were made that crosses between geographical strains of a species may give valuable progeny of possibly greater growth and adaptability than 'pure' strains. On the other hand, intra-specific crosses for commercial production.

Group incompatibilities should be studied, for this may limit the possible heterozygosity of forest trees.

It was questioned whether volume or density is required most of forest trees. It may be a question of the mass of cellulose the land will grow in a given time. Dr. Schreiner introduced the question of rotation age, where by proper v. s. incorrect selection two crops may be harvested in the time of one.

Mr. Holst commented that white spruce from Saskatchewan has grown at Petawawa 60 to 70% as much as local strains of the same age. The western strain may or may not catch up in time. He would rather use good local trees for hybridization than strains from farther afield. Petawawa is on the fringe of the distribution area of white spruce and there would be little advantage in bringing northern strains south.

With respect to flower inducing, Mr. Holst said it was concerned with three phases of tree growth - plants, man-high trees and mature trees.

The possibility was suggested of growing a large plant in a short period of time by commencing with seed and subjecting it to continuing and special treatment. When large enough the tree might be induced to flower. Dr. Schreiner suggested that it was a problem for the physiologist, who could take a basic approach rather than the empirical. It was further suggested that the use of early flowering root stocks may assist in the early production of flowers.

"J" A.W.S. Hunter

In a letter to the secretary, A. W. S. Hunter wished to acknowledge the co-operation of the Horticulture Division, Ottawa, and of the Forest Biology Laboratory, Department of Agriculture, Laval University, in connection with the Dutch Elm Disease Investigations at L'Assomption, P.Q.

"K" A. H. Hutchinson

Dr. Hutchinson pointed out that interest in forest tree improvement had existed for many years, and expressed the hope that further interest would be developed in British Columbia.

The problem should first be recognized. Ten years ago the Sloan Commission voiced the opinion that natural reproduction would take care of foreseeable future wood requirements. Today the demand for wood has doubled and another recent commission has recognized the problem of reforestation, especially in Douglas fir, yellow pine and western larch.

The speaker referred to the work of Mr. Orr-Ewing which indicated a diminution in growth of natural regeneration arising from cut-over forests.

Natural selection has resulted in improvement of qualities enabling species to be better able to survive under given ecological conditions. Logging leads to lower quality natural regeneration from remaining scrub trees. Positive selection should result in a corresponding improvement.

It is claimed that within three years, seedlings within a progeny test can be rated for quality, growth, form and disease resistance.

Dr. Hutchinson referred to the Monterey-Knob cone pine hybrid developed at Placerville, California, and the possibilities for selection for growth and frost resistance.

Claims have been made for ten times the growth in some hybrids than either of the parents, but other factors such as snow damage may limit the usefulness of specific hybrids.

Experimental proof was essential to show the value of tree improvement programs. It must be demonstrated that the selection of good phenotypes will coincide with the selection of good genotypes. The influence of site must be taken into account, and selections made from the poorer as well as the better sites.

"L" H. S. MacGillivray

Mr. MacGillivray was not present at the meeting.

"M" R. J. Moore

Dr. Moore pointed out that his Cytogenetic studies in Caragana occupied only a small part of his time.

In further comment he stated that germinating Caragana seed had been treated with colchicine, the effects of which were evident for only one year.

"N" <u>A. L. Orr-Ewing</u>

A letter from Mr. Orr-Ewing was read in which he expressed his regret that he was unable to attend the meeting, and hoped that some future meetings might be held nearer to British Columbia.

"O" <u>W. A. Porter</u>

The comment was made that Mr. Porter's work and conclusions were similar to the corresponding work carried out by Dr. Heimburger.

NOTES ON SYMPOSIUM

Poplar Breeding in North America

Mr. Holst introduced the following speakers to the members:

Dr. W. H. Cram	Indian Head, Saskatchewan
Dr. C. C. Heimburger	Maple, Ontario
Dr. S. S. Pauley	Minnesota, U.S.A.
Dr. E. J. Schreiner	Pennsylvania, U.S.A.

Mr. Holst noted the emphasis on breeding in poplar improvement work, saying that each of the speakers had developed an individual approach to the problem.

Dr. Heimburger

Dr. Heimburger opened the discussion with the following paper dealing with poplar breeding in Eastern Canada.

POPLAR BREEDING IN NORTH AMERICA
EASTERN CANADA

Utilization of Poplar Wood

Until relatively very recently, poplar wood has not been merchantable in large areas of Eastern Canada. In lumber and pulpwood operations, aspen and other poplars were not harvested, except occasionally as poor firewood and for camp construction. Match factories were the first to utilize good poplar wood, and in recent years poplar wood has been used for pulp manufacture after suitable pulping methods have been found and made economically feasible. A furniture factory in southern Ontario is interested in good poplar wood for veneer core stock. At present there is good demand for high quality poplar wood for match stock and for veneer and some demand for poplar pulpwood, especially in southern Ontario. In northern Ontario, as well as in the northern Prairie Provinces, large quantities of very good poplar wood are being allowed to rot on the stump while softwood species on the same areas are being harvested. The situation is in a state of rapid change, however, and one can anticipate increasing demands for good poplar wood, also in the northern forest. The recent increase in degree of utilization of poplar wood came about partly because of scarcity of better pulpwood species and partly because of development of new techniques in wood utilization. The transportation problem is important in this respect. Poplar is difficult to drive unless killed and peeled on the stump, which is expensive. The recent development of truck transportation has been very favourable to the increased

utilization of poplar wood. Several pulp mills in southern Ontario situated a long distance from wood supplies are becoming interested in poplar growing on their own land. They buy reasonably good farmland within trucking distance (up to 100 miles) from their mills and are beginning to plant poplars. There is also evidence of increased interest in good poplar wood in southern Quebec and in New Brunswick, under a setup very similar to that of southern Ontario, i. e. mills located in areas of good soil and relatively densely settled, so that more intensive methods of wood production are possible.

The production of new poplar materials that can satisfy the present demands in poplar plantations is the present aim of poplar breeding. Poplar arboriculture as practised in western Europe with cottonwood hybrids is at present not applicable to southern Ontario. We need poplars that can be grown in stands, under forest conditions, and supply large quantities of good wood in the shortest possible time. Two lines of development are at present being pursued in North America to this end. One line is based on the development of balsam poplar hybrids as exemplified by the work of Dr. Schreiner, and another line is based on the development of superior aspens, following the Scandinavian example, which is being followed in southern Ontario. Most pulp mills in Canada reject balsam poplar wood in preference to aspen wood, and are not favourably inclined towards the growing of hybrid balsam poplars. The wood of balsam poplars has not been found suitable for the manufacture of match stock or veneer. However, a species of balsam poplar is being used for match manufacture in Japan, and western cottonwood, which is a balsam poplar, is being used for veneer manufacture in southern British Columbia. Cottonwoods are being used for veneer in Canada and for match manufacture in Europe and South Africa. There is thus a lot of prejudice to be overcome in the utilization of poplar wood. The use of aspen wood for match stock and for veneer is well recognized and some pulp mills at least will utilize aspen wood with and without the admixture of spruce, for pulp manufacture.

The Problem

The present problem of poplar breeding is the production of aspen types that can satisfy the requirements mentioned above to the fullest extent. Largetooth aspen is the most valuable native species in the area in question but, unfortunately, this species does not lend itself easily to intensive production methods. It is very difficult to grow from seeds, to propagate by means of root cuttings and grafting; it is sensitive to poor drainage conditions and requires somewhat richer soil for good development than trembling aspen. Trembling aspen does not reach good sizes and produce high quality wood in southern Ontario. Of exotic species, silver poplar (*P. alba*) is planted rather widely on farms, is often of very poor growth form, has poor wood, but can reach larger sizes than the aspens because it is longer lived than these. European aspen does not offer great promise for direct use in plantations, because of its sensitivity to grasshoppers, to attacks by sapsuckers and to die-back caused by *Fusicladium* species and other fungi. It is possible, however, that after exploring a very wide range of biotypes of P. alba and P. tremula some will be found that are of direct value for growing in southern Ontario. The same is the case with their hybrids, the so-called P. canescens, of which a very wide variety of types exist in Europe. Therefore, work in acquisition and testing of various forms of P. alba, P. tremula and P. canescens is in progress. Thus far we have found a form of P. alba from Hungary, forms of P. canescens from Hungary and Czechoslovakia and an aspen from Czechoslovakia to be promising and to merit further propagation. The so-called "roumi" poplar of Lebanan and adjacent countries is a form of P. alba with fastigiate growth. It is far superior to the usual P. bolleana types used for decorative purposes and may be of some use for direct planting when we will know a little more about its habits.

The main work with aspen poplars at present consists of the production of hybrids. The hybrid P.tremuloides x tremula and reciprocal was first produced by Wettstein before the second World War. I saw it near Berlin in 1937 and it did not look very promising there. Shortly thereafter the same hybrids were produced in Denmark and Sweden, with the most promising results. The production of these hybrids is being continued in both these countries on an increasingly large scale and data are at hand in both these countries that show the superiority of the hybrids as compared with their native aspen. We have been sending pollen of trembling aspen to Denmark and Sweden and, more recently, to Finland, in very large quantities for the production of such hybrids there. These countries are becoming self-supporting in respect to pollen of trembling aspen which they raise from grafts. Attempts in vegetative propagation of the hybrids have also shown some success. The cross of our largetooth aspen with European aspen has been attempted several times, both here and in Europe but has thus far not produced hybrids of superior growth rate as compared with their parents. In recent years hybrids of European and trembling aspen with the Asiatic species P. adenopoda and P. davidiana have been produced here and in Europe, with very promising results. The cross of European aspen with trembling aspen has for quite a number of years not given us anything of promise. Recently, we were able to obtain pollen of P. tremula from Poland, Czechoslovakia, Hungary and Italy. These more southern pollens have given us hybrids that are far more rapid growing than those produced with Scandinavian and Central European pollen and offer great promise. Therefore, we are very much interested in Italian aspen at present. The Asiatic aspens have thus far not given anything of promise when crossed with our largetooth aspen. Crosses of several forms of P. canescens with largetooth aspen have been very promising, especially the cross P. canescens x grandidentata, because it is often difficult to obtain good P. canescens pollen. Several forms of P. canescens are superior to aspens in their longevity, rapidity of growth and large size. Many of these are used in forest planting in Europe and are growing well on reasonably good sites in spite of often very heavy competition from grass and weeds. Therefore, attempts were made in my early work with poplars, to cross P. alba with our native aspens, to produce new types resembling

P. *canescens*. This has been done with great success and since my early work in 1936 several hundred natural hybrids between P. *alba* and native aspens have been found in Ontario, Quebec, New Brunswick, Nova Scotia, Maine, New Hampshire, New York, Michigan and Wisconsin. These hybrids are very widespread and will probably be found in other areas also where P. *alba* is being grown close to native aspens. It so happens that most planted P. *alba* in eastern North America are female and flower at the same time as largetooth aspen. The resulting hybrids are often very vigorous. Unfortunately, only a very few of such natural hybrids reach large size before becoming stagheaded. The stagheadedness is a kind of die-back and is probably caused by fungus attacks. The few large trees of good form are being taken into cultivation and show very promising growth in the nursery and in young plantations. Several thousand of such hybrids have been produced artificially by using selected parents, in the hope of improving on nature. Pollen of P. *alba* received from Alberta and Europe has been used to make the reciprocal crosses. By using the best types of P. *alba* in crosses with the best available largetooth aspens, there is still a wide field open for the production of superior hybrids. Schlenker in Germany found recently that P. *alba* x aspen hybrids largely inherit the sex of their aspen parent used in the cross. Thus by directing the cross it is possible largely to control the sex of the resulting hybrids. This is also the case with hybrids of P. *alba* and American aspen species, and female P. *alba* x aspen are very rare indeed.

The hybrids P. *alba* x *tremuloides* are found more rarely, probably because of differences in flowering time of the parent species. They are usually slower growing than hybrids with largetooth aspen and have poor growth form, possibly because the trembling aspens available for such hybridization in nature within the range of planted P. *alba* usually are rather poor types. Artificial hybrids of this kind produced with pollen of good northern trembling aspen look very promising. Some of the very best types of trembling aspen are found in the Northwest and the use of such types in future hybridization work should prove promising were it not for their long-day preference which seems to be dominant in crosses with the day-neutral P. *alba*. The wood of P. *alba* x *tremuloides* has been found superior to all other aspen woods for veneer purposes so also from this standpoint these hybrids offer promise. The site requirements of P. *alba* x aspen hybrids are rather high, they are higher than the requirements of aspens and approach those of P. *alba*. To produce more aspen-like hybrids some of the natural P. *alba* x aspen hybrids have been crossed with aspens. The resulting back-crosses are very heterogeneous, as could be expected, but even the best seedlings are not promising as compared with the F_1 generation. Better results have been obtained in back-crossing to P. *alba*. Some very good P. *alba*-like materials have been obtained in this way, at least by using largetooth aspen hybrids and by avoiding inbreeding. Such P. *alba*-like types could possibly be used in further breeding work when they start flowering. P. *alba* has also been crossed with the Asiatic aspens, and with promising results thus far. All the American P. *alba* x aspen hybrids found thus far undoubtedly still represent the F_1 generation.

By the use of proper breeding methods it should be possible to produce still better aspen-like types, especially with the very great number of good aspens available.

Other Aims in Aspen Breeding

Rooting of Cuttings. During early work in aspen hybridization the raising of seedlings was a very difficult and circumstantial procedure. Only very recently has it been possible to raise seedlings in large numbers without too much work. Because of this, the interest in vegetative propagation of the resulting hybrids by means of stem cuttings was aroused and since aspens do not root from cuttings, numerous clones of *P. alba* were collected in Canada and tested for rooting ability of their cuttings, usually made from root suckers. As soon after the war as possible, a great number of *P. alba* forms were obtained from Europe, from a very wide range of localities, and we now have perhaps the largest collection of different *P. alba* types in North America. Tests for rooting ability within this range of materials were rather disappointing, however, only some Italian *P. alba* have thus far shown superior rooting as compared with types already grown in Canada. The rooting ability of poplar clones has until very recently been determined by counting the number of living plants in relation to the number of fall-planted cuttings. The cuttings are usually planted in the nursery in the fall, right after they have been prepared, as this saves storage and utilizes available manpower during the long period of favourable weather at that time. The cuttings are hilled for the winter to prevent frost-heaving, and de-hilled in the spring. The short and very busy work period in the spring can then be used for other tasks than poplar propagation by means of cuttings. Recently, populations of *P. alba* and *P. alba* x aspen hybrid seedlings have been mass-selected for rooting ability by cutting the tops of the seedlings and making them into cuttings. The roots are used for field plantings, so that the original populations are not destroyed. Any cuttings that do not root after fall planting are automatically eliminated and the surviving plants, with rooting ability, are used for further propagation and testing. It has been found, however, that this procedure is too severe a selection of the seedling materials and may involve the elimination of potentially good rooters. Many clones of *P. alba* have been tested for rooting ability after fall planting of cuttings during several years, and a great variation of rooting percentage has been observed from year to year in the same clone, depending mostly on weather conditions after planting, during the winter and the following spring. Therefore, beaker tests in the laboratory during February-March have been used recently and these tests have given more consistent results than fall planting of cuttings in the nursery. It is possible that spring planting of cuttings after storage will give more uniform and therefore reliable results. This remains to be investigated, particularly in the mass selection of seedling populations for rooting ability, to avoid possible elimination of good rooters. Several clones of *P. alba* have shown about 80% rooting of fall planted cuttings in favourable years. *P. alba* x aspen materials have rooted up to 20%. In these tests several clones of cottonwood and balsam poplars and their hybrids have shown more consistent and superior rooting ability than the *P. alba* and aspen

hybrid materials, also after fall planting of cuttings. This indicates that any further improvement in the rooting ability within the P. alba and aspen group might possibly also be obtained from outside besides through selection within that group. In this respect the cross P. alba x trichocarpa seems to offer promise. This cross was first made by Wettstein and has recently been repeated by Schlenker. We obtained some hybrid seeds of this kind from Schlenker in 1954 and have had very promising results with the seedlings. The cross has been repeated in 1955 using pollen of P. trichocarpa from 4 western American sources, besides pollen of the P. trichocarpa clone commonly grown in Europe. Only the "European" P. trichocarpa has thus far been successfully crossed with P. alba. The cross P. alba x deltoides has not been successful with us and crosses of P. deltoides with aspens have not been promising. It remains to be seen if the P. alba x trichocarpa hybrids are fertile and thus can be used for incorporating the superior rooting ability of P. trichocarpa into the P. alba-aspen group. The rooting ability of P. alba is partially dominant in crosses with aspens and various P. alba clones show rather wide variation in the transmission of the rooting ability to their hybrids with aspens. This indicates the presence of several genes for rooting within P. alba and opens possibilities for further selection and breeding. The best P. alba x aspen hybrids obtained thus far do not root enough from stem cuttings to make vegetative propagation in this manner commercially feasible, although the possibility still exists that this can be achieved by selection of better parents in the future. Many P. alba materials obtained from abroad are still in the juvenile stage and in time will flower and could then be used in further breeding work. A clone of P. alba obtained from Italy roots very poorly after fall planting, probably because of poor lignification of the shoots in our climate. Spring planting of stored cuttings selected for good lignification has given excellent rooting, however, indicating the availability of new genes for rooting ability, not present in P. alba types used currently in breeding work.

Early Flowering

Precocious forms of P. tremuloides are found in southern Ontario of which some flower at the age of 4 years from seeds. These have been used with good success as stocks for grafting, to induce early flowering in some late flowering breeding materials. The best results have been obtained by grafting the juvenile scions into the crowns of such early flowering trees. This has prompted the breeding of still more precocious types, using the native precocious materials for this purpose. In 1954 a precocious type of P. grandidentata was discovered and immediately used in a breeding program for the production of precocious types. The breeding of precocious aspens is thus, essentially, the production of better tools to shorten the breeding cycle of late flowering aspen materials. The breeding of precocious aspen materials can be used for still another purpose. Because of the short breeding cycles involved, it should be possible to incorporate the valuable properties of P. alba into precocious aspens within a relatively short time. As this still is an empirical process with many unavoidable mistakes and errors, these can be detected relatively soon and the efforts

directed towards the most promising crosses. The most promising crosses can then be repeated with normal, late flowering materials, thus avoiding many mistakes. The same process should also be possible in breeding for disease resistance in poplars. Any unpromising precocious materials obtained in this way could be utilized as stocks for grafting and are thus not completely wasted. In other words, it should be possible, first to produce perfect dwarfs and in the process of doing this to discover the best procedure of producing perfect normal aspen hybrids. Crosses of precocious aspens with normal late-flowering types indicate that the precocious flowering habit is largely dominant. This is also the case in crosses of these types with P. alba and P. tremula. If the precocious flowering in aspens is based on a small number of dominant genes, it should also be possible to change perfect dwarfs into perfect normal types by means of a few well-directed crosses. This should make the precocious types useful in a general speeding up of the aspen breeding program. These problems are under investigation at present.

Dr. Pauley

Dr. Pauley discussed the poplar studies he initiated in 1946 under the Maria Moors Cabot Research Foundation at Harvard University, and which are being continued there. The studies have no utilitarian objective and pertain to variation and hereditary characteristics of native Populus species. The sections Aegeiros, Tacamahaca and Leuce are being investigated and a collection of North American materials has been assembled for this purpose.

1. Aegeiros, Tacamaha

Two thousand clonal lines have been collected in the form of four cuttings of each clone. If the cuttings failed to root the respective clones were discarded. P. deltoides and P. trichocarpa are the principal species collected; also some P. tacamahaca. The best rooting, P. deltoides, are found along the Illinois-Mississippi area and south; poor rooting in the northwest and northeast parts of the range of the species. There is great selection pressure on seedlings under natural conditions and better sampling of adapted materials is by taking cuttings from trees. Very vigorous seedlings were seen in north central Louisiana. Populations from Arkansas were found to be hardy at Weston, Mass. where permanent test plots have been established. These are the source of future flowering materials. The photoperiodic response was studied in the P. deltoides complex, P. trichocarpa and the aspens. All were found highly sensitive to photoperiod and also varied according to the elevation of their source. The time of growth cessation is governed by the prevailing photoperiod. Thus P. trichocarpa from Alaska in Wsston stops height growth about the 20th June after having grown 8" in height; materials from the coast of Oregon and Washington cease height growth in the latter part of September after having grown about 6' in height. No effect of northern rootstock was found on southern scions, and vice versa. Differences were found in time

of leaf flushing, canker resistance, frost resistance, morphological characteristics, especially branching within P. trichocarpa. A fastigiate form of this species from the Bitterroot River valley was found. Hybrid vigour is here treated as the sum of all characteristics in response to a given environment and is not the same as in animals. Crosses were made between latitudinal and elevational sources and the hybrids show an intermediate condition. Thus, inheritance of adaptation to daylength appeared to be multifactorial. The cross P. alba x deltoides yielded cactus-like hybrids.

2. Aspens

Studies of variation and mode of inheritance were made in seedling progenies. The seedlings were set out in permanent test plantations. A good collection of western aspens has been assembled. Aspen in the Rocky Mountains produces seeds in the very early spring when the stands are largely inaccessible. They are adapted to a short growing period. Intraspecific crosses were made between provenances of P. tremuloides and P. grandidentata. P. tremuloides from the Lower Peninsula in Michigan and from Wisconsin showed good combining ability in crosses with other P. tremuloides origins and with P. tremula. P. tremuloides x grandidentata often gave non-promising offspring but some were good. P. tremuloides was crossed with 10 sources of P. tremula from various parts of Europe. As a rule the northern P. tremula with the exception of one source from southern Norway, gave slower growing hybrids with P. tremuloides than the southern aspens. Hybrids with aspen from Sweden, Poland, Italy and Germany were satisfactory in respect to growth rate. The hybrids P. tremuloides x adenopoda were susceptible to die-back. Inkspot disease was found on leaves of several families. A new disease was found on leaves - chocolate brown leaves, caused by a Gnomonia. All this information is of basic value to breeding work with poplars and aspens.

Dr. Schreiner

Dr. Schreiner discussed the utilization of poplar wood in the U. S. A. Cottonwood is used for lumber and for veneer. Veneer logs have been produced from cottonwood hybrids at Williamstown, Mass. in 14 years. The primary interest of the Northeastern Forest Experiment Station is with the cottonwoods. Good upland sites in the Northeast are better suited for good hardwoods and as a rule contain no aspen. Aspen is not found on cottonwood sites. The planting is done at a spacing of 6' x 6' in stands, followed by early thinning. Two hundred and fifty hybrid clones have been selected for clonal tests. Of the first 50 selected clones, only 10 were found resistant to Septoria canker. Of the remaining 200 clones, 85% were resistant. The 250 clones are now being widely distributed for statistically sound clonal tests. For $1.00 a co-operator can receive two cuttings of four clones, distinguishable by leaf shape, so as to prevent mixups. The main concern at present is the creation of markets for poplar wood. Integration of pulpwood and log production is important.

Dr. Cram

Dr. W. H. Cram presented the following paper.

POPLARS FOR PRAIRIE CANADA

Because of their rapid growth, Poplar spp. meet one important requirement of shelterbelt trees. However, because they lack drought resistance they do not occupy a prominent place under prairie conditions, except in some irrigated areas. Poplars are planted in shelterbelts to provide early growth and shelter. They seldom reach maturity and may be considered as temporary and/or 'nurse' species in prairie Canada. As such their importance in a breeding program for improved shelterbelt trees is secondary.

Nevertheless, requirements for a desirable poplar clone for prairie planting may be stated:

1) tolerance to extremes in cold and drought
2) outstanding rooting capacity from cuttings
3) strong vigor
4) resistance to attack by insects and diseases

While quality of wood is of minor importance, staminate or male clones are in greatest demand. In this day of oil and gas heating, the production of wood for fuel has little place in Western Canada.

Active research with Populus spp. at the Forest Nursery Station, Indian Head, was limited to the 1947-1952 period. Prior to 1947, test plantings of some 80 hybrids and 40 species had been established, while many more went out. Performance records as to adaptability, vigor and disease resistance led to the selection of 20 superior clones. Rooting and vigor studies of these were initiated in 1948, 1949, 1950 and 1951.

Results, reported to this group in 1952, were briefly as follows:

1) Rooting capacity of the 20 clones varied from 45 to 92%, while that of the standard Northwest Poplar was 59%.
2) Maximum rooting was exhibited by two clones of P. petrowskyana, namely Volunteer and Dunlop.
3) A high degree of rooting (above 80%) characterized four other clones, P. tristis, F.N.S. 44-52, Brooks 10 and Brooks 7.
4) Two clones demonstrated outstanding juvenile vigor at the end of two seasons of growth; these were F.N.S. 44-52 (a natural hybrid of P. deltoides) and Brooks 10.

It would seem that the following conclusions may be drawn from studies conducted:

1) P. petrowskyana carries desirable factors for rooting.
2) P. deltoides carries desirable vigor factors.
3) Exploratory crosses made suggest the two species are incompatible.

Due to the pressure of other project work, the poplar investigations have been held in abeyance since 1952.

Dr. Skinner

The following paper by Dr. F. L. Skinner entitled "Poplar Breeding at Dropmore, was received by Dr. Heimburger after the conclusion of the meeting, and is included here for information.

POPLAR BREEDING AT DROPMORE

In northern Manitoba we have two native poplars, P. balsamifera and P. tremuloides, the former is known locally as the black poplar, and the latter as the white poplar. The balsam poplar is a fast growing, upright tree that is easy to propagate and a well grown mature specimen is quite a handsome tree with its deeply furrowed bark and glossy leaves, but its wood checks rather badly and the leaves become so badly infested with rust in some years that the tree becomes defoliated quite early in autumn. P. tremuloides, with its white bole is also a handsome tree and the soft white wood takes on quite a satiny finish, but unfortunately it cannot be propagated from hard wood cuttings.

In the hope of securing poplars that would have as many as possible of the good qualities of our two native species and eliminate their worst faults, I have imported quite a number of poplar species and have also done quite a bit of breeding work in which our native species were used as one of the parents.

The Dakota cottonwood was one of the first poplars that I imported, and with us it is a fast growing tree, but like our balsam poplar it is very subject to leaf rust and aphids frequently cause unsightly galls on its leaves. Crossed with our balsam poplar I have secured hybrids that have so far proved immune to the gall forming aphids and less susceptible to leaf rust than either of the parents and one female hybrid is a very fast grower with nice, soft, white wood.

P. tristis of Kew is one of the balsam poplars that is very fast growing, easily raised from hard wood cuttings, and has so far been quite immune to leaf rust even though balsam poplars growing within fifty feet of it have been badly infested. This is a male tree and I have raised quite a few hybrids between it and our native balsam poplar. Some of these are very promising trees that show a considerable degree of resistance to leaf

rust.

Hybrids have also been raised between this male P. tristis and a female cottonwood hybrid and an extremely variable bunch of trees have been secured. These are just three years old, but have so far been quite immune to leaf rust, though a planting of cottonwood within 75 years has been badly infested.

Imported from Kew at the same time as P. tristis was a male tree of Populus laurifolia, and it too has shown resistance to leaf rust. Hybrids have been raised between this P. laurifolia and both P. balsamifera and the cottonwood hybrid mentioned earlier. The latter lot were raised in 1954 and though planted quite close to the rusted cottonwoods have shown no sign of rust. Unlike the hybrids having P. tristis as male parent, these were a very even lot, definitely showing the influence of P. laurifolia in their foliage and twig structure. A few have been more vigorous in growth than their fellows. However, two or three years are not sufficient to evaluate hybrids of this kind, and it will probably be at least twenty years before we can definitely say that we have secured hybrids that are superior to those now in common use. However, the results to date are very promising and I feel that work of this kind should yield useful results.

While at Kew in 1947, I spent some time going over the poplar collection very carefully. P. tristis that does so well at Dropmore is rather a poor thing at Kew. The winters are too mild for it, and it starts into growth so early that it frequently is cut back by late spring frosts. Many other trees from cold continental climates behave in this fashion at Kew, so I concentrated on those varieties that were doing badly at Kew. The ordinary form of P. simoni kills back badly at Dropmore and has been discarded, and while this form was doing fairly well at Kew there was one form that was no more thrifty looking than P. tristis, so cuttings of it were eventually secured and now I have a form of P. simoni that is quite hardy here.

P. maximowiczii is one of the very large trees of eastern Asia where it ranges as far north as Kamschatka, There, I have read, it grows so large that sea going dugout canoes have been made from it. It has rugose, glossy leaves and the gum on the winter buds is very fragrant. Unfortunately the forms of it that I have been able to secure cuttings of have not been hardy at Dropmore. A very similar, though smaller tree, P. koreana, is quite hardy here and possibly it will be useful in breeding work, though it has not yet flowered with me.

There are exceptions to all rules, and while at Kew I noticed two poplars that were doing well and that I thought worthy of trial in Manitoba. They were tall trees with widely spreading branches and the fact that one of them came from Central Asia and the other from northern Manchuria suggested that there was a good chance that they would prove hardy. The one from central Asia, P. octorabdos, resembles the cottonwood in the

young state and it seems to be immune to leaf rust. The other is P. songarica and it also seems to be healthy and quite hardy.

Notes from General Discussion

Southern high altitude and northern poplar provenances responded equally with respect to length of growing season in the central Massachussetts daylength.

Apical dominance is a desirable characteristic in poplars and has shown to be an inheritable characteristic. Aspen typically exhibits apical dominance. Dr. Pauley described a specimen which might have a weeping habit. In the spring of the second year it produced flower buds. Subsequently the top was cut off to promote lateral bud growth, but the laterals did not produce flowers.

In a discussion of the utilization of poplar for pulp or veneer, it was agreed that a combined operation provides the best solution.

With respect to desirable planting distances for poplar 6' to 8' is considered normal, although closer spacing may be used if cultivation is maintained. "Stump" seedlings, ie. nursery seedlings which have been cut down, proved to be more satisfactory planting stock than untreated seedlings.

It was suggested to Dr. Cram that P. tremula from Lebanon may prove to be a suitable drought resistant stock for prairie cultivation.

P. alba was reported to be resistant to salt water inundation, and P. canescens resistant to salt spray.

It was questioned whether it was sound to test P. alba cuttings for root formation by planting in the fall, since valuable clones may be lost. On a commercial scale, cuttings are propagated in the spring. Fall planting does alleviate labour problems encountered in the spring. Dr. Pauley suggested that seedlings may prove to be a better proposition than cuttings, by maintaining a degree of variability in the planting stock. However, this depends on the object in view. Seedlings are more expensive to raise than cuttings, which is a reason for breeding for root-ability.

In answer to a question it was said that back crosses to P. alba showed an increase in root-ability of cuttings of the progeny.

It was stated that regeneration by means of root suckers may be successful beyond two generations.

Dr. Schreiner cited an example of poplar regeneration in Venice. Advantage is taken of the stable water table, whereby roots are cut from a 20' tree, a hole dug 4' deep and a further 8' penetrated with a bar. The

poplar pole is planted in the hole. This method has resulted in a 90% take.

In a discussion of artificial disease inoculation as compared to natural inoculation with respect to susceptibility of poplar clones, it was pointed out that tests should be made in natural conditions following the results of artificial inoculation. A disease vector, e.g. an insect, may be involved under natural conditions.

APPENDIX "A"

COMMITTEE ON FOREST TREE BREEDING

Report of Work at Glendon Hall - 1955

During the past year two experiments were established by Mr. J. A. C. Grant for the purpose of:

(a) Determining what effect release from shade has on the growth of white spruce seedlings of different provenances.

(b) Determining what effect different photoperiods have on the growth of Norway spruce seedlings of different provenances.

A brief account is given below of each of these projects.

Project L-1 To determine the response of white spruce (*Picea glauca* (Moench) Voss) of different provenances to release from shade at different ages.

White spruce seed of the following provenances was used: Fort William; Thessalon; Dore Lake, Saskatchewan; Dryden and Denbigh.

Approximately 40 seedlings of each provenance were planted in each of five compartments out-of-doors. Four of these compartments were covered with wire screens which gave approximately 19% illumination to the seedlings. No screen was placed over the fifth compartment.

At the beginning of each growing season, for the next four years, one screen will be removed from a compartment. Heights measurements are being made of the seedlings at the end of each growing season.

From the height measurements made at the end of the 1955 growing season it appears that the unshaded seedlings have made slightly better growth than the shaded seedlings, and in both the shaded and the unshaded compartments seedlings of the Denbigh provenance have made the best height growth.

This experiment will be completed in 1959.

Project P-1 To determine the growth response of Norway spruce (*Picea abies* (L) Karst) of different provenances to various photoperiods.

Seed of the following provenances was used:

Istebena, Poland	Elevation 600 m.	Lat. 49° 35'N
Nagold, Germany	Elevation 555 m.	Lat. 48° 33'N
Harzen, Germany	Elevation 200-400 m.	Lat. 51° 40'N
Thüringen, Germany	Elevation 400 m.	Lat. 50° 40'N
Regensburg, Germany	Elevation 1000-1250 m.	Lat. 49° 01'N

It will be seen that there is little variation in the latitudes of the areas from which the seed was obtained.

Ten seedlings of each provenance were placed in each of four compartments in the greenhouse. They were then grown under the following photoperiods: 17 hours; 19 hours; 21 hours; 23 hours.

The seedlings were put in the compartments in July 1955, a few week after germination, and the experiment terminated November 1955.

At the end of the experiment, measurements were made of the height growth and dry weight (root and shoot separately) of each seedling. In addition the presence or absence of buds was noted.

The analysis of the results has not yet been completed, but from the raw data the results appear to be:

(a) All seedlings grown under a photoperiod of 21 hours made better height growth than seedlings grown under the other photoperiods.

(b) Nearly all seedlings grown under the 17 hour photoperiod were dormant with well-formed terminal buds. Seedlings under 21 and 23 hour photoperiods were nearly all in an active state of growth with no terminal buds formed. Under a photoperiod of 19 hours approximately half the seedlings were dormant and had terminal buds.

(c) All seedlings except those of the Regensburg provenance show similar growth patterns. The pattern, generally, shows an increase in both height and dry weight with increase in photoperiod to 21 hours. The Regensburg seedlings show only a very slight increase in height from a 17 hour to a 19 hour photoperiod, and a decrease in dry weight. The increase in growth for seedlings of this provenance occurred only from a 19 hour to a 21 hour period.

(d) Under the 23 hour photoperiod only Regensburg provenance seedlings showed a fairly high percentage of seedlings which were dormant.

<u>Present Work</u>

White spruce seedlings of different provenances are being grown under different photoperiods similar to the treatment of Norway spruce seedlings in Project P-1. In addition, experiments are being undertaken to determine the influence of change in photoperiod on the growth of Norway spruce seedlings.

APPENDIX "B"

REPORT TO COMMITTEE ON FOREST TREE BREEDING
March, 1956

A. J. Carmichael
G. B. Withers
Ontario Tree Seed Plant, Angus

Test Planting 1955

A. Introduction
B. Machine Planting Procedure
C. Hand Planting Procedure
D. 1955 Planting Program
   1. Jack Pine Provenance Test
E. 1954 Test Plantings
   1. Red Pine Provenance Test
   2. Scotch Pine Provenance Test
   3. Pine Shoot Moth Test

Seed Production

A. Seed Production Areas
   1. Nairn Township
   2. Lynn Tract, Drury Forest

B. Seed Orchard Production
   1. White Pine
   2. Red Pine
   3. Scotch Pine
      A. Timber Types
   4. Yellow Birch

TEST PLANTING 1955

A. Introduction

It has been necessary to reduce the size of test plantings due to the difficulties in obtaining larger land areas. We will plant 100 trees in each sample (instead of 400 trees) and repeat each sample four times on the area. This requires 400 trees for each strain or provenance on one planting site, and takes an area of 0.27 acres when planted at a 6' x 6' spacing.

Machine planting of jack pine, using a standard model, trailer type Lowther, was carried out on 32 acres of land in spring 1955. The areas planted supported a variable cover of poplar, hazel, blueberry, sweetfern and fallen trees. The trees were planted better than they could have been by furrowing and hand planting. A better planting might have resulted if a bulldozer had been used to draw the machine and break down logs and stumps. It was not possible to maintain proper spacing in the row, on the type of site used. It was also very difficult to make survival counts. It is to be hoped that a better means of test planting can be found for rough sites, where furrowing is not practical.

B. Machine Planting Procedure

The field was marked previous to planting, by placing single furrows across the field at intervals of 120 ft. By planting at right angles to these furrows the planter could observe each change of provenance.

A crew of four was used, one man drove the tractor, two men planted and one man supplied trees to the planting crew. A tractor and stoneboat were used to bring trees from the boxes to the planter. Proper allocation of the various provenances was maintained by having a sectional tub in which to place the trees. Two bundles of trees were placed in each section of the tub for one provenance. There were six sections in all. The bundles were to contain 20 trees, however, since 25 trees are normally placed in a bundle it was difficult to maintain a uniform count of 20. One bundle was to be planted going down the field, the other on the return trip. The trees were arranged in the tub so that the selection of bundles from compartment in a clockwise manner corresponded with the provenances, doing down the field. On the return trip a counter clockwise selection was used. One man walked beside the planter to select the bundles, cut the strings and loosen the trees before handing them to the planter. These two men alternated after planting four rows (480 trees). The man supplying trees to the planter was responsible for placing stakes in front of the sample block in the first and last rows of each provenance. It was found that once the planting crew was organized they could plant over 1,000 trees per hour. It has been customary to mark the two front corners of each provenance with an 18" stake made of 3/4" angle aluminum. In some locations these stakes are removed as souvenirs, so that we must change to a less attractive marker. The use of mild steel rod 3/8" diameter will be tried in 1956. This will reduce the cost of markers from 28¢ for angle aluminum

to 7¢ for a steel rod of the same length.

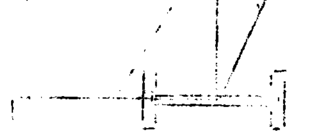
C. Hand Planting Procedure

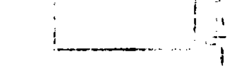
In order to improve the furrow which is made in sod or in heavy blueberry turf a single hydraulic lift plow, with a 14" bottom, has been fitted with two 18" notched coulters to give a 16" furrow. These coulters cut both sides of the furrow slice, and allow the mouldboard to throw the slice free from the furrow. This prevents the slice from rolling back into the furrow, a common occurrence with heavy turf. It is important to have the centre of the coulter on the furrow slice side opposite or ahead of the point of the ploughshare.

It has been found difficult to maintain an accurate spacing between furrows when ploughing on rough terrain. In order to have a marker which will run in the adjacent furrow and which can be raised when passing stumps or slash, a moveable guide and marker has been built.

The guides consist of two arms of angle aluminum 6' in length, which are fastened at one end to the centre of a bumper in front of the tractor. The arms are supported in a horizontal position by means of brackets fastened to the outer edges of the bumper. The position of these arms is such that they are in front of the tractor wheels and about 17" above the ground. A piece of spring steel, with one end coiled to form a spring, is fastened to the outer edge of the guide to act as a marker. This marker rides in the adjacent ploughed furrow and is about 2" above the ground when the tractor is level.

A T-frame is fastened to the middle of the bumper, and supports two pulleys which carry cords passing from the ends of the guide arms to fixed holders in front of the steering wheel. The arms are raised when not in use and are held in a vertical position. The arm which is being used as a guide will be in a horizontal position. It can be raised to avoid a stump by reaching forward and pulling on the cord.





D. 1955 Planting Program

1. Jack Pine Provenance Test

Twelve sources of jack pine seed were used. They had been collected from six forest sections of the Boreal Forest Region (B4, B7, B8, B9, B10, B11), and three forest sections of the Great Lakes-St. Lawrence Forest Region (L9, L10, L11). The planting took place in Hills' Site Region 5 in Maria Township and in SR4 in Cane Township.

Site Region 5

A total of 9,600 trees was planted on an area of 20 acres. Survival counts made on November 8, 1955 showed a mortality of 28% on the average for all provenances. This varied from 9% to 54% for different provenances. There were on the average 6% more trees planted than were required, an indication of the difficulty of obtaining bundles containing 20 trees, and of the lack of uniformity with machine planting on a rough site. The number of extra trees varied from 0.5% to 13% for different provenances.

It is of interest to note that four times as many trees died in the medium sized group (36% of 4"-6" ht., 64% of 6"-12" ht.) than in the group of trees classed as larger (31% of 4"-6" ht., 62% of 6"-12" ht., 7% of 12"-18" ht.). The count of survival may have been affected by the fact that larger trees would be less likely to be missed, whereas smaller trees could be missed, particularly when dead. It was found also that five times more "extra trees" were present in the planting of the group of larger trees than in the group of medium trees.

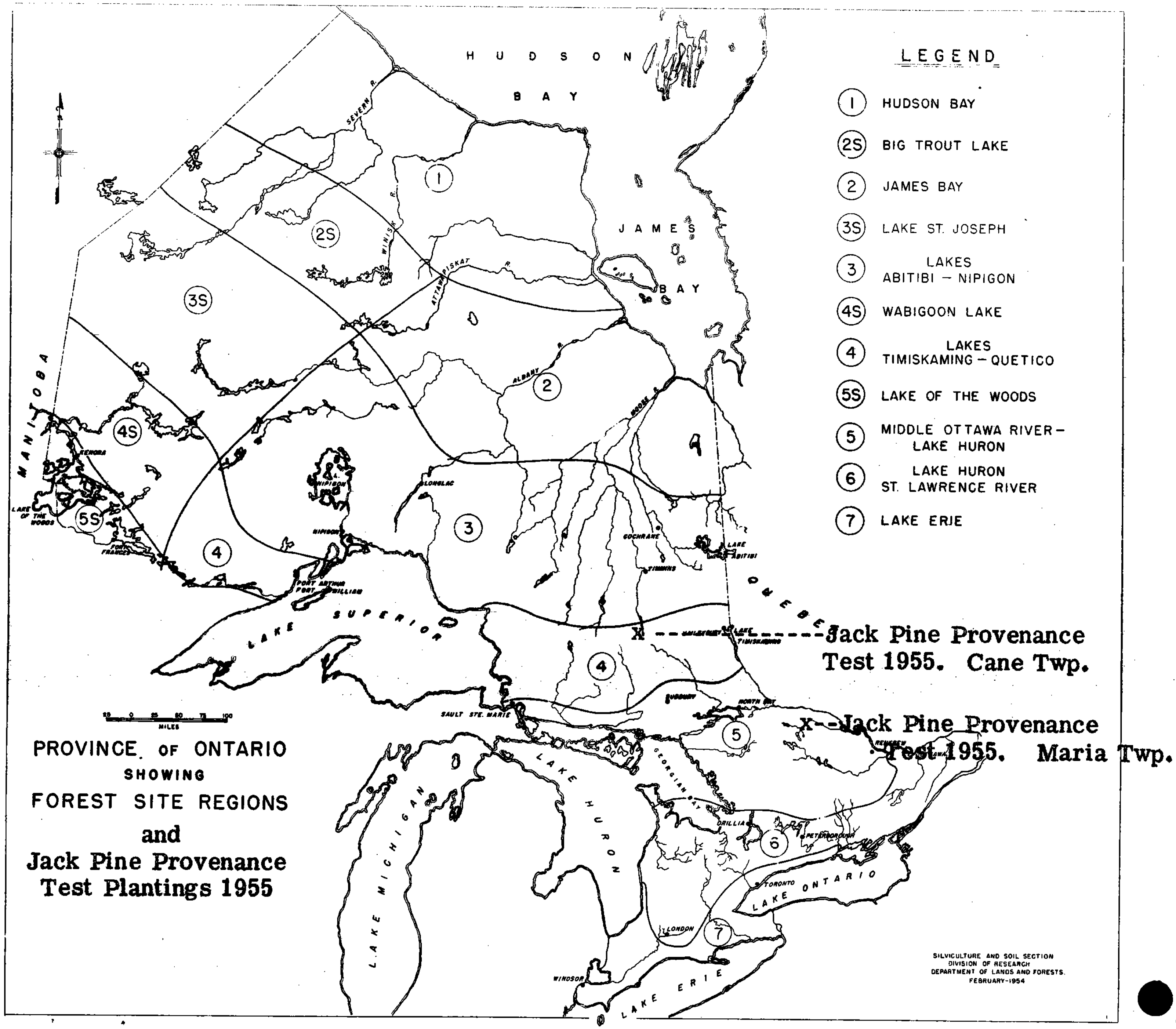
A greater portion of the variation which was present in the size of stock was due to variations in nursery treatment rather than inherent differences.

A replacement of the dead trees is planned for 1957.

E. 1954 Test Plantings

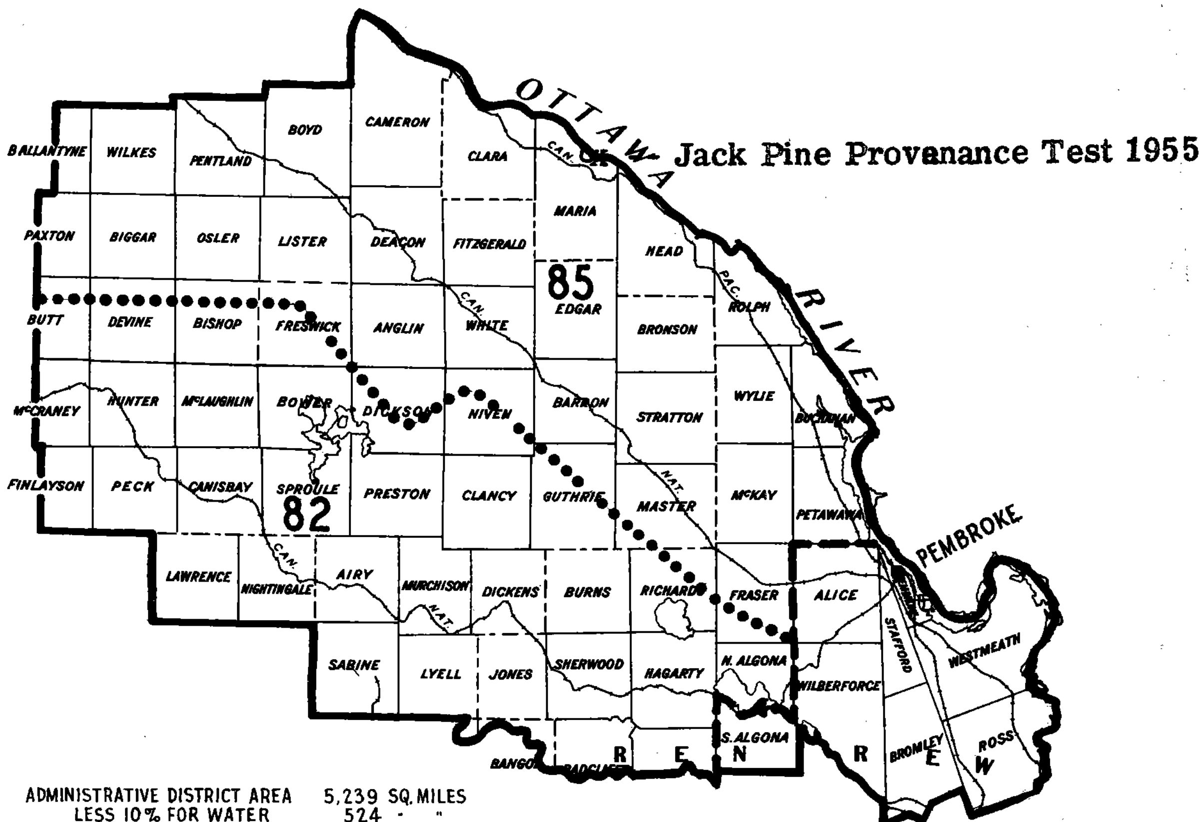
1. Red Pine Provenance Test

The sample blocks have been reduced in size from 400 trees to 100 trees. The smaller blocks, lying in the centre of the previous block, will be used for all future measurements. Replacement plantings will utilize trees from the unused portion of the old block, commencing with the outside rows. The very dry summer in 1955 increased the overall mortality in Site Region 3 at German Township from 4% to 13% and in Site Region 5 at Rose Township from 1% to 10%. Replacement plantings will be made in 1956 or 1957.



HUDSON BAY
JAMES BAY
MANITOBA
QUEBEC
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
GEORGIAN BAY
LAKE ONTARIO
LAKE ERIE
SEVERN R.
WINISK R.
ATTAWAPISKAT R.
ALBANY R.
MOOSE R.
KENORA
LAKE OF THE WOODS
FORT FRANCES
NIPIGON
L. NIPIGON
PORT ARTHUR
FORT WILLIAM
LONGLAC
COCHRANE
TIMMINS
LAKE ABITIBI
LAKE TIMISKAMING
SAULT STE. MARIE
SUDBURY
NORTH BAY
ORILLIA
PETERBOROUGH
TORONTO
LONDON
WINDSOR
MILES
LEGEND
1 HUDSON BAY
2S BIG TROUT LAKE
2 JAMES BAY
3S LAKE ST. JOSEPH
3 LAKES ABITIBI – NIPIGON
4S WABIGOON LAKE
4 LAKES TIMISKAMING – QUETICO
5S LAKE OF THE WOODS
5 MIDDLE OTTAWA RIVER – LAKE HURON
6 LAKE HURON ST. LAWRENCE RIVER
7 LAKE ERIE
X-----Jack Pine Provenance Test 1955. Cane Twp.
X--Jack Pine Provenance Test 1955. Maria Twp.
PROVINCE OF ONTARIO
SHOWING
FOREST SITE REGIONS
and
Jack Pine Provenance
Test Plantings 1955
SILVICULTURE AND SOIL SECTION
DIVISION OF RESEARCH
DEPARTMENT OF LANDS AND FORESTS.
FEBRUARY-1954

PEMBROKE DISTRICT



ADMINISTRATIVE DISTRICT AREA	5,239 SQ. MILES
LESS 10% FOR WATER	524 " "
NET AREA	4,715 SQ. MILES

PLAN SHOWING ——
Location of Jack Pine Provenance
Test, 1955. Maria Township.
Site Region 5

MILES
20 10 0 20 40

DEPARTMENT OF LANDS AND FORESTS 13 APR. 1954

FORM F.P. 25

District ____________________

REPORT ON FOREST FIRES

For the Period from ____________________ to ____________________

Rangers on Duty, No. ____________________ Extra Fire Fighters, No. ____________________

Precipitation for week ____________________ ____________________

____________________ ____________________

Hazard, Past week ____________________ Probable next week ____________________

FIRES FOR WEEK

FIRE NO.	LOCATION	CONDITION	CAUSE	AREA	DATE OF ORIGIN

All towers were manned during week, except ____________________

____

All communication systems are operating, except ____________________

____

Remarks: ____________________

____
DISTRICT FORESTER

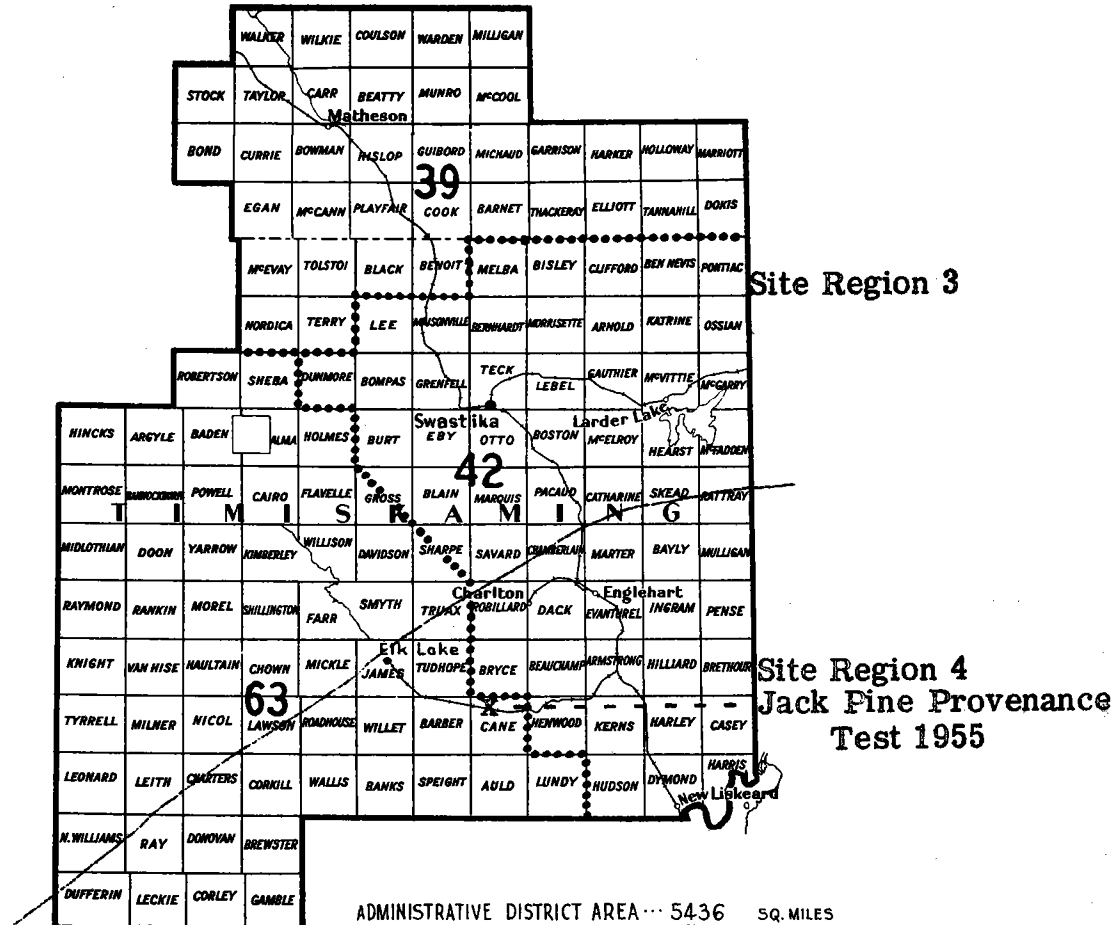
Algoma 1-1	Pickle Lake 1-2	Connaught 1-3	Markstay 1-4	Franz H 2-1	Sioux Look. 2-2	Connaught 2-3	Goldie 2-4
Mobert 1-5	Kab Lake 1-6	Goldie 1-7	Franz H 1-8	Gerald-ton P. L. 2-5	Hardwick 2-6	Kab Lake 2-7	Pickle Lake 2-8
Hardwick 1-9	Sioux Look. 1-10	Timmins 1-11	Gerald-ton P. L 1-12	Mobert 2-9	Markstay 2-10	Timmins 2-11	Algoma 2-12
Gerald-ton P. L. 3-1	Markstay 3-2	Timmins 3-3	Franz H 3-4	Goldie 4-1	Markstay 4-2	Gerald-ton PL 4-3	Sioux Look. 4-4
Connaught 3-5	Mobert 3-6	Goldie 3-7	Sioux Look. 3-8	Kab Lake 4-5	Connaught 4-6	Franz H 4-7	Mobert 4-8
Hardwick 3-9	Kab Lake 3-10	Pickle Lake 3-11	Algoma 3-12	Hardwick 4-9	Pickle Lake 4-10	Algoma 4-11	Timmins 4-12

JACK PINE PROVENANCE TEST SITE REGION 5

Maria Twp. 1955

Filled in with P. L. = Pickle H. = Hardwick

SWASTIKA DISTRICT



ADMINISTRATIVE DISTRICT AREA ··· 5436 SQ. MILES
LESS 10 % FOR WATER ··· 543.6 SQ. MILES
NET AREA ··· 4892 SQ. MILES

PLAN SHOWING ——

~~Location of Jack Pine Provenance~~

~~Test 1955, Cane Township~~

~~Site Region 4~~

MILES

20 10 0 20 40

DEPT. OF LANDS & FORESTS — APRIL 1953

FORM F.P. 25

District ____________

REPORT ON FOREST FIRES

For the Period from ____________ to ____________

Rangers on Duty, No. ____________ Extra Fire Fighters, No. ____________

Precipitation for week ____________ ____________

____________ ____________

Hazard, Past week ____________ Probable next week ____________

FIRES FOR WEEK

FIRE NO.	LOCATION	CONDITION	CAUSE	AREA	DATE OF ORIGIN

All towers were manned during week, except ____________

____

All communication systems are operating, except ____________

____

Remarks: ____________

____
DISTRICT FORESTER

Markstay 1-1	Kab Lake 1-2	Pickle Lake 1-3	Connaught 1-4	Kab Lake 2-1	Hardwick 2-2	Algoma 2-3	Mobert 2-4
Timmins 1-5	Sioux Look. 1-6	Geraldton PL 1-7	Goldie 1-8	Geraldton PL 2-5	Connaught 2-6	Markstay 2-7	Timmins 2-8
Franz H 1-9	Algoma 1-10	Mobert 1-11	Hardwick 1-12	Franz H 2-9	Sioux Look 2-10	Goldie 2-11	Pickle Lake 2-12
Kab Lake 3-1	Geraldton PL 3-2	Sioux Look 3-3	Mobert 3-4	Franz H 4-1	Timmins 4-2	Mobert 4-3	Goldie 4-4
Pickle Lake 3-5	Timmins 3-6	Hardwick 3-7	Franz H 3-8	Hardwick 4-5	Algoma 4-6	Connaught 4-7	Gerald-ton PL 4-8
Goldie 3-9	Algoma 3-10	Connaught 3-11	Markstay 3-12	Markstay 4-9	Pickle Lake 4-10	Kab Lake 4-11	Sioux Look. 4-12

JACK PINE PROVENANCE TEST SITE REGION 4

Cain Twp. 1955

Filled in with PL = Pickle Lake H = Hardwick

54
53
51
50

2. Scotch Pine Provenance Test

The sample blocks have been reduced in size from 196 trees to 100 trees. Replacement plantings will be made in 1956 utilizing the trees from the unused portion of the old block.

Survival counts made in the fall of 1955 have shown the same trend as in 1954 when stock of northern origin had a greater mortality than southern stock of the same age. This was probably due to the smaller size of northern stock. In Site Region 3 and Site Region 5, further evidence was found of the burial of stock whenever furrows had been ploughed too deeply. However, in Site Region 6 there was no evidence of burial and twice as many trees died of northern origin than of southern origin. It was found also that large stock continue to survive better than small stock regardless of whether they are of northern or southern origin.

Observations on foliage colour for plantings in Site Region 6 show that two French sources, Cevennes and Haute Lorie had the greatest number of green trees in the fall. Some yellow foliage did appear in two of the four replications of these sources. In general, the more northerly sources from the Scandinavian and Baltic countries, all had a yellow foliage colour in November. Further observations on foliage colour and other tree characteristics will be made in 1956.

3. Pine Shoot Moth Test

A comparison of Pinus nigra cebennensis from Cevennes, France and red pine from Douglas in Site Region 5 is being made on two areas, to determine if there is any difference in the attack of shoot moth on these species. In June 1954 the Corsican pine had completed four growing seasons from seed and the red pine had completed five growing seasons.

A one hundred percent check was made by the Forest Biology Ranger staff on June 14 in Site Region 6 and on June 2 in Site Region 7. This survey was similar to that carried out in July 1954. The following observations have been made from their tallies.

1. In 1954 -

   - shoot insects attacked 8% of all trees planted in Site Region 6 and Site Region 7.
   - shoot moth attacked 5% of all trees planted in Site Region 6 and Site Region 7.
   - other shoot insects attacked 3% of all trees planted in Site Region 6 and Site Region 7.
   - shoot insects attacked 3 times as many trees in Site Region 6 as in Site Region 7.

- shoot moth attacked slightly more trees in Site Region 6 than in Site Region 7.

- other shoot insects attacked 3 times as many trees in Site Region 6 as in Site Region 7.

2. In 1955 -
   - shoot insects attacked 55% of all trees planted in Site Region 6 and Site Region 7.

   - shoot moth attacked 49% of all trees planted in Site Region 6 and Site Region 7.

   - other shoot insects attacked 6% of all trees planted in Site Region 6 and Site Region 7.

   - shoot insects attacked 5 times as many trees in Site Region 7 as in Site Region 6.

   - shoot moth attacked 5 times as many trees in Site Region 7 as in Site Region 6.

   - other shoot insects attacked 5 times as many trees in Site Region 7 as in Site Region 6.

3. Those Corsican pine which were attacked with shoot moth tended to maintain upright growth habit with a single terminal shoot. Those red pine which were attacked with shoot moth tended to develop a bush habit without any definite terminal shoot.

   A large proportion of the damage attributed to other shoot insects in Site Region 7 was due to feeding on the new shoots by long horned borers. A large concentration of borers is present in slash piles adjoining the test area.

SEED PRODUCTION

A. Seed Production Areas

1. Nairn Township

The alternate rows in a 6' x 6' planting were removed in 1954. The alternate trees, in the rows remaining, were removed in October 1955.

Some of the trees cut in 1954 had been removed and piled adjacent to the thinned area. These piles were removed in October 1955. In addition, the trees cut in 1955 were removed from the area to prevent any possible build of Ips, due to their presence.

- shoot growth attacked slightly more than in [illegible] [illegible] in Region 7.

- [illegible] attacked [illegible] times as many trees [illegible] Region 5 as in [illegible] Region 4.

2. [illegible]

- [illegible] in [illegible] planted in [illegible] Region [illegible].

- [illegible]

- [illegible]

- [illegible] Region 2.

- shoot [illegible] 5 times as [illegible] Region [illegible].

- other [illegible] 3 times [illegible] trees [illegible] Region 4.

3. The [illegible] shoot [illegible] [illegible] [illegible] planted [illegible]

[illegible] planted [illegible] [illegible] feeding [illegible] shoots [illegible] large [illegible] tion of [illegible] piles [illegible]

[illegible]

A. [illegible] Introduc[illegible]

1. [illegible] Township

The alternate trees in [illegible] planting were removed in 19[illegible]. [illegible] alternate trees, in the [illegible] remaining, were removed in October 1955.

Some of the [illegible] in 1954 [illegible] piled adjacent to the thinned area. The piles were removed in October 1955. In addition, the trees [illegible] were removed from the [illegible] to prevent any possible build of [illegible] to their presence.

There are about 2,400 trees remaining at a spacing of 12' x 12'. Plans will be made for fruit induction tests in 1956.

2. Lynn Tract, Drury Forest

The alternate rows in a 6' x 6' planting were removed in 1954. The alternate trees in the rows remaining were removed in November 1955. There are about 1,200 trees remaining at a spacing of 12' x 12'.

An area of four acres was thinned in November 1955 to a spacing of 18' x 18' by means of the removal of two rows for each row left standing, and the removal within the remaining rows of two trees for each tree left standing.

In felling these trees all branches were removed up to the first whorl and the stems and branches were left on the ground to rot. It was felt that, because of the small diameter of the stems cut, the possibility of an Ips attack was slight. The fire hazard is not considered to be extreme. In addition to a saving in the cost of thinning, there is the increase in soil nutrient which will be retained when the materials decay.

Plans will be made for fruit inductinn tests in 1956. An area of 1.2 acres, which was thinned to a 12' x 12' spacing, has been used by Mr. Mark Holst for a fruit induction study utilizing the application of various chemicals to the soil surface.

B. Seed Orchard Production

1. White Pine

A test for fall grafting of white pine was outlined in the report to the Committee on Forest Tree Breeding, March 8, 1955. This test showed that by June 16, 1955 there was a significantly lower survival of grafts made on fall potted Scotch pine than on spring or fall potted white pine stock. There was no significant difference between the survival of white pine grafts using scions from the top or basal branches of old trees or from young trees, when side grafted to spring or fall potted white pine stock. The average survival of the grafts on white pine stock was 94%.

A total of 647 successful white pine grafts was made on potted stock in the greenhouse during January 1955. This was done to assist Dr. Heimburger in the production of white pine materials from Pointe Platon, Quebec, and Connaught Ranges, Ottawa, for use in blister rust resistant tests.

Further assistance was given to Dr. Heimburger by potting and raising 5,000 white pine stock plants. Two thousand of these were delivered to Maple and 3,000 were kept at Angus for use in grafting during the winter of 1956.

[illegible] remaining at a spacing of 12' x 12'.
[illegible] in 1956.

[illegible]

[illegible] removed in 1954.
[illegible] in November 1956.
[illegible] 12' x 12'.

[illegible]

In potting the white pine about 1/5 of the terminal portion of the roots was removed to prevent curling of the roots in the pot. The result has been to produce a less healthy plant with a weaker root system. It is felt that a closer selection of a rootstock size which would not require root pruning would produce a better plant.

2. Red Pine

The accumulation of scion materials from Northern Ontario has continued. In February 1955 scions were collected by the Reforestation Supervisor at Cochrane and shipped to Angus. One hundred and eight grafts were made in the greenhouse on red pine, Scotch pine and mugho pine stock. The survival on June 16, 1955 was over 80% on all stock species and there was no significant difference between stock species.

One hundred and ninety grafts were made on Scotch pine stock plants between 5' and 12' in height at Kirkwood Forest. A survival count of these grafts has not been made as yet.

3. Scotch Pine

A. Timber Types

The propagation of 10 selected trees in the Cochrane vicinity was continued. A total of 664 grafts was made on potted stock of Japanese red pine, mugho pine, red pine and Scotch pine. The grafting was carried out in September 1954, and February 1955.

The overall success was 65% on June 1, 1955. The greatest survival was on mugho pine stock at 100%. The survival on stock plants of the other varieties, in descending order was red pine, Scotch pine, and Japanese red pine. The survival for Japanese red pine was 43%.

4. Yellow Birch

The yellow birch program will be one of establishing seed orchards without the application of intensive study as to the combining ability of the various clones.

In 1955, 655 scions were grafted with a success of 31%. The surviving grafts were placed half at Algonquin Park on the Swan Lake Research Areas and half in the nursery at Angus. The trees at Swan Lake were protected by means of a deer fence.

The proposed seed orchard site has not been selected as yet. It is hoped that the area will be located and prepared in 1956.

It was reported in 1954 that we felt yellow birch scions were incompatible with white birch stock. The survival in 1955 on white birch stock was 32%. Continued observation will be necessary to determine whether any incompatibility exists.

APPENDIX "C"

REPORT ON SHELTERBELT TREE BREEDING IN 1955

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Plant Breeder
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Investigations in 1955 involved ramifications of three main projects with: (1) Caragana, (2) Spruce, and (3) Damping-off. The assistance of a second technician and one student resulted in gratifying progress in all phases of the work. Two seed insect problems were encountered with spruce.

Investigations were confined to field material in the absence of adequate greenhouse facilities. The scope was limited by adverse weather conditions. An early spring was followed by a cool and wet period, which continued until mid-July. Then followed a period of extremely hot weather until September 2nd. A frost-free period of 128 days was recorded from May 4 to September 10.

Caragana

Cross-compatibility determinations were made for 50 selections of *Caragana arborescens* to resolve the compatibility of self-sterile and other vigorous selections. Only 300 of 450 controlled pollinations were completed due to adverse weather and transportation difficulties. Compatibility results for 12 selections have been summarized in Table 1.

Selections are listed in column one in order of increasing self-compatibility from 0 to 41%. The results appears to segregate the 12 selections into three fertility groups. First, there was a group of six self-incompatible selections, which were cross-incompatible. Second there was a group of three low (1 to 5%) self-compatible selections, which were somewhat cross-compatible. Lastly, there was a group of three moderately self-compatible and cross-compatible selections. Selections in group I were cross-incompatible as pollen parents with those in group II, while those in group II were cross-compatible as pollen parents with group I. Selections in group III were cross compatible with selections of groups I and II. These results may be explained by the oppositional factor theory if dominance decreases as the allelomorphic series progresses; that is, if selections with the genotypes S_1S_2, S_1S_3, S_2S_3 etc. exhibited increasing degrees of self- and cross-compatibility. With this interpretation the respective genotypes proposed for the three fertility groups would be: S_1S_1 for group I; S_1S_2, S_1S_3, etc. for group II, and $S_fS_?$ for group III selections.

Cross-compatibility (%) for 12 Selections of Caragana arborescens

Pollen tree ♂	♀ Seedtree ♀									
	A-1	V16	2116	B24	152	B11	103*	135*	B42	V-2
A-1	S	0	0	0	0	0	0	0	0#	2
V-16	0	S	0	0	0	0	0	0	0	4
21-16	0	0	S	0	0	0	0	0	4	10
B2-4	0	3#	0	S	0	?	0	0	4	0#
15-2	0	3#	0	?	S	0	0	0	0#	2
B1-1	0	0	0	0	0	S	0	0	0	3
10-3	24	58	37	48	0	?	(2)	11	?	26
13-5	33	6	3	10	5	?	?	(1)	?	12
B4-2	33	29	38	20	3	0	?	18	(4)#	41
V-2	30	61	21	15	12	6	5	8	6	(28)
B4-5	63	35	44	29	11	?	?	?	31	48
B5-1A	25	16	15	40	16	?	?	?	11	11

* Seedtrees with short pistils had flowers emasculated in bud stage
# Results opposite in 1954; i.e. set or no set obtained
S Self-incompatible; 0 cross-incompatible; ? no data available

The above information is of paramount importance in a breeding program, where hybrid seed is to be mass-produced by natural pollination. First, only one of the two clones in isolated natural crossing blocks could be a self-incompatible selection and the hybird seed would be produced on this clone. Second, polycross progeny tests present an economical means of identifying the self-incompatible clones which manifest highest combining ability.

Ovule number and pollen viability were investigated for 41 caragana selections in 1955. The number of ovules per ovary ranged from 8 to 20 for a mean of 14.2 ± 2.4. The percentage of abortive pollen varied from 0.8 to 96.2% for a mean of 7.2%. An abnormal amount of abortive pollen was produced by four selections: namely B2-4 (10%), A-1 (23%), 8-6 (37%) and B6-2 (96%). The self- and cross-incompatibility of tree B6-2 was evidently due to non-viable pollen.

Viability of caragana seed was further investigated in 1955 to determine the influence of soaking as a pre-sowing treatment. Results of a preliminary test have been listed in Table 2.

It was evident that low viability of seed of Caragana arborescens was due to a mild embryo dormancy. This dormancy was readily broken by stratification for 15 days. Soaking for 24 hours followed by naked stratification proved as efficient a pre-sowing seed treatment as stratification in moist sand. Scarification prior to soaking reduced the viability of caragana seed.

Table 2
Viability of Seed of Caragana arborescens following Five Pre-Sowing Treatments

Treatments[1]	Moisture[2] Content	Germination[3] speed	Germination[3] capacity
	(%)	(index)	(%)
Check (dry)	10.3	.24	44.2
Soaked one hour	12.2	.21	40.0
Scarified and soaked one hour	17.5*	.55*	30.0
Soaked 24 hours	29.6**	.85**	82.5**
Sand stratified 15 days	50.0**	.87**	82.5**

1 Soaked seed all subsequently naked stratified at 41° F for 15 days
2 Moisture content of seed just prior to sowing
3 Germination speed as rate index and capacity as % of seed sown
*, ** Significantly greater than check at 5% and 1% level

Propagation. Most caragana selections have been satisfactorily propagated from softwood cuttings. Tip cuttings, which had a moisture content of more than 70% when collected in June, exhibited superior rooting to basal, and more mature, cuttings. Rooting was slightly increased by the application of 'Rootone' hormone. Some 30 selections were rooted in 1955.

A Potted Orchard of rooted cuttings and grafted material has been accumulated for future greenhouse studies. Numerous rooted cuttings were lost due to disease organisms, which were apparently enhanced by storage and handling practices. Grafted material has demonstrated superior survival to rooted material in the potted orchard. The 'catch' of grafts on stocks, which were potted the previous spring, has been twice that of those grafted on stocks potted just prior to grafting. In 1955 some grafted material was lost due to a new (Phytophthora?) disease, for which no control has been recommended. The present potted orchard includes grafts of 14 caragana species and 39 selections, as well as rooted cuttings of 20 selections.

Two Polycross Blocks have been established on the station with rooted cuttings. Seed was harvested in 1955 from all 12 clones of the 1952 polycross block. This seed will produce polycross progenies whose performance will evaluate the general combining ability of the respective clones.

The Clonal Observation plot was enlarged in 1955 and now contains 75 clones or some 500 rooted cuttings.

Juvenile and Mature Vigor of caragana seedlings were found to be significantly correlated for 28 inbred progenies. Height of sexually mature 6-year old seedlings bore a direct relationship to that of juvenile 3-year old seedlings for all 28 progenies. A similar relationship was evident when the 28 progenies were ranked as to mean height after 3 and 6 years of growth. These results suggest that the vigor potential of progenies might be accurately estimated from the height of the 3-year old seedlings. The economic value of this shortcut in a tree breeding program is apparent.

Spruce

Seed Viability is a factor of prime importance in a spruce breeding program due to the high production cost of controlled pollination seed. For this reason studies were made in 1955 to establish the optimum stage of development for harvesting cones of white and Colorado spruce. Cones were harvested at weekly intervals from two mature seedtrees of both spruce species. Samples of 50 and 30 cones, for the two respective species, were segregated into specific gravity classes at each date of harvest, and the seed extracted for viability tests. Moisture content and specific gravity determinations were made in triplicate with small cone samples for each date of harvest. The results obtained have been listed in Tables 3 and 4. The data in Tables 3 and 4 indicate the maximum production and development of spruce seed is favored by delaying harvest until cone maturity. It would appear that both white spruce and Colorado spruce cones should be harvested when the moisture content falls below 50%, and/or the specific gravity falls below 0.96. All white spruce cones and 92% of the Colorado spruce cones were found to have a specific gravity of less than 0.94 one week prior to natural seed shed. These results suggest that harvesting of cones from white and Colorado spruce should be delayed until all cones float in linseed oil, which has a specific gravity of 0.94.

Isolation Bags of three types and several pollination techniques were evaluated using three white spruce trees in 1955. (Unfortunataly, almost all cones harvested in this study were infested with insect larvae (*Laspeyresia* and/or *Dioryctria* spp.). Cellophane bags deteriorated rapidly after rains and proved ineffective. Manilla paper bags were damaged by the action of winds and rains, but appeared to provide adequate isolation of the bloom. However, paper bags prevented the precision of visual pollinations. Polyethylene bags withstood weathering conditions and provided adequate isolation as well as permitting visual pollinations. On the other hand, transpiration moisture accumulated and some needle burn occurred within the polyethylene bags. Nevertheless, seed set following controlled pollinations was higher under polyethylene bags than under paper bags for the three trees in the test. Sausage casings, which were not available for use in 1955, have been procured for 1956.

Table 3
Cone and Seed Characteristics of Two White Spruce Trees As Determined From Four Weekly Harvests in 1955

Tree	Date of# harvest	Specific gravity[1] of cones	Moisture of cones	Seed per cone	Seed weight
W-1	Aug. 3	1.044	60.2	32.0	3.02
	Aug. 10	1.052	60.7	36.3	3.26
	Aug. 17	1.028	59.5	37.6	3.09
	Aug. 24	0.800*	49.8*	58.8	3.23
W-2	Aug. 10	1.012	59.0	26.0	3.73
	Aug. 17	0.963	59.3	20.2	3.42
	Aug. 24	0.744*	48.3*	27.1	3.72

Cones opened prematurely Aug. 30-31 due to hot weather and insects
[1] Average specific gravity for 3 damples of 5 cones
[2] Average moisture content (fresh weight) for 3 samples of 5 cones
[3] Average seeds extracted per cone and seed weight in g/1000
* Significantly less or more than for previous date

Table 4

Cone and Seed Characteristics of Two Colorada Spruce Trees As Determined from Six Weekly Harvests in 1955

Tree	Date of harvest	Specific gravity[1] of cones	Moisture[2] of cones	Seed[3] per cone	Seed[3] Weight
C-1	Aug. 15	1.036	59.5	75.0	4.72
	Aug. 22	1.033	59.1	-	-
	Aug. 29	1.025	58.9	76.8	4.41
	Sept. 5	0.934*	56.6*	81.3	4.72
	Sept. 12	0.839*	48.4*	77.9	4.59
	Sept. 19	0.628*	17.9*	61.4	4.81
C-2	Aug. 15	1.039	57.2	155.6	4.41
	Aug. 22	1.055	56.3	-	-
	Aug. 29	1.043	57.5	158.9	4.61
	Sept. 5	1.015*	55.9	149.4	4.59
	Sept. 12	0.924*	49.9*	151.0	4.79
	Sept. 19#	0.652*	21.7*	161.0	4.66

[1] Average specific gravity for 3 samples of 3 cones
[2] Average moisture content (fresh weight) for 3 samples of 2 cones
[3] Average seeds extracted per cone and seed weight in g/1000
* Significantly less or more than for preceeding date

Compatibility of Colorado spruce was investigated in 1955. Blossoms on duplicate branches of 17 selections were utilized to ascertain the fertility following open-, cross-, and self-pollination. The bloom was isolated in polyethylene bags fitted with glass drainage tubes. Efficient isolation was ensured by the fact that no seed set was recorded for any of the duplicated checks. Seed set and seed size data for the 17 trees under three types of pollination are listed in Table 5. Regretably, no precise comparisons between open- and controlled-pollinations were possible because most cones within isolation bags were damaged by insect (Dioryctria abietella) larvae. The results obtained would suggest the following conclusions concerning Colorado spruce (Picea pungens).

1. Individual trees of Colorado spruce differ with respect to self-compatibility. In this study, the self set varied from 0 to 18% of the open set.

2. Some degree of cross-incompatibility exists between trees within the species.

3. Control measures for larvae of the insect, Dioryctira abietella, are urgently required for future spruce breeding work.

Table 5

Seed Set* and Seed Weight Following Open-, Cross-, and Self-Pollination of 17 Colorado Spruce Selections in 1955

Seedtree	Average seed weight			Seeds per cone		
	Open[1]	Cross[2]	Self[3]	Open[1]	Cross[2]	Self[3]
	(mg)	(mg)	(mg)			
C-81	-#	5.2	5.6	0.0#	0.4	0.3
C-7	5.8	-	3.0	55.6	0.0	0.5
C-60	5.6	-	5.6	113.0	0.0	1.5
C-75	6.2	5.2	5.7	48.2	4.8	1.9
43-6	5.9	-	5.4	45.6	0.0	2.2
C-28	5.7	-	5.9	149.1	0.0	3.0
C-78	4.8	-	5.2	66.5	0.0	3.0
C-79	4.5	4.7	4.7	82.5	1.6	3.4
47-13	4.3	4.4	4.8	121.0	0.6	3.9
C-80	5.0	-	5.4	97.5	0.0	4.4
42-3	4.7	5.0	5.0	59.0	0.7	4.6
47-11	4.5	5.3	4.6	88.1	5.0	5.8
C-13	4.3	3.8	4.5	110.0	3.0	6.0
C-27	4.2	4.4	4.5	87.3	12.1	6.6
44-7	-#	-	5.5	0.0#	0.0	9.0
47-15	5.4	5.7	5.4	125.0	3.9	10.6
54-16	4.9	5.4	5.2	122.0	14.3	16.2
C-12	5.7	5.8	5.3	146,3	3.0	27.0
Average	5.1	5.0	5.1	94.8	4.5	5.8

1 set under open-pollination (not bagged)
2 set in isolation bag with pollen of 44-7 and/or 43-6
3 set in isolation bag with own pollen
* most cones in isolation bags damaged by Dioryctria larvae
# cones lost to squirrels

Damping-Off Control

Co-operative projects were initiated with Dr. A. Vaartaja of the Forest Biology Division in 1953 to determine: (1) the toxicity of pesticides, (2) the pathogenicity of isolates, and (3) control of damping-off. Our 1953 study revealed Captan and Tersan to be relatively non-toxic to spruce and caragana seed. In 1954 we found Rhizoctonia to be our most virulent pathogen with Pythium of secondary importance.

In 1955 two greenhouse studies were conducted at the Forest Nursery Station to evaluate fungicides for the control of Rhizoctonia damping-off. In the first study Captan and Tersan were applied as soil drenches to Rhizoctonia inoculated seedbed soil, and the results are summarized in Table 6.

Table 6
Average Stand of Seedlings (%)[1] for Three Tree Species in Rhizoctonia Inoculated Seedbed Soil Under 5 Concentrations of 2 Fungicides

Fungicide &	Concentration[2]	Picea pungens	Pinus sylvestris	Caragana arborescens	Means
Captan	0.0 (check)	14.0	27.3	66.0	35.8
	0.1	29.3	69.3*	86.7*	65.1*
	0.5	32.0*	60.7*	94.7*	62.4*
	2.5	16.7	53.3	66.7	45.6
	10.0	10.0	8.7#	87.3*	35.3
Tersan	0.0 (check)	21.3	28.0	60.0	36.4
	0.1	58.7*	75.3*	93.3*	75.8*
	0.5	46.7	73.3*	96.0*	72.0*
	2.5	46.0	53.3	89.9	63.1*
	10.0	44.0	46.7	91.3	60.7*

1 Seedling stand as a percentage of the stratified seed sown
2 Fungicidal drench in grams per sq. ft. applied at 9 weekly intervals
* Significantly greater than check
# Significantly less than check

Briefly, conclusions from this study were: (1) Pre-emergent and post-emergent losses, emergence and final stand differed between trees within species as well as between species, (2) Pre-emergent losses accounted for 30% of the seed sown; (3) Post-emergent losses by Rhizoctonia and natural Pythium were largely controlled by either fungicide at 0.1 to 0.5 gm/sq. ft.; (4) Average stands were materially increased by the same fungicidal applications; (5) Captan at a concentration of 10 gm/sq. ft. proved phytotoxic to conifers but not to caragana, while tersan had no significant phytotoxic effects.

Later in 1955 a similar study was conducted involving six treatments with Tersan. The results for two Colorado spruce and two caragana progenies have been summarized in Table 7. Conclusions from this Tersan study were: (1) Pre- and post-emergent losses were at a minimum, emergence and stand were at a maximum, when a 0.5 gm/sq.ft. soil drench was applied just prior to sowing and followed by 0.1 drenches at weekly or bimonthly intervals; (2) Pelleting of stratified seed proved detrimental to germination and hence stand of caragana, but not to Colorado spruce.

Table 7

Average Germination Capacity, Speed, and Losses, and Seedling Stand for Two Trees Species under Six Tersan Treatments in Rhizoctonia Inoculated Seedbed Soil.

Treatments#		Germination[1]			Sdlg[2] stand
		Cap. (%)	Speed (index)	Losses (%)	(%)
Check (no Tersan)		80.0	.88	40.5	50.4
Pellet then low drench	7 da.	83.3	.79*	14.7	73.4*
Low conc. drench	7 da.	92.9*	.88	15.6	79.3*
High then low drench	3.5 da.	88.3*	.88	9.0	82.1*
" " " "	14 da.	97.5**	.86	4.2	93.3**
" " " "	7 da.	97.4**	.88	1.7	95.8**

High (0.5 gm/sq. ft.) and low (0.1) concentrations applied prior to sowing, then low concentration at 3.5, 7 and 14 day intervals

1 Germination capacity as % of seed sown, speed as index rate, losses as % of emerged seedlings

2 Seedling stand as % of seed sown 47 days previously

*, ** Significantly more or less than check treatment at 5% and 1% levels

APPENDIX "D"

TESTING OF HYBRID POPLAR, IN ONTARIO, FOR DISEASE RESISTANCE

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A co-operative programme for assessing the disease resistance of hybrid poplars has been initiated, at Maple, by the Ontario Department of Lands and Forests and the Canada Department of Agriculture. The varieties to be tested have been developed by Dr. C. Heimburger who considers them to be superior, silviculturally, to those species and varieties of *Populus* already present in Ontario.

The need for a testing programme is attributable to the fact that hybrid trees may be particularly susceptible to pathogens which, on native hosts, are not dangerous. With poplar hybrids this hazard is unusually high since the parents are prone to disease. In view of these considerations and, prior to distribution on a commercial scale, it should be demonstrated that a desirable poplar hybrid is immune or resistant to disease.

Before undertaking a programme of testing hybrid poplar for disease resistance, extensive exploratory work must be undertaken with regard to host-parasite relationships and mycological considerations. In the current programme at Maple, this investigation falls into three phases, viz:

(1) Determination of the fungus flora of *Populus* in Ontario and, isolation of these fungi in pure culture so that a source of inoculum may be available for infection studies. A number of blight and canker-causing fungi have been isolated and cultures of these are being maintained in storage.

(2) Determination of the life histories of destructive poplar pathogens in those instances where this information is lacking. An understanding of the life cycle of the pathogen is of fundamental importance in the conduction of infection studies. In this regard, the life history of *Didymosphaeria populina* Vuill. (imperfect stage, *Pollaccia elegans* Serv.) has been determined and this information is being published. Furthermore, it seems that the perfect stage of *Fusicladium radiosum* (Lib.) Lind has been located; this hyphomycete is the cause of a serious leaf and twig blight of *P. tremuloides* and *P. grandidentata*, being particularly injurious to regeneration of those species.

(3) Development of effective testing techniques. Artificial infections, even with virulent pathogens, are difficult or impossible to obtain unless all the conditions necessary for natural infection are recognized and duplicated. Effective techniques will permit negative results from test inoculations to be attributed to host resistance with some degree of confidence.

To avoid ambiguity and to have a measure of the aggressiveness of a pathogen towards poplar hybrids, it is essential to know that infections of the pathogen can be artificially initiated on its natural host (i.e. control). A prerequisite of such knowledge is an understanding of the influence of the environmental conditions that are acting on host and parasite at the time infection occurs. It was for this reason that numerous inoculations have been made on trembling and largetooth aspens, using spores of F. radiosum as inoculum.

While no inoculation techniques used caused infections so destructive as those that arose naturally, still, true infections could be initiated artificially and, at will, when the principal controlling environmental factors were known. With further experimentation, it is probable that an inoculation technique will be developed which will result in infections which are undistinguishable from those that occur in nature.

From these experiments it has been learned that only juvenile leaves of aspen are susceptible to infection by those pathogens which have been used to date (F. radiosum and P. elegans). Further, it was found that spores of F. radiosum germinate in the range from 35 to 60° F and at 90 to 100% R.H. This information coupled with an effective method of applying inoculum and other related details consistently yielded infections of F. radiosum. It was found most practical to inoculate well-established potted plants rather than cuttings since the latter invariably developed physiological disorders which resembled infections of F. radiosum.

With other pathogens, the inoculation technique will be modified according to the requirements of each; meanwhile, it is planned to commence testing of commercially interesting hybrid poplar varieties for immunity to F. radiosum and, perhaps, to closely related pathogens. To this end, a small sample plot of five hybrid varieties has been established at Maple.

APPENDIX "E"

PHYSIOLOGICAL STUDY OF FACTORS INFLUENCING FLOWERING IN SPRUCE

D. A. Fraser
Petawawa Forest Experiment Station

This project was initiated in 1955. It is divided into two parts:

(a) Mature Trees. A study of growth and flower production in mature trees in relation to site and weather is to serve as a preliminary step to control of flower production in young trees. Twig samples are taken periodically for anatomical studies to determine the time of initiation of flower primordia. It would be of practical value to determine more precisely the time and external conditions of the origin of flowers in order to be able to foretell seed years.

(b) Experiments have been initiated on the effect on growth and flowering of young spruce trees of photoperiod, day and night termperatures, and the application of various substances including antiauxins and sugars. One important phase in accelerated flowering studies would be to have several periods of growth per year (or continuous growth) using greenhouse and growth chamber facilities during the winter.

Literature: A review of the literature concerning physiological factors influencing flowering in plants was submitted March 1955.

Plot Establishment: An eight-acre experimental spruce plot was established in the summer of 1955 and periodic observations on ecological conditions and tree growth were made. Sections of twig samples and compilation of data remain to be completed.

Flower-inducing Experiments: A number of spruce seedlings of Petawawa origin were subjected to various photoperiod and chemical treatments. Effects of flowering and growth will not be known until 1956.

Breaking Spruce Dormancy Experiments: Spruce seedlings have been brought into the laboratory cellar under a 16-hour photoperiod, at fortnightly intervals from December 1, 1955. Dormancy in white spruce was broken by January 1, 1956, while that in black spruce is later. Spruce seeds are being germinated to provide experimental material for the summer of 1956.

Auxin Experiments: The addition of a graduate assistant to the physiology section planned for May 1956 will facilitate the assay of growth hormones in flowering trees and experimental seedlings.

Future Plans: These will involve the continued observation of the experimental spruce plot to study periodicity of flowering. Experiments on accelerated flowering in young trees will be expanded as growth chamber and greenhouse facilities become available in the new laboratory. A publication and detailed report is planned for 1956-57 covering the first year's experiments in this project.

APPENDIX "F"

REPORT ON FOREST TREE BREEDING IN 1955

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Ontario Department of Lands and Forests

WORKING CONDITIONS

Working conditions continued to show steady improvement as compared with former years and nothing exceptional in this respect is to report.

The summer of 1955 was very hot and dry, and heavy losses of newly planted materials in the poplar arboretum were experienced. Watering facilities in the nursery were adequate to take care of the drought conditions.

Breeding work with white pine, aspen poplars and two-needled pines were the main projects. In addition, some work with chestnut was started.

WHITE PINE

Selection for resistance to blister rust continued to be the main object of the work, in addition to adaptation to climate, for good growth form and growth rate, and possible resistance to weevil attack. The trend of the main work from acquisition of new materials to their testing and evaluation continued.

Provenance Tests

During August, 1955 a meeting was held in Washington, D.C. where a co-operative seed-source study of white pine covering the entire range of this species in the U.S. and Canada was organized. Representatives from the Northeastern, Southeastern, Central States and Lake States Forest Experiment Stations and from the Southern Research Station decided on a co-operative plan of action. According to this plan, three white pine cone collections were made in Canada during the fall of 1955, to supply a part of the seeds for this study. The collections were made at Spragge, Ont. by the staff of the Seed Plant at Angus, in the Parc de la Verendrye at the Upper Ottawa River in Quebec by the staff of the Southern Research Station, and near Bridgewater, N.S. by the Nova Scotia Department of Lands and Forests. A subsequent trip was made to the collection locality in Nova Scotia, to check on the cone collection and on details of the stand and site description. All the Canadian seed portions have been extracted at Angus and are now in the process of being distributed to the American stations, in exchange for portions of their seeds.

Acquisition of New Materials

Scions were obtained and successfully grafted of the following white pine materials: a witches' broom on a tree near Richmond Hill, Ontario, showing abundant cone formation, of possible value in flowering induction of breeding materials; a single tree escaping heavy infection by blister rust in a plantation in Switzerland; a seemingly resistant seedling in the plantation at Pointe Platon, P.Q.; of 71 selected trees in the plantation at Connaught Ranges near Ottawa; of two seemingly resistant trees of western white pine in B.C.; of two population samples in Quebec and one in Nova Scotia, obtained in connection with the provenance test cone collections.

Re-grafting for Additional Inoculation with Blister Rust

The inoculation method used in 1954 caused such heavy infection of seedlings and grafts in 1955 that it was considered advisable to re-graft some of the most promising and seemingly resistant clones, to produce small bushy plants suitable for renewed inoculation with blister rust, for testing of their resistance under the new inoculation technique. Scions of 45 clones of native white pine and exotic species and hybrids were used for this in spring grafting in the greenhouse and in fall grafting on spring-potted stock in coldframes.

Grafting of Seemingly Resistant Materials in Forest Plantations

Scions of 20 clones of native white pine were collected from selected young trees free from blister rust under conditions of severe infection in the plantation at Connaught Ranges near Ottawa. They were grafted outside on to young planted stock on a cut-over area near Dorset, to transform some of the bulk planted materials into seemingly resistant white pine and thus, possibly, to make the plantations more resistant to blister rust in the future. It is planned to retain the grafts as crop trees in these plantations if their growth and other performance warrant this and thus, possibly to introduce resistance to blister rust into forest management in this manner. About 400 such grafts were made in the early spring. They were quite successful, with about 80% take.

Fall Grafting Outside

The fall grafting experiment mentioned in the report for last year, with nine different combinations of inner and outer bags, yielded positive results. The combination of an inner bag of pliofilm and an outer bag of double kraft paper gave good take, survival and growth of the scions in the summer following the grafting. In addition, this kind of protection of the grafts proved to be reasonably "Hazelproof" (hurricane proof). This method was again used in the fall of 1955, for the propagation of some selected white pine materials.

Summer Grafting Outside

In order, possibly, to extend the outside grafting period in spring to the early summer, some late June grafting was tried, after the main rush of hybridization work was over. Last year's (1954) shoots with stumps of 1955 growth were used as scions. Ordinary side-grafting was used. The grafts were covered with pliofilm bags inside of kraft paper bags and the place of grafting was tied with friction tape. The experiment was not successful, only one out of 20 scions being alive in August. This is in marked contrast to the successful summer grafting lately obtained with southern pines. Apparently, white pine grafts are sensitive to high temperatures. Our early failures with too early fall grafting, before the onset of cool fall weather, also indicate this. Similar experiments with Scotch pine gave much more promising results.

Bare Root Grafting in the Spring

At the third Southern Conference on Forest Tree Improvement held in New Orleans early in January of 1955, Mr. H. C. Grigsby of the Mississippi Forestry Commission, reported promising results with bare root grafting of southern pines (see Proceedings of this Conference, p. 116). A modification of this method with white pine was tried. Vigorous nursery stock was lifted in early April and heeled-in in a coldframe with moist sand. The coldframe was covered with sash and an unbleached cotton shade. The plants were kept moist and warm until new root growth began. They were then lifted and bench-grafted with scions from the selected trees of the plantation at Connaught Ranges. Side-grafting low on the stem was used. The roots were kept between moist burlap during transportation. The grafts were set directly into the inoculation beds and planted so that the place of grafting was partly below the soil surface. The beds were covered with lath screens and wet burlap, and kept moist. As the grafts started to grow, the shades were gradually removed, but frequent watering was necessary during the hot and dry summer of 1955. Seven hundred and seventy-nine scions belonging to 39 clones were grafted in this manner. In late August there were 635 surviving grafts in good growth, i.e. a take and survival of about 82%. The grafting took about half the time of ordinary pot grafting and the grafts were ready for inoculation with blister rust during the same year without much further care. The growth is bushy and compact, and much better suited for inoculation with blister rust than the somewhat leggy pot grafts. The method shows promise for mass propagation of white pine in conjunction with testing for resistance to blister rust. A more detailed report on this experiment has been presented to the Second Lake States Forest Tree Improvement Conference on August 31, 1955 and will be published in the Proceedings of this Conference. This experiment is being repeated during the winter to test its adaptation to greenhouse grafting. In the fall, nursery stock of white pine and Scotch pine was heeled-in in a coldframe with sand in the greenhouse, for possible bench-grafting during the winter.

Hybridization

Seeds were harvested from the following crosses made in 1954:

Species	No. of clones pollinated	No. of clones yielding seeds
Strobus x pentaphylla	40	22
Strobus x flexilis	2	2
Parviflora x flexilis	4	3
Peuce x flexilis	3	3
Monticola x peuce	6	5
Griffithi x pentaphylla	1	1
(Griffithi x Strobus) x pentaphylla	1	1
(Peuce x Strobus) x flexilis	1	1
Monticola x wind	2	2
Griffithi x wind	1	1
Peuce x wind	1	1

All these crosses were made on young grafts, with the exception of P. peuce x wind the seeds of which were harvested from young trees of seedling origin. The use of plastic tubes to isolate female flowers, proved inferior to glassine and kraft paper bags in 1954 and 1955 by reducing cone formation and seed setting in comparison with the latter method.

All crosses of 1955 were also made on grafts; these were:

Species	No. of clones pollinated	Bags or Tubes	
Griffithi x koraiensis	2	23 bags	18 tubes
koraiensis x Griffithi	4	13 bags	
Peuce x Griffithi	9	27 bags	1 tube
Monticola x pentaphylla	3	7 bags	
Parviflora x Griffithi	2		3 tubes
Strobus x Griffithi	4		44 tubes
Flexilis x Griffithi	1	2 bags	
(Monticola x Griffithi) x pentaphylla	1	3 bags	
(Griffithi x Strobus) x koraiensis	1		1 tube
(Strobus x Peuce) x Griffithi	2	3 bags	4 tubes
(Peuce x Strobus) x Griffithi	4	5 bags	3 tubes

The white pines flowered about 18 days earlier than normal in 1955, and most of the flowers available for hybridization on the grafts were missed.

Inoculation with Blister Rust

As in 1954, shoots of black currants with green leaves carrying abundant telial columns were stuck into the soil close to the pine seedlings and grafts in the inoculation beds and the soil was thoroughly watered. Small seedlings were inoculated by planting green currant leaves with telia among the seedlings. The petioles were inserted into moist soil and the inoculation beds were thoroughly watered. The beds were covered with lath screens and burlap and kept wet by means of plastic soakers. This is essentially the method used by R. T. Bingham of the Spokane Blister Rust Control Unit. In 1955, 1704 grafts belonging to 83 clones and 1044 seedlings and 189 grafts belonging to 31 populations were inoculated by using this method. The currant shoots were left in the beds through the following winter, and most began to produce leaves in the spring as they had rooted in the meantime. They were then removed. A heavy spotting of the pine needles, characteristic of early infection with blister rust, soon became very noticeable. Some of the needles were sectioned and showed the presence of blister rust hyphae. A detailed study of the various degrees of spotting was made in early July of 1955, as more pressing work in grafting and hybridization precluded an earlier tally. The spotting was tallied for each plant as 0- no spots, 1- weak spotting, 2- medium spotting and 3- heavy spotting. The results undoubtedly show a much heavier infection than has taken place, as many other kinds of spots than those caused by blister rust were tallied at this late date. The final evaluation will be possible as cankers appear.

The results of the tally are as follows:

Clones (C) or Populations (P)	No. plants	Plants with spots	Total spot score	% with spots	Av. spot score
Strobus grafts (scions from trees)					
48C	858	748	934	87.2	1.09
Strobus grafts (scions from seedlings)					
3P	128	118	184	92.1	1.48
Monticola grafts (scions from trees)					
5C	66	55	107	83.3	1.62
Peuce grafts (scions from trees)					
7C	120	97	107	80.7	0.89
Griffithi grafts (scions from trees)					
3C	22	22	23	100	1.04

Clones (C) or Populations (P)	No. plants	Plants with spots	Total spot score	% with spots	Av. spot score
Strobus seedlings					
34P	2911	2903	6882	100	2,36
Monticola seedlings					
4P	93	93	155	100	1.67
Peuce seedlings					
1P	9	6	6	66.7	0.7
Griffithi seedlings					
8P	1050	1029	2479	98	2.36
Strobus x pentaphylla seedlings					
1P	32	32	79	100	2.5
Strobus x Peuce seedlings					
1P	123	109	152	88.6	1.3

During the latter part of the summer of 1955 the inoculated seedlings began to show heavy mortality. Pycnia and other lesions on the stems were abundant. The grafts did not show any mortality thus far, nor have any pycnia been found. The position of every graft and seedling in the inoculatinn beds has been noted in the tallies so that the future development of the disease can be followed and possible correlations can be observed between degree of spotting, pycnia formation, cankering and mortality caused by blister rust, in relation to the white pine materials inoculated. This and other information on the results obtained thus far with blister rust work at this Station has been presented to the Third Northeastern Forest Tree Improvement Conference in August, 1955 and will be published in the Proceedings of this Conference.

The black currant materials used for inoculation thus far have not been fully satisfactory because they tend to drop their leaves during late summer following a heavy infection by the rust. The growing of black currants in a lath house prevents this somewhat but does not quite solve the problem of scarcity of suitable inoculum at the time of inoculation. Some black currant bushes capable of retaining their leaves in the open in spite of heavy rust infection, have been located on a farm near Maple, Ont. and cuttings from these bushes are being propagated in the greenhouse during this winter possibly to produce more suitable material for inoculation.

Poplars

The production of aspen-like hybrids with rapid growth,good growth form, resistance to several important diseases, and capability of producing high yields in forest plantations in Southern Ontario, is the aim of the poplar breeding project, as it has been in former years. Ease of vegetative propagation is also one of the long-range objectives.

Acquisition of new materials, their evaluation in terms of combining ability in crosses and the production of new hybrids are at present the main phases of the work. Co-operation with other poplar breeders in U.S. and in Europe makes it possible to carry out a wide range of crosses and to obtain new breeding materials from new regions, for further evaluation and use. Poplar breeding is at present in a state of very rapid evolution abroad and our project is deriving great benefit from such new contacts, with our background of many years of previous experience.

Acquisition of New Materials

By means of exchange with other poplar breeders and through our own collections, the following new poplar materials were obtained:

P. nigra, Lebanan	1 clone
P. alba, Algeria	2 "
P. alba, Hungary	3 "
P. alba, Iowa	8 "
P. alba, Ontario	1 "
P. grandidentata, Quebec	1 "
P. grandidentata x tremula, Harvard Forest	2 "
P. alba x grandidentata, Iowa	2 "
P. alba x grandidentata, Czechoslovakia	3 "
P. alba x tremula, Hungary	1 "
P. alba x tremula, Czechoslovakia	1 "
P. alba x tremuloides, Ontario	2 "
P. canescens, England	2 "
P. canescens, Hungary	4 "
P. hybrida, Iran	1 "
P. tremula, Lebanon	2 "
P. tremula, England	1 "
P. tremula, Norway	4 "
P. tremula, Sweden	3 "
P. tremula, Hungary	2 "
P. tremula, Harvard Forest	9 "
P. tremula x alba, Hungary	1 "
P. tremuloides, Harvard Forest	7 "
P. tremuloides, Quebec	1 "
P. tremula, seeds from Czechoslovakia	2 populations
P. nigra, " " "	1 "

The aspen materials obtained from Hungary continue to show very good growth and are of great promise. The P. alba x grandidentata materials from Czechoslovakia have been produced with pollen obtained from here. The Iowa hybrids have recently been discovered by foresters in Iowa (see Journal of Forestry 52:528-529, 1954) and specimens of these have been deposited in the National Herbarium of Canada and in other herbaria.

From among the poplar populations raised in former years, the following outstanding clones have been selected in 1955:

P. alba	2 clones
P. alba x grandidentata	6 "
P. alba x trichocarpa	1 "
P. canescens	5 "
P. canescens x grandidentata	1 "
P. grandidentata	1 "
P. tomentosa x grandidentata	1 "
P. grandidentata x alba	2 "
P. tremula	1 "

Rooting Capacity

Laboratory tests for rooting capacity of several poplar clones, described in the report for 1954, were continued in 1955. The results were in accord with those of previous years, thus establishing the value of such tests. It was found that the cuttings used in such laboratory tests should receive very uniform treatment, however, all the cutting materials are usually collected in the fall and stored in moist peat in an unheated garage until the tests are made in the laboratory during February-March. Freshly collected cuttings of the same clones have shown much lower rooting values in such tests than stored cuttings. It is possible that the rooting capacity of stored cuttings can be enhanced to such an extent by storage in moist peat through the winter that some clones at least could be propagated by means of spring planting of stored cuttings. This remains to be investigated.

The fall planting of cuttings collected from populations, for purposes of mass selection, mentioned in the report for 1954, has not always been satisfactory. In many cases the selection pressure caused by this method has been too great, eliminating materials with satisfactory rooting capacity. Also for this purpose spring planting of stored cuttings may be more satisfactory.

Hybridization

The program of poplar hybridization has expanded greatly in 1955, as compared with previous years. This was caused, in part, by the increasing demands of wood-using industries for hybrid poplar seedlings and, in part, by improved possibilities for co-operation with poplar breeders abroad, making new breeding materials available. As formerly, the hybridization work has been sub-divided into the following three main phases:

1. Mass production of the most promising hybrids for industrial use.
2. Breeding of early-flowering materials, to shorten the breeding cycle.
3. Incorporation of good rooting capacity and other desirable properties of silver poplar and other poplar species into aspen hybrids.

Breeding for Industrial Use

The following crosses were made, with the aim of producing hybrid seedlings of direct value to planting in southern Ontario:

P. tremuloides x tremula	15 populations
P. tremula x tremuloides	2 "
P. tremula x tremula	1 "
P. alba x tremuloides	1 "
P. (alba x tremuloides) x tremula	1 "
P. (grandidentata x tremuloides) x grandidentata	1 "
P. grandidentata x tremula	1 "
P. alba x grandidentata	6 "
P. grandidentata x alba	7 "
P. grandidentata x (alba x grandidentata)	2 "

It was possible to obtain pollen of P. tremula from many new places in southern Europe, and the results with this pollen have been outstanding. The resulting hybrids with P. tremuloides were 4-5 times taller during their first year than corresponding hybrids produced with pollen of P. tremula from northern Europe. It has thus been possible, for the first time, to produce P. tremuloides x tremula hybrids that are at least as promising under our growing conditions as similar hybrids are in Europe. It has also been possible to obtain pollen of P. alba from several new sources in southern Europe and to use it in crosses with P. grandidentata. The resulting hybrids seem to be superior to those obtained previously, with P. alba pollen from central Europe.

Breeding of Early Flowering (Precocious) Materials

The breeding of precocious aspen materials has in 1955 been carried out mainly to transfer the precocious flowering habit found in some native aspens to other species. At least some of the resulting hybrids are expected to be precocious and make possible relatively rapid advances in long-term breeding projects because of their short breeding cycles. The following crosses have been made with this in mind:

P. tremuloides prococious x tremuloides precocious	1 population
P. tremuloides precocious x tremula	1 "
P. tremuloides precocious x grandidentata precocious	1 "
P. grandidentata x tremuloides precocious	1 "
P. alba x tremuloides precocious	1 "

Breeding for Rooting Capacity

Attempts to incorporate good rooting capacity of other poplar species into aspen hybrids by means of appropriate crosses have been continued. An F_2 generation of an P. alba x aspen hybrid, using unrelated parents, has also been produced with the aim of recovering the original good rooting capacity of the P. alba materials in some of the offspring. The following successful crosses have been made:

P. alba x trichocarpa	1 population
P.(alba x tremuloides) x (alba x tremuloides)	1 "

The cross P. alba x trichocarpa is a wide cross and seems difficult to make. The P. trichocarpa pollen used in this cross was obtained from Europe and was the same as has been used in 1954. Pollen obtained from 4 sources in western N. America (Washington, Oregon, Montana and B.C.) did not yield any hybrid seedlings. The recent discovery of a femals P. alba x tremuloides made the aspen cross possible. The crosses P. alba x deltoides and P. grandidentata x deltoides have not been successful.

Propagation

The technique of raising aspen seedlings by direct sowing of the seeds in seed beds has been improved in 1955 by mixing the seeds with finely pulverized and sifted peat. This allowed better distribution of the seeds and resulting seedlings in the bed, with less crowding and more uniform seedling development than in former years.

The experiment in bench-grafting of aspen hybrids, to find a cheap method for mass-propagation of such materials have, at last, given some promising results. The use of plate budding in combination with the usual bench-grafting procedure, appears to have solved the problem. A description of this method and the results obtained have been presented to the Second Lake States Forest Tree Improvement Conference, on August 30, 1955, and will be published in the Proceedings of this Conference.

Test Plantations

A large poplar plantation was established by the Ontario Paper Company in the spring of 1955 on Manitoulin Island, on recently acquired farm land of good quality. About half of the area was planted with rooted poplar cuttings raised in the Gore Bay nursery of that company. The other half was planted in the fall of 1955 with aspen seedlings from the Gore Bay nursery and from this Station. A fairly large number of small aspen seedlings were shipped to the Gore Bay nursery, to supply planting materials in other plantations next year. The co-operation with Howard Smith Paper Mills Ltd. of Cornwall, Ontario and with the Canadian International Paper Company at Harrington, P.Q. continued, in supplying these organizations with a limited number of hybrid aspen seedlings for field planting, in the fall of 1955. Knechtels Limited in Hanover, Ontario were supplied with fairly large numbers of hybrid aspen seedlings for direct field planting and for growing on in the nursery on their Markdale property.

Poplar Arboretum

The poplar breeding arboretum was expanded considerably during 1954, It was planted with new poplar materials in the fall of 1954 and the

spring of 1955. The severe drought during the summer, destroyed most of the newly planted poplars however. All dead plants were removed during the late summer of 1955 and the land was given one additional cultivation, to keep it reasonably free of weeds. New poplars were then again planted in the fall of 1955 and lifted in the nursery for planting there during the spring of 1956.

Pollen Fractionation

One of the giant type P. grandidentata growing at this Station was thrown over by hurricane Hazel during the fall of 1954. In the following late winter its branches were salvaged for pollen production in the greenhouse. As the pollen grains seemed to vary somewhat in size, a portion of the pollen was sent to Mr. P. G. Howe of the Division of Applied Chemistry, National Research Council, Ottawa, to be separated into four fractions in a Particle Size Analyzer. The pollen retained its viability during and after separation and was used in crosses with the same P. alba. The four progenies resulting from the different pollen fractions, as well as a progeny from unseparated pollen were successfully raised in the nursery at this Station. Thus far, there is no appreciable difference in size of the hybrid seedlings resulting from the different pollen fractions.

Two-needled Pines

This project is carried out in co-operation with the Petawawa Forest Experiment Station of the Forestry Branch, with the aim of developing strains of 2-needled pines with resistance to the European pine shoot moth and suitable for growing in southern Ontario, in areas with heavy shoot moth infestation. Several Asiatic 2-needled pines and, to a certain extent, species of the P. nigra group, to which Austrian pine belongs, show resistance to the shoot moth, and the procedure is thus to incorporate the resistance of these species into the more commonly planted red and Scotch pine. The project is as yet concerned mainly with the acquisition of new breeding materials and with exploratory hybridization. During 1955, scions of 10 clones of Pinus densiflora, the Japanese red pine, were obtained from a plantation near Midhurst, Ontario and grafted on Scotch pine at this Station. The following crosses of 1953 yielded seedlings in 1955:

P. densiflora x silvestris	1 cross	2 seedlings
P. densiflora x nigra Austriaca	2 "	103 "
P. densiflora x ponderosa	1 "	4 "

Of the crosses made in 1954, the following yielded seemingly viable seeds:

P. silvestris x densiflora	1 cross	14 seeds
P. silvestris x resinosa	1 "	5 "
P. densiflora x silvestris	3 "	45 "
P. densiflora x nigra Poiretiana	1 "	182 "
P. densiflora x wind	1 "	23 "

The following crosses were made in 1955:

P. densiflora x resinosa	2 crosses	165 bags
P. densiflora x (rigida x taeda)	4 "	56 "
P. densiflora x nigra Poiretiana	1 "	86 "
P. densiflora x (echinata x taeda)	1 "	29 "
P. densiflora x taeda	1 "	80 "

From the crosses made thus far with these materials, it appears that P. densiflora can be crossed most easily with P. nigra and related species. The cross of P. densiflora with P. silvestris is more difficult. Only a very few trees of P. densiflora have thus far set seed when pollinated with P. resinosa and it is uncertain as yet if the seedlings produced are actually hybrids. Pollen of P. Thunbergii, the Japanese black pine, has been collected in fairly large quantities in Rochester, N.Y. and is stored for hybridization work in 1956.

The partial girdling experiment of planted red pine started in Vivian Forest in 1947, was again tallied in 1955. The trees have not been girdled for several years and the tally at present shows no significant differences between the numbers of cones on the girdled trees and the controls. The data are now being analyzed for a report.

An experiment in phloem inversion was started in another, much younger, plantation in Vivian Forest, in 1955. Phloem inversion has been used by Dr. K. Sax at the Arnold Arboretum to induce flowering in young apple trees and the aim of our experiment is possible flower induction in young red pine. The pines were about 4'-6' tall; a ring of bark, about 2" wide, was removed from the lower part of the stem and replaced upside down. The place of bark incision was covered with friction tape and the whole inversion was protected with strip of pliofilm. On the controls, the branches were pruned to the same height, as on the treated trees but the bark was not removed. The work was done in late July, not the best time for such treatment. In early September, the strings holding the pliofilm strip were removed, the pliofilm having disintegrated in the meantime. Good callusing was observed underneath the friction tape on some of the treated trees. A similar experiment with young white pine was unsuccessful, probably because bark removal and replacement were done too late in the summer.

Chestnut

A chestnut breeding project was started in 1955. The aim of this project is to produce hardy dwarf chestnuts resistant to blight. Such materials could be of possible use as dwarfing stocks, to induce early flowering in any breeding program with timber type chestnuts and could, perhaps, also be used for edible nut production in small gardens. Some very precocious chestnuts were once produced by Burbank in crossing the chinkapin with Japanese chestnut in California. Similar crosses of

the chinkapin with Asiatic and other chestnuts could, possibly, yield types hardy in the climate of this Station. Some plants of native chestnut were received in the spring of 1955 from a nursery in British Columbia. These plants were raised from seeds collected in Ontario from trees free of blight under conditions of severe infection. The plants were set out in the nursery and in an arboretum. Of 135 plants set out in the arboretum 95 were alive in the fall of 1955. The rest perished in the severe drought. Seeds of chinkapin were received from two sources in the United States in the fall of 1955 and stored over the winter in moist peat at slightly above freezing. Nuts of Italian chestnut were purchased in a fruit store and stored in the same manner.

APPENDIX "G"

NOTES ON THE THIRD NORTHEASTERN FOREST TREE IMPROVEMENT CONFERENCE

C. C. Heimburger
Division of Research
Ontario Department of Lands and Forests

The Conference was held at Cornell University on August 30 and 31, 1955, and was sponsored by the Cornell Departments of Plant Pathology, Plant Breeding and Conservation.

The Following Papers were Presented:

H. I. Baldwin and J. W. Wright, Report on 17-year performance of the international Scotch pine seed origin test (IUFRO) at the Fox Forest, Hillsboro, N. H.

The results presented indicate generally poor growth form but good growth in provenances from Central Europe. There was little difference in growth rate between a rather wide range of Central European provenances but appreciable differences between northern and southern provenances. Riga pine showed good growth form but only fair growth rate also in these tests. Nevertheless this provenance was considered the best for general timber production purposes in the Northeast. A strain combining good growth rate and excellent growth form was not found within the materials tested. Dr. Baldwin presented some data on needle discoloration during the winter (see Fox Forest Note No. 61) of interest to Xmas tree growers.

J. D. Diller. The girdle-graft method of propagating American chestnut scions on Asiatic and American chestnut root stocks.

A shoot of the rootstock is girdled, roughly imitating the action of a mouse or a rabbit. The girdled part is then bridge-grafted with a scion of a desirable clone. Grafting, binding and waxing techniques are very similar to those used in repairing rodent damage to fruit trees. After the graft has taken, the part of the stock above and including the girdled portion are removed, as is the upper part of the scion. This seems a rather complicated method used to achieve simple results. In addition, Dr. Diller showed slides of several large and still healthy native American chestnuts recently located in some of the Eastern and Southeastern States, from which scions are being collected for testing under artificial inoculation with the blight.

R. M. Echols. Report on a study of hemlock flowering from differentiation through pollen shedding and pollination.

Hemlock flowers are differentiated in late summer. Meiosis takes place in the spring of the year of flowering and further events follow the normal schedule of conifer flowering. Some slides of processes already abundantly illustrated in several botany textbooks for other conifer species were shown.

W. Gabriel. Investigation of clonal differences in the wood of native cottonwoods.

Report on research at the Cabot Foundation, Harvard University.

Nine clones of P. deltoides differed in density, wood rays, fiber length and other characters of their wood at an age of about ten years.

C. Heimburger. Blister rust resistance in white pine. The work at the Petawawa Forest Experiment Station, Annex of the National Research Council at Eastview and Connaught Ranges, and at the Southern Research Station was summarized. Until 1954, the Wisconsin method of inoculation was used at Maple, after this the Spokane method was used. The latter caused very heavy infection of seedlings and heavy needle spotting of some grafts during the spring following inoculation. Grafts are much more difficult to infect with blister rust than are seedlings. Thus, seedlings cannot be used as controls when infection of seemingly resistant grafts is being studied. Better black currants, retaining their leaves at the time of inoculation, are desirable. More compact grafts may be easier to infect with blister rust than somewhat leggy pot grafts produced thus far. Seedlings of seemingly resistant grafts are almost as susceptible as seedlings of unselected population samples. Grafts from plus trees, not selected for resistance to blister rust, are almost as resistant as grafts from seemingly resistant trees. Some exotic species and their hybrids show promising resistance to blister rust as seedlings.

E. J. Schreiner. Report on a reconnaissance of the Spanish races of Pinus sylvestris.

Scotch pine is in Spain, at the extreme S.W. end of its range, differentiated into specialized high-elevation types. These have thin crowns, fine branches, relatively short needles that remain green in winter, slow growth, excellent growth form and, probably, produce very good wood. The trees grow largely on north slopes of mountains. Planting is done with very small 1/0 stock after careful site preparation. The strain has been kept pure from admixture through old tradition. Introgression from the Pyrennean race of Mugo pine is not evident in the materials shown on numerous slides.

E. H. Wollerman. Studies on resistance to borer attack in black locust.

Appreciable differences in borer attack on different clones of black locust are reported. Under conditions where some clones are heavily attacked, others show no or weak attacks.

F. S. Santamour. A hermaphroditic aspen. Report on research at the Cabot Foundation, Harvard University.

A femals P. tremuloides which produces anthers on its catkins, together with typical female flowers, is described. Its progeny segregates into hermaphrodites and normals according to a simple monofactorial ratio.

S. O. Heiberg. How much forest tree improvement can we expect from silvicultural methods?

Removal of phenotypically inferior trees during thinnings in even-aged stands will retain the phenotypically best trees towards the end of the rotation and give reasonable assurance of genetypically better than average parents for the next crop. Introduction of selected superior types during regeneration will further improve quality of next crop. Grafting of scions from selected trees on to young seedlings in natural or artificial reproduction may also be a useful step in a long-term stand improvement.

F. Mergen. How much forest tree improvement can we expect from genetical methods?

Work on chromosome doubling has thus far not been of promise in forest tree improvement. Work with mutagens and radiation, to cause chromosome alterations, inversion and translocation, is yet too uncertain to be of practical value. Selection for single characters, such as resistance to specific fungi and insects, superior growth form, such as stem form and branching habit, and adaptation to climate and site, offers results of more immediate value. Work with selection for gum yield was cited as an example of successful selection for a character of economic importance.

E. O. Ehrhart. A pulpwood operational routine designed for tree improvement.

In mixed stands of hardwoods and softwoods there is wide scope for selection of the best species and types for pulpwood production in relation to site and existing markets.

E. L. Giddings and T. F. McLintock. How can genetical methods be introduced into management of the spruce-fir type?

Retention of phenotypically superior plus trees in uneven-aged stands is not practical as younger unselected trees also contribute to total source of pollen and seeds. Use of selected types is considered feasible in type conversion of hardwoods to spruce-fir. Mechanization of logging and transportation makes possible the utilization of many, formerly unmerchantable species and types of spruce and fir, and the increase of more valuable species and types already found in the stands.

E. O. Ehrhart. Management of mixed hardwoods for high quality production.

Black cherry is given as an example of a valuable hardwood species that can be favoured in the management of mixed hardwood stands. Selection of the best logs is traced back to the stumps from which these logs were cut. Sprouts from such stumps can be thinned and give rise to a, presumably, second crop of good logs and are a source of seeds of better than average quality.

APPENDIX "H"

ANNUAL REPORT 1955-56
FOREST TREE BREEDING AND GENETICS
at
PETAWAWA FOREST EXPERIMENT STATION

M. J. Holst

1. General

No changes in personnel have taken place. It had been hoped that the program could be expanded this year, but it has not been possible to obtain the necessary personnel.

Plans for an additional greenhouse and work room were approved and these are to be added in 1956.

A small seed extraction plant was erected and partly equipped.

2. Problem 20 - Selection, Breeding and Genetics of Spruce

White Spruce

The search for white spruce plus trees was this year concentrated in and around Algonquin Park, in an attempt to find local types which would be suitable to the local climate. Although considerable time was spent on the search, only ten trees were found. This is a good indication that the area covered has been heavily cut over. It is difficult to find suitable trees.

No provenance collections were made in white spruce this year, but 1-0 seedlings of previous collections of white spruce provenances from the Great Lakes - St. Lawrence Forest Region were exposed to 8, 12, 16, 20 and 24 hour days. A rough compilation of the data indicates that there are clear-cut growth differences for all provenances in respect to day length, but there is very little difference from provenance to provenance. The experiment seems to indicate that the differences in day length between the northern and southern part of the Great Lakes - St. Lawrence Forest Region will have a minor effect on our selection program in white spruce in this region. Length of growing season, summer temperature, frost hardiness and site, are apparently the most important factors controlling growth rate.

Cone collection for the white spruce provenance experiment to be undertaken in co-operation with the C. P. P. A. during 1955 was postponed to 1956, because 1955 was an extremely poor seed year for white spruce. The hot and dry summer of 1955 should bring about an abundant white spruce seed crop in 1956.

Two one-parent progeny tests with Petawawa white spruce were field planted (Exp. Nos. 71-A and 71-B), to provide information about the

amount of variation there is in the local white spruce population, and to investigate whether such an approach is feasible.

One provenance experiment (Expt. no. 73) including Petawawa and Adirondacks white spruce and a number of Norway spruce provenances was field planted to compare the production of white and Norway spruce. A somewhat similar experiment was field planted at Harrington Forest Farm, (Expt. no. 165). To investigate an as yet unidentified needle yellowing and needle drop of white spruce transplants, an experiment was field planted including yellow-tipped and healthy white spruces of Petawawa and Adirondack Mountain origin (Expt. no. 164). The yellowing is not due to soil deficiencies, and the Forest Biology Division was not able to find any insects or diseases on the material we sent them. The yellowing may be due to some sucking insects feeding in the early summer, but we have not been able to verify this assumption.

This yellowing was observed on white spruce only, and occurred on all provenances grown in the nursery. Adjacent Norway, red, and black spruces were not affected. Yellow-tipped white spruces were not confined to our nursery at Petawawa but were also observed in Gore Bay and in Midhurst.

A provenance experiment with Labrador, Quebec, and Ontario white spruce was sown in the nursery (Exp. no. 144). The seed originated from collections in northern areas requested for reforestation experiments in Greenland and Finland, and we expect to use this material for studying the variation of botanical characteristics.

Norway Spruce

Acquisition of material necessary for breeding of a winter hardy, weevil resistant Norway spruce type was continued. Selection of material is guided by our hypothesis that we can transfer the weevil resistance from white spruce (or Picea pungens) to Norway spruce by means of an intermediate (we cannot cross white spruce and Norway spruce directly). As Sitka spruce crosses readily with white spruce and the Sitka x Norway spruce hybrid has been made in Germany, it is assumed that the genes for weevil resistance can be transferred from white spruce via Sitka spruce to Norway spruce. As Sitka spruce is a coastal species, most of the Sitka x white spruce hybrids we have had on trial have not been hardy. It is quite possible that the use of Picea kojamai or Picea koraiensis would be better for our purpose. However, it has been difficult to locate material of these Asiatic spruces.

Two experiments with weevil resistant and weevil susceptible Norway spruce single tree progenies were field planted (Expt. no. 120-A and 120-B). Thirteen Norway spruce trees were selected in New York and Quebec for their high resistance to weevil damage. These trees were grafted and our collection of slender hardy and potential weevil resistant Norway spruce now totals about 30.

An attempt was made to fix weevil resistance and weevil susceptibility in the Norway spruces at Hudson's Place by means of self-pollination. These selfed progenies will eventually serve the following purposes: (a) fixing of weevil resistance in apparently weevil resistant trees, (b) provide plants for a comparison of resistant and susceptible selfed progenies thus making it possible to study the nature of this problem more closely, and (c) provide material for demonstration.

Selection of good Norway spruce is of course essential for breeding of weevil resistant types, and the selected trees may eventually produce somewhat resistant (but not immune) offspring. However, to establish the crossing bridge between a white-Sitka-Norway spruce, the following population samples have been grafted: various Danish Sitka x white spruce hybrids, Danish Yeddo x white spruce hybrids, and German Sitka x Norway spruce hybrids. Furthermore, to increase our collection of hardy Sitka spruce and Sitka spruce hybrids, we have obtained seed from Alaska of Picea sitchensis, Picea Lutzii (and Picea glauca); we have crossed boreal white spruce (Cochrane) with B.C. Sitka spruce; Mr. A. W. Porter has crossed B.C. Sitka spruce with Petawawa white spruce for us and has returned the seed; and we seem to have successfully crossed our weevil resistant Norway spruces from Hudson's Place with B.C. Sitka spruce.

Sitka spruce is not resistant to the white pine weevil. Dr. C. C. Heimburger observed severe attack on Sitka spruce planted in Nova Scotia. Furthermore, Sitka spruce on the West Coast is attacked by the Sitka spruce weevil. It would therefore be interesting to know whether some of the Sitka x white spruce hybrids are resistant to those two closely related weevils. To investigate this problem further, we obtained large quantities of seed from plantations in Denmark where these hybrids are quite common. The Danish Heath Association supplied the seed and we put it on trial for hardiness and white pine weevil resistance in eastern humid climates at Acadia (Exp. no. 136), and New York (Exp. no. 138). In Ontario, this seed was put on trial at Petawawa (Exp. no. 139) and at Dorset (Exp. no. 137). Seed of these Sitka x white spruce hybrids, various eastern white spruce provenances, and selected Norway spruce provenances were put on trial for hardiness and resistance to the Sitka spruce weevil at Green Timber Nursery, New Westminster, B.C. (Expt. no. 129) and at Forest Industries Nursery, Nisqually, Washington, D.C. (Exp. no. 127).

Red and Black Spruce

Seed for a red spruce provenance experiment were sown in nurseries at Acadia, Valcartier and Petawawa. Only at Acadia are the results satisfactory; those at Valcartier and Petawawa are rather poor. This is not surprising, as red spruce is known to be difficult to raise. Twice the amount of seed needed was sown to meet this difficulty, but it is doubtful whether it is possible to plant the experiment according to the plans.

Our collection for study of the red-black spruce problem was increased by a field planted one-parent progeny test of black spruce and

red x black spruce hybrids (Exp. no. 72); by sowing a black spruce provenance experiment including Labrador, Newfoundland, Quebec and Ontario provenance; and by collection of various herbarium material.

Interspecific Crosses

The spruce pollination work was very limited this year due to absence of flowers. However, a set of selfings was made on weevil resistant and weevil susceptible Norway spruce on Hudson's Place. White spruce female flowers were isolated, but the Sitka spruce pollen requested from B. C. and Washington was not collected and the bags were lost.

Flower Inducing in Spruce

White, black, and Norway spruce seedlings were exposed to a combination of fertilizers, prolonged day, high pH, and shock, in a search for a suitable method to overcome the juvenile stage (Exp. nos. 147, 149, 151, 153). Nursery transplants were given a combination of fertilizer and shock treatments to induce flowering (Exp. no. 155); also man-high white spruces were given similar treatments (Exp. no. 158).

Work Proposed for 1956-57

1. To cross local white spruce and Norway spruce with pollen collected in various Arboreta of Picea kojamai, Picea koraiensis, and a northern type of Picea jezoensis. To cross black spruce with southern red spruce and with Picea omorica.

2. As white spruce is expected to have a large cone crop in 1956, an attempt should be made to organize cone collection for the white spruce provenance experiment to be undertaken in co-operation with the C. P. P. A.

3. To select more white spruce plus trees in the Great Lakes-St. Lawrence Forest Region, preferably in a climatic area similar to Petawawa.

4. To collect cones from previously selected white spruce plus trees.

5. To select more weevil resistant Norway spruce.

6. To graft population samples of Picea kojamai, Picea koraiensis, and northern Picea jezoensis which may be obtained from various Arboreta.

7. To prepare various papers on the white spruce provenance problem.

8. Continue experiments on flower-inducing in spruce.

Lists of Active Projects and Reports Submitted

Projects

P-131 Study of racial and clinal variation in red spruce.

P-132 Study of racial and clinal variation in the white spruces of the Great Lakes-St. Lawrence Forest Region.

P-133 The location, recording, testing and preservation for the future of superior phenotypes of white spruce in the Great Lakes-St. Lawrence Forest Region.

P-134 Study of racial and clinal variation in black spruce.

P-135 Investigation of the red spruce-black spruce problem.

P-136 Provenance experiments with Norway spruce and other exotic spruces.

P-137 Breeding of weevil resistant and frost-hardy Norway spruces for eastern Ontario and elsewhere.

P-138 Investigation of flower inducing techniques for spruce.

Reports

1. Some Provenance and Selection Problems in Eastern Canadian Tree Breeding. M. J. Holst. Pulp and Paper Magazine of Canada. Woodlands Review. pp. 18-23. November, 1955.

2. Notes from a Trip to the Southern United States, January 1953. C. C. Heimburger and M. J. Holst. Forestry Chronicle 31(1):60-73. 1955.

3. Canada Aids Greenland's Reforestation Program. M. J. Holst. Forest and Outdoors 51(12):21. December, 1955.

4. An Observation of Weevil Damage in Norway Spruce. M. J. Holst. Forestry Branch, Tech. Note No. 4. 1955.

5. Breeding for Weevil Resistance in Norway Spruce. M. J. Holst.

   Zeitsch. Forstgenetik 4(2):33-37. 1955.

6. Notes on the Norway Spruce - White Pine Weevil Relationship in the Adirondacks. Alumni News. New York Ranger School. In print.

7. Travel Report for a Trip to New York and Quebec Made in the Fall of 1955 by Mark Holst. 10 pages.

3. Problem 21 - Selection, Breeding and Genetics of Hard Pines

Hybridization with red pine was planned this spring, but as flowering was about two weeks earlier than normal, the pollen requested from outside arrived too late and had to be stored for use next year. A few crosses were made on rootstocks and scions in the greenhouse. Jack

pine was crossed with Virginia pine, and various Scots pine and red pine were crossed with Japanese red pine. It was again observed that jack pine abort the flowers readily, while red and Scots pine flowers seems to be more sturdy.

Red Pine

The nursery provenance experiments (Exp. no. 68 and 68-A), and nursery one-parent progeny test (Exp. no. 69) were followed with phenological observations. A rough check of these data indicates that differences in height of various provenances are not only related to differences in summer temperature index (or length of growing season) but also seem to be related to inherent differences in growth cycle.

The one-parent progeny test showed surprising differences. It is usually difficult (if not impossible) to see differences in growth and quality in any one stand, the reason being that most stands usually originated from few mother trees after fire. The trees are therefore closely related. Instead of testing a number of trees from one stand we tested one tree from each of a number of stands within the Petawawa Forest Experiment Station area. The differences in height-growth displayed in this small experiment were clearly related to growth cycle, ie. the trees of exceptional height also displayed exceptional growth curves.

A number of red pine provenances were subjected to various day lengths, but the experiment failed, perhaps because of too heavy (rich) soil and over-watering.

Flower Inducing in Hard Pines

In an attempt to overcome the juvenile phase in pine seedlings, a number of experiments were initiated with red, jack, and Scots pine using a combination of varying day lengths, soil fertility and pH, and shock treatments (Exp. nos. 148, 150, 152, 154). The flower inducing effect of a combination of fertilizer and root pruning on standard size nursery plants of red, jack, and Scots pine was also investigated (Exp. no. 156), and the same combination was studied in man-height plantations of Scots pine (Exp. no. 157), red pine (Exp. no. 159), and jack pine (Exp. no. 160). Various fertilizers applied in three doses were given to one of the young red pine plantations in Drury Forest which was thinned for seed orchard purposes by the Ontario Department of Lands and Forests (Exp. no. 167).

Jack Pine

The jack pine nursery provenance experiment was followed with phenological observations to study the shoot growth pattern in relation to total height of the various provenances. The data on this experiment have not yet been compiled (Exp. no. 70).

The jack pine provenance problem is now under intensive investigation in the Lake States. The Forestry Branch was offered some of this plant material for planting in Canada. Sixteen jack pine provenances were planted at Petawawa F.E.S. in an experiment with a statistical design (Exp. no. 125), and observation plots with the same sixteen provenances were planted at Valcartier F.E.S. (Exp. no. 132) and at Harrington Forest Farm (Exp. no. 133).

About 1000 grafts were made of jack pine population samples. This material is intended for future provenance hybridization.

Scots Pine

To meet requests for information about Scots pine provenances suitable for Christmas trees, our Scots pine provenance experiment was measured and rated for important Christmas tree characteristics (Exp. no. 170). The conclusions of this study were that none of the Scots pine provenances will give 100% utilization but some provenances are clearly better than others - and some provenances should never be used for this purpose. It is suggested that we should select plus trees and propagate these for seed orchard purposes.

Five Scots pine Christmas trees were selected and grafted. The total number of potential elite Christmas trees is now forty.

Work Proposed for 1956-57

1. Pollination of Petawawa red pine with southern (Lake States) red pine, and with *Pinus densiflora* and *Pinus Thunbergii*.

2. Repeat crosses on jack pine with Virginia pine.

3. Phenological observations in red pine provenance experiment.

4. Recording the effect that various flower inducing treatments had on red, jack, and Scots pine.

5. Further experimenting with flower inducing.

6. Write publications on red and jack pine provenance experiments.

7. Propagation of promising single trees, and planting of provenance experiments.

Projects

P-139 Study of racial and clinal variation in red pine.

P-140 Study of racial and clinal variation in jack pine.

P.141 Provenance experiments with exotic hard pines.

P-142 Finding, recording, testing, and preserving for the future superior phenotypes of red pine.

P-143 Finding, recording, testing, and preserving for the future superior phenotypes of jack pine.

P-144 Breeding hard pine types resistant to European pine shoot moth.

P-145 Investigation of flower inducing techniques for hard pines.

P-146 Interspecific hybridization in the group Insignes.

P-147 Selection of the perfect Scots pine Christmas tree.

Reports

1. The Breeding of Hard Pine Types Resistant to European Pine Shoot Moth (Rhyacionia buoliana Schiff.). M. J. Holst and C. C. Heimburger. Forestry Chronicle 31(2):162-169. 1955.

2. Breeding of the Perfect Scots Pine Christmas Tree. Submitted for publication as Forestry Branch Technical Note. 60 pages.

4. Problem 70 - Selection, Breeding and Genetics of Miscellaneous Conifers

The work consisted mainly of increasing our collection of various conifers. One lot of improved Alp larch from Denmark was put on trial at Petawawa, New York, Toronto University Forest, and at Drummondville, P.Q. (Exp. no. 172). A white pine nursery provenance experiment was measured (Exp. no. 32).

Projects

P-148 Provenance experiments in white pine and testing of the pines belonging to the section Cembra and Paracembra.

P-149 Breeding of larch suitable for uplands in eastern Ontario and elsewhere.

P-150 Selection of suitable Douglas fir for eastern Ontario and elsewhere.

Reports

1. Observation of various provenances and single tree progenies of Larix for further selection. M. J. Holst. Establishment Report for Expt. no. 35. 7 pages.

5. Problem 71 - Selection, Breeding and Genetics of Miscellaneous Hardwoods

Maintenance of previously established poplar plantations and minor collections, mainly of seed, was done during the year, and various birch provenances were sown.

Project

P-151 Growth behaviour of exotic hardwoods.

6. Problem 72 - Development of Techniques and the Maintenance of Facilities for Tree Breeding

Vegetative Propagation

A total of 4, 683 grafts were made during 1955. Experimental interspecies grafting was done with red, jack and Scots pine. Red and jack pine do very poorly on each other. Jack pine does best on jack pine, Scots pine best on Scots pine, but red pine does best on a Scots pine root-stock. A summary of the grafting performed during 1955 is shown in Table II.

Nursery Work

Eighty-one thousand three hundred 2-0 seedlings were transplanted. Fifty per cent of these were spruce, 40 per cent hard pines, and 10 per cent were larch.

The nursery was enlarged by 3. 9 acres by cutting and clearing a red pine stand south of the nursery. This makes a total of 15. 6 acres. However, before we can practice the much needed fallow rotation, an additional 10 acres are needed.

Plantation Work

The test plantations planted during 1955 are shown in Table I. A total of 21, 500 plants were planted in eight experiments at Petawawa F. E. S. Four hundred and fifty grafts were planted in the pine graft Arboretum. Some 16, 500 2-2 transplants were shipped out for field planting at Valcartier F. E. S. and at Harrington Forest Farm. About 74, 600 2-0 seedlings were sent to Gore Bay, Valcartier, and Harrington Forest Farm for transplanting and for subsequent field planting.

Plantation areas have been cleared and partly cultivated for the 1956 planting program.

Other Work

Lack of personnel has made it difficult to keep the records up to

date. Establishment reports for projects and experiments are not yet up to date but the status of the indexing system is satisfactory.

Three hundred and twenty-one letters were received during 1954 and 370 letters and memoranda were written.

Aspen pollen was sent to Sweden, Denmark, and France, and extensive collections of balsam fir have been made for the benefit of reforestation projects in Greenland and Iceland.

Other small requests for plant material were filled on receipt.

Work Proposed for 1956-57

Routine work in nursery, greenhouse and plantations. Building of additional greenhouse and work rooms, and erection of shade house in lower nursery.

Projects and Reports

Projects

P-4 Acquisition and distribution of plant material.

P-45 Arboretum.

P-51 Nursery work.

P-60 Techniques in forest tree breeding.

P-61 Establishment and maintenance of experimental plantations related to tree breeding.

Reports

1. Report on Spring Planting, 1955. File Report. C. W. Yeatman. 10 pp.

2. Brush Spraying - 1955. File Report. C. W. Yeatman. 3 pages.

3. Forest Tree Breeding in Canada. M. J. Holst. Second Lake States Forest Tree Improvement Conference. August 1955. In print.

4. Grafting Methods used at Petawawa Forest Experiment Station. M.J. Holst Second Lake States Forest Tree Improvement Conference. Aug. 1955. In print.

Table I

Plantation Experiments 1955
Seed sown and distributed, seedlings distributed, and plantations established.

1. Seed distributed for the subsequent establishment of experimental plantations.

Expt. No.	Title	Agent
127	Resistance to Sitka spruce weevil of selected white spruce and Norway spruce provenances, and of white x Sitka spruce hybrids.	Forest Industries Tree Nursery, Nisqually, Washington, U.S.A.
129	Resistance to Sitka spruce weevil of selected white spruce and Norway spruce provenances, and of white x Sitka spruce hybrids.	B.C. Forest Service, Reforestation Div., Green Timber Nursery, New Westminster, B.C.
131	Observation test of nine Norway spruce provenances.	Ontario Forest Ranger School, Dorset, Ont.
134	Comparison of "Danish" white spruce and Sitka x white spruce hybrids, and local New Brunswick white spruce, planted in New Brunswick.	Forestry Branch, Fredericton, N.B.
135	Comparison of "Danish" white spruce, and Sitka x white spruce hybrids, and local Quebec white spruce, planted in Quebec.	Forestry Branch, Valcartier, F.E.S., P.Q.
136	Comparison of "Danish" white spruce, and Sitka x white spruce hybrids; Alaska Sitka and white spruce; and local Newfoundland white spruce. Planted in Newfoundland.	Forestry Branch, St. John's, Nfld.
137	Comparison of "Danish" white spruce and Sitka x white spruce hybrids with local white spruce (Sand Lake) Dorset, Ontario.	Ontario Forest Ranger School, Dorset, Ont
138	Comparison of "Danish" white spruce and Sitka x white spruce hybrids with Ontario white spruce and (local) New York white spruce. Planted in New York.	State of New York Conservation Dept., Albany 1, N.Y., U.S.A.

Table I continued

Expt. No.	Title	Agent
142	Comparison of branch types of Swedish Norway spruce from Hedesunda.	Ontario Forest Ranger School, Dorset, Ont,
162	Observation plots of mountain hemlock from Alaska and eastern hemlock from northern Pennsylvania.	Ontario Forestry Ranger School, Dorset, Ont.
163	Observation plots of mountain hemlock from Alaska and eastern hemlock from northern Pennsylvania.	Forestry Branch, Fredericton, N.B.
172	Trial of improved (4th generation) Alps larch from Denmark at Univ. of Toronto, Drummondville, P.Q., New York State University, N.Y. Conservation Dept., and Petawawa Forest Expt. Station.	See title

2. Seed sown at Petawawa Forest Expt. Station, spring and fall, 1955

Expt. No.	Title
119	Transfer of weevil resistance from white spruce to Norway spruce by means of a crossing bridge: white-Sitka-Norway spruce.
139	Comparison of selected Sitka spruce, white spruce, and hybrids.
140	Polish and German provenances of Norway spruce, and selected slender Finnish plus trees, on trial for weevil resistance.
141	Comparison of branch types of Swedish Norway spruce from Hedesunda.
143	Provenance experiment with Labrador, Newfoundland, Quebec, Ontario and Wisconsin black spruce.
144	Provenance experiment with Labrador, Quebec and Ontario white spruce.
161	Observation plots of mountain hemlock from Alaska, and local eastern hemlock.
173	Trial of northern Canadian birch.

3. 2-0 seedlings shipped out for transplanting, for subsequent establishment of experimental plantations

Expt. No.	Title	Agent
57	Provenance experiment including five races of Norway spruce to be planted in Quebec.	Forestry Branch, Valcartier F.E.S. P.Q. (also Nicolet and Drummondville).
166	Observation plots of German and Austrian Norway spruce originating from plus stands, Gore Bay, Ontario.	Ontario Paper Company, Gore Bay, Ontario.

4. 2-2 transplants shipped out for the establishment of experimental plantations.

Expt. No.	Title	Agent
132	Observation plots of 12 provenances of Lake States jack pine, Valcartier F.E.S.	Forestry Branch, Valcartier F.E.S., P.Q.
133	Observation plots of 12 provenances of Lake States jack pine, Harrington Forest Farm.	Canadian International Paper Co., Harrington Forest Farm, P.Q.
165	Observation plots of white and Norway spruce provenances, Harrington Forest Farm.	Canadian International Paper Co., Harrington Forest Farm, P.Q.

5. 2-2 transplants planted in field experiments at Petawawa F.E.S.

Expt. No.	Title
71A	One parent progeny test of P.F.E.S. white spruce.
71B	One parent progeny test of P.F.E.S. white spruce.
72	One parent progeny test of black spruce and red x black spruce.
73	Provenance and species test of white and Norway spruce.
120A	One parent progeny test of Hudson's Place Norway spruce.
120B	One parent progeny test of Norway spruce from mother trees rated as having good and poor weevil resistance.
125	Provenance experiment with Lake States jack pine.
164	White spruce from P.F.E.S. and Adirondack Mountains selected for yellow and green foliage in the nursery.

Table I continued

Expt. No.	Title
6	Pine grafts field planted at Petawawa F.E.S. 450 grafts of the hard pines were planted in the pine graft arboretum.

Table II

Summary of Grafting during 1955

Spring 1955	Number grafted
Inter-species grafting of red, jack and Scots pine (Exp. no. 124)	840
Picea kojamai and *omorica*	80
Jack pine population samples (Exp. no. 130)	1004
Red pine population sample	200
Fall 1955	
Scots pine Christmas trees (5 clones). (Exp. no. 86)	117
Three population samples of Russian Norway spruce	209
Picea rubens	175
Picea sitchensis	20
Red pine population sample	75
10 white spruce plus trees	1000
13 Norway spruce clones selected for weevil resistance	963
	4683

APPENDIX "I"

Committee on Forest Tree Breeding
Report on the Lake States Forest Tree Improvement Conference
August 30-31, 1955

M. J. Holst
Petawawa Forest Experiment Station, Chalk River, Ont.

The proceedings of the Lake States Forest Tree Improvement Conference is published by the Lake States Forest Experiment Station as Miscellaneous Report No. 40, December 1955. 108 pp.

The Conference was opened with progress reports presented by the many workers in the Lake States; these were: The Lake States Forest Experiment Station, University of Minnesota, Quetico-Superior Wilderness Research Center, University of Wisconsin, University of Michigan, Michigan State University, The Institute of Paper Chemistry, Nekoosa-Edwards Paper Company, Marathon Cooperation, Kimberly-Clark, and Consolidated Water Power and Paper Company. These reports cannot possibly cover the variety of fields taken up for investigation but they show clearly how effectively the newly established Lake States Forest Tree Improvement Committee is working. There is hardly any duplication of the work. The large work consuming provenance experiments are handled on a co-operative basis and the ease with which the co-operation is organized makes it possible to start with complete coverage of the Lake States. Also the fact that so many private companies are actively involved in both practical silvicultural improvement work, in co-operative testing conducted by the Lake States Forest Experiment Station and the Lake States Universities and in their own selection programs, indicates how determined the foresters are to try their hand on genetical improvement work. I think the reason for this intensive activity is that the Lake State Foresters are planting so much and they reason that they might as well plant the best.

Thereafter followed progress reports on the work going on at the Southeastern, Southern and Northeastern Forest Experiment Stations, the Central States, and Canada. Again the activity seems to follow the planting programs. For instance, the Southeastern Forest Experiment Station has a very large breeding program (both practical and theoretical) and 185 million seedlings were planted within the Station territory in 1954. The timber cut still exceeds growth in most areas, and the size of the average tree is decreasing.

Three panel discussions were held but limited time prevented extensive discussions.

The first discussion was on seed and pollen collection, storage, and exchange. Dr. Pauley gave a good outline of how to organize collections and Dr. Nienstaedt gave some interesting information on the forcing of Tsuga pollen in 20-hour light period. In this way the pollen may be

Forest Tree Breeding

Forest Tree Improvement Conference

1955

W. J. Reist

Station, River, Ont.

gathered some 10 days earlier than by normal day. Dr. Shea discussed the dangers of pollen exchange without quarantine regulations. The shipment of pollen (and seed) is a somewhat calculated risk. So long as we use intelligence and ordinary precaution we probably are on the safe side. So far as possible, both pollen and seed should be collected and handled by trained scientific personnel.

The second discussion was on vegetative propagation. It was clearly indicated how the various workers were trying to overcome the difficulties of vegetative propagation and how intensive the research is on these problems. All tree breeders aim to find suitable techniques for large scale production and the preferred techniques seem to be as many as there are tree breeders and tree species. This is very fortunate and has lead to the discovery of many new techniques.

S. R. Gevorkiantz presented some interesting statistical methods for the selection of plus trees. The system is based on a so called space-competition index. Tree volume or growth is correlated with age and space-competition index and analysed by partial correlation analyses. The system seems good for uniform, evenly-aged stands which have not been suppressed, or, more specifically, for plantations of intolerant species. The system is not likely to work for the selection of plus trees in tolerant species where suppression is a normal occurrence.

The panel discussion on testing for resistance to disease and insects emphasized what we do not know rather than what we do know, and this is probably quite typical of the situation today. But of course intelligent questions may be half solved problems.

An interesting paper was presented by H. L. Mitchell dealing with breeding for high-quality wood. Wood-quality evaluations are based largely on three anatomical and physical features, namely: percentage of summer wood, fibril angle, and wood density. Correlated with these are such quality factors as mechanical strength, shrinkage, pulp yields, and other wood properties. The techniques for the rapid and accurate determination of wood characteristics from small samples of living trees are now available. The techniques mentioned were: Smith's maximum moisture method for determining specific gravity of single annual rings in increment cores and Mart's fluorescent microscopic technique for measuring fibril angles directly on cores from standard increment borings. Canadian tree breeders should keep in touch with this development and eventually apply these techniques for the rating of their selected trees. Beside growth and form selection, we should include a check on wood-quality.

Mr. Mitchell then discussed the effect of a 50 per cent increase in both growth rate and specific gravity, which in southern pines would increase kraft pulp yields per acre about 2 or 3 times. This is an enormous improvement, and should be taken with a grain of salt. It is not likely that the production of bone dry matter per any given acre can be increased more than perhaps 10 per cent, unless special silvicultural treatments

(for instance fertilizing) are applied. The highest recorded volume improvement is from 20 to 50 per cent (German Norway spruce grown in southern Sweden). High volume production is most often correlated with low density wood. However, Mr. Mitchell is right in pointing out this quality aspect, although he could have been a bit more conservative in his estimates of what tree breeders can produce in terms of improvements.

The Lake States Forest Tree Improvement Committee also undertook active work projects which are dealt with by sub-committees. Four such sub-committees were active: (1) Seed collection zones, (2) Tree and stand selections, (3) Bibliography and directory and (4) projects for study.

A most interesting work project was the attempt to establish seed collection zones. The zones are based on summation of temperatures about 50° F. Intervals of 1,000 "degree-days" about 50° F and of 4° F in average January temperature provides some 26 zones in the Lake States. Within any one of the Lake States the "degree-day" would suffice and this would provide 6 zones for Minnesota, 5 for Michigan and 4 for Wisconsin.

The Conference terminated with a field trip of which the most interesting stop was Dr. Reikers old white pine blister rust test garden.

APPENDIX 'J"

Report to Committee on Forest Tree Breeding

A. W. S. Hunter
Experimental Farms Service, Horticulture Division

Dutch Elm Disease Investigations

C. E. Quellet, Experimental Farm, L'Assomption, P.Q., in co-operation with Horticulture Division, Ottawa and Forest Biology Laboratory, Department of Agriculture, Laval University, P.Q..

Inoculation

The inoculation of seedlings of American elm with the Dutch elm disease organism was continued in 1955. The number of seedlings inoculated since this work began in 1952 is as follows:

1952	289
1953	1,519
1954	5,396
1955	16,600

In 1955 a few hundred seedlings were grown in the greenhouse and were inoculated in April to determine if this procedure might be used to spread the work of inoculation over a longer period. The bulk of the seedlings were planted in the field and inoculated there in June and August. The per cent infected seedlings were 74.0 and 82.5 respectively.

Most of the uninfected seedlings are escapes and become infected upon reinoculation. However, three plants have withstood inoculation in three successive years without exhibiting symptoms.

Irradiation

In 1954, open pollinated seeds of American elm were x-rayed at dosages ranging from 500r to 16,000r. The resulting seedlings were inoculated in 1955. Irradiation appeared to have little effect on the per cent infected plants in comparison with non-irradiated checks. There was also no consistent difference between rates of treatment. However, several plants with markedly abnormal foliage, grown from x-rayed seed, did not show disease symptoms. Also, a number of seedlings did not exhibit symptoms in all branches. These uninfected branches were propagated by leafy stem cuttings and will be inoculated next year to determine whether they are escapees or have grown from sectors of mutated, disease resistant tissue.

Propagation

Studies on elm propagation were continued. The longevity of American elm seed may be increased greatly by storing the seed in sealed containers at 28° F and by soaking the seed in water for 48 to 72 hours before planting.

The age of the tree and the condition of the cutting has a marked effect upon the rooting of leafy stem cuttings. Only 21 per cent of the cuttings from mature trees rooted in 1955, compared to 91.6 per cent from one-year old seedlings. The severe drought of 1955 is believed to have been responsible for the poor performance of the cuttings from mature trees.

The rooting of cuttings is inversely proportional to the length of time elapsing between taking the cuttings and insertion in the rooting medium.

APPENDIX "K"

Summary of a Report Presented to the University of British Columbia on a Survey of Forest Genetics Developments in Canada and North-Western U.S.A., with a View to a Program for British Columbia

A. H. Hutchinson
University of British Columbia, Vancouver, B.C.

PART I

THE ROLE OF FOREST GENETICS IN A TREE IMPROVEMENT PROGRAM

The Role of Forest Genetics in the maintenance and improvement of The Pacific Northwest Forests.

That the proposed replanting and restocking can be most effective only

(1) by utilizing the genetically best stock now available as seed and grafting progenitors, in accordance with specific ecological (provenancal) requirements.

(2) by providing new genetic forms with a view to greater growth rate, better form, texture, wood quality, disease resistance, and greater vigour to withstand particular or marginal conditions, and fruitfulness.

This requires the application of genetic and ecological principles and the operation of silvicultural practice in nurseries and in forests, in order to speed up the conversion of the old forest to the new, improved forest and to compensate for the rapidly increasing utilization of forest products.

That the culmination of the Forest Conversion Project is dependent upon the joint action of Government, Industry and University; upon scientific experiment, analysis and direction by geneticists, silviculturists, ecologists, entomologists, pathologists, physiologists and agronomists; upon the establishment of arboreta, nurseries, experimental plantations and finally upon the full utilization of the findings by foresters and the holders of forest lands. This involves a carefully organized and co-active program.

APPENDIX "P"

COMMITTEE ON FOREST TREE BREEDING MEMBERSHIP

1956-57

Name	Class	Address
Dr. G. S. Allen	Sponsoring	~~President, Pulp and Paper Research Institute of Canada, 3420 University St., Montreal 2, P.Q.~~ Dean University of B.C.
K. A. Armson	Active	School of Forestry, University of Toronto Toronto, Ontario.
A. Beckwith	Active	Dept. Lands and Forests, Southern Research Station, Maple, Ontario.
A. Bickerstaff	Sponsoring	Forestry Branch, Dept. Northern Affairs and National Resources, Ottawa, Ontario.
Dr. J. E. Bier	Sponsoring	Associate Chief, Forest Biology Division, Dept. Agriculture, Ottawa, Ontario.
A. J. Carmichael	Active	Dept. Lands and Forests, Tree Seed Plant, Angus, Ontario.
Dr. L. Chouinard	Active	Faculty of Land Surveying and Forestry, Laval University, Quebec, P.Q.
Dr. W. H. Cram	Active	Dept. of Agriculture, Experimental Farms Service, Forest Nursery Station Indian Head, Sask.
Dr. B. W. Dance	Active	Division of Forest Biology, Dept. Agriculture, Southern Research Station, Maple, Ontario.

Name	Class	Address
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Dr. D. A. Fraser	Active	Forestry Branch, Dept. Northern Affairs and National Resources, Petawawa F.E.S., Chalk River, Ontario.
Dr. N. H. Grace	Corresponding	Director of Research, Research Council of Alberta, Edmonton, Alta.
J. M. Halpenny	Sponsoring	Dept. Lands and Forests, Division of Reforestation, Toronto, Ontario.
J. D. B. Harrison	Sponsoring	Chief, Forest Research Division, Forestry Branch, Dept. Northern Affairs and National Resources, Ottawa, Ontario.
Dr. C. C. Heimburger	Active	Dept. Lands and Forests, Southern Research Station, Maple, Ontario.
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M. J. Holst	Active	Forestry Branch, Dept. Northern Affairs and National Resources, Petawawa F.E.S., Chalk River, Ontario.
Dr. A.W.S. Hunter	Active	Dept. Agriculture, Experimental Farms Service, Ottawa, Ontario.
Dr. A. H. Hutchinson	Active	Dept. of Biology and Botany, University of B.C., Vancouver, B.C.

Name	Class	Address
Dr. W. Kirkconnell	Sponsoring	President, Acadia University, Wolfville, N. S.
Dr. Andre Lafond	Alternate	Faculty of Land Surveying and Forestry, Laval University, Quebec, P. Q.
A. P. Leslie	Sponsoring	Asst. Chief, Division of Research, Dept. of Lands and Forests, Southern Research Station, Maple, Ont.
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Dr. R. J. Moore	Active	Division of Botany and Plant Pathology, Dept. Agriculture, Ottawa, Ontario.
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Dr. R. Pomerleau	Active	Division of Forest Biology Dept. of Agriculture, c/o School of Forestry, Laval University, Quebec, P. Q.
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Dr. M. L. Prebble	Sponsoring	Chief, Forest Biology Div., Dept. of Agriculture, Ottawa, Ontario.

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Dr. H. A. Senn	Sponsoring	Division of Botany and Plant Pathology, Dept. of Agriculture, Ottawa, Ontario.
J. W. B. Sisam	Sponsoring	Dean, Faculty of Forestry, University of Toronto, Toronto, Ontario.
Dr. E. C. Smith	Active	Acadia University, Wolfville, N.S.
R. H. Spilsbury	Sponsoring	Officer-in-charge, Research Division, Dept. Lands and Forests of British Columbia, Victoria, B.C.
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Dr. L. R. Thiesmeyer	Sponsoring	President, Pulp and Paper Research Inst. of Canada, 3420 University Street, Montreal, P.Q.
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PART II

THE PROVISION OF RESEARCH PERSONNEL THE CONDUCT OF BASIC RESEARCH

The contribution of the University of British Columbia to Basic Forest Genetics should have two aims:

(1) the participation in joint research projects having more general applicability to forests and

(2) the more direct analysis and experimental solution of specific research problems applying to the Pacific, North, Western Forests.

These contributions may be approached as being composed of three phases:

(a) the production of research personnel, that is the instruction and direction of both undergraduate and graduate students;

(b) the conduct of research which is basic to the production of improved forests and

(c) the application of genetic and related scientific principles to silviculture and forest management and the transmission of the same to forest management officials and others who may profit directly from the research findings.

A number of recommendations directed to the University of British Columbia are presented. The parts taken by the Canadian Government, the Provincial Department of Lands and Forests and by Industry are regarded as outside the scope of this brief, except to recognize what is now being done by the various bodies and to correlate the contribution of the University along co-active lines.

It is recommended:

(1) That the University of British Columbia support and extend instruction in Forest Genetics including the provision of additional courses.

(2) That provision of scholarships and fellowships be made for undergraduate and graduate students.

(3) That the Botanical Gardens of the University and the University Forest be developed and utilized, in part, for Forest Genetic Research Projects.

(4) That basic genetic research on Douglas fir, spruces, pines (particularly endemic), hemlock, poplars, birches and ash be conducted; secondly, balsam fir, (Abies), larch and yellow cedar (Chamaecyparis).

(5) That ecological, cytological and physiological phases of forest genetics be emphasized and supported.

(6) That support be given to a co-operative genetic attack on disease producing fungi, insects and other disease causing organisms, through breeding for resistance.

PART III

GENETIC SELECTION OF SUPERIOR PROGENITORS OF CERTIFIED SEED

The applied phases of Forest Genetics are modern extensions of silviculture and Forest Management, on the parts of the University, Governmental Agencies and Forest Industry.

Biological variation is the prime requirement of progression and to be useful variations must be advantageous and inheritable. In the slow process of natural selection favourable variants survive, thrive and if they are inheritable become dominants. To improve forests man must select superior mutants, must increase their occurrence and promote their maintenance . Natural selection segregates the survivals, which are far from the 'fittest', man's selection of the genotypically 'superior' is directive, self-perpetuatiog, more rapid, and extremely more effective. Selection has made possible the production of 500 million bushels of hard wheat, annually on the Canadian Prairies, and groves of trees are being grown in Saskatchewan. How much more, starting with the best which nature has provided should the British Columbia forests be developed to superabundance!

Endemic trees, in British Columbia, are the result of natural selection during the period since the ice age. Mostly they are wind pollinated and genetically, hybrids. As experiment shows, they are variable. Man may select the best from these naturally selected populations, and use them as progenitors which in turn may be progeny tested as a basis of further selection of true breeding, superior forms. Thereby certified seed may be produced. At the same instance the progenitors of this seed should be certified and marked to produce seed for a hundred years. Recent results have demonstrated that the primary characteristics of form, texture, wood quality, rate of growth, ecological adaptation, disease resistance, general vigour and fruitfulness are independently inherited and may be observed or experimentally determined as early as the third year of seedling growth.

Thereby, an evaluation of the genetic composition is feasible. Progenitor trees are selected on a basis of the uniformity of their production of 'superior' progeny, that is for one or more desirable characters. If progenitors with all favourable characters are not readily available, hybridization may be used to procure the required genetic combination.

The report gives specific comments and procedure directions for particular tree forms.

The attached Five Year Plan for the early production of certified seed outlines a major research project. Other phases of research, although important, are not included in this brief statement.

APPENDIX "L"

REPORT ON FOREST GENETICS STUDIES AT ACADIA FOREST EXPERIMENT STATION, 1955

H. G. MacGillivray

The forest genetics work which was done at Acadia Forest Experiment Station during 1955 was chiefly concerned with:

(1) Selecting balsam fir for resistance to spruce budworm

(2) Growing and studying provenance material

(3) Studying the relationship between seed size and cotyledon numbers

(4) Studying different methods of vegetative propagation

(5) A comparative study of the morphology of red and black spruce in New Brunswick.

Selection for Spruce Budworm Resistance

An attempt was made to propagate two apparently resistant trees from the Green River watershed during March, 1955. The scions were obtained from lower branches and were therefore quite weak. As a result only five grafts out of 36 survived.

A field trip was made to the Green River watershed in the latter part of August. Trees selected for apparent resistance to an earlier date were reclassified. Six new trees were also selected. Scions were collected from eight selected balsam fir and one white spruce.

About 180 grafts were made, half of which were placed outdoors and the other half in the greenhouse. Of the latter, only two survived. The scions had been collected during relatively warm weather and could not be grafted for several days. This was a possible cause for the high mortality.

Provenance Experiments

Red Spruce

Nineteen red spruce seedlots were sown in the spring of 1955. These seedlots were collected throughout the range of red spruce. This material formed part of a large red spruce provenance experiment being directed by Mark Holst.

The seedlots were sown following stratification. Germination was good. A fall count indicated that an ample number of seedlings had survived the first summer. Cotyledon counts were made on this material during the summer. The weight per 1000 seeds for each seedlot had been found at an earlier date.

Balsam Fir

Three balsam fir seedlots were received from Newfoundland during the fall of 1955. These seedlots will be sown this spring along with three New Brunswick seedlots. The seedlings will be used to establish provenance experiments in Newfoundland and New Brunswick to study the genetic aspects of the slow growth, after a certain age, of some Newfoundland balsam fir.

Several small balsam fir seedlots from Newfoundland, Labrador, Quebec and Manitoba were obtained from Mark Holst. These will be used in the establishment of small observation plots.

Some Relationships Between Cone Size, Seed Size, Number of Cotyledons and Seedling Weight

This study was made to check the relationship between seed size and cotyledon numbers. The cones used in this experiment came from a single black spruce tree in the fall of 1954.

Some of these cones were divided into three cone size classes:

(1) Large Cones - those greater than 1.1 inches in length

(2) Medium Cones - those between 1.1 and 0.9 inches in length

(3) Small Cones - those smaller than 0.9 inches in length.

The remainder were left unclassified as control cones. The seeds were extracted and cleaned by hand. The seeds from each cone size class and half of the seed from the control cones were separated by screening into three seed size classes:

(1) Large Seed - those greater than 1.8 mm in diameter

(2) Medium Seed - those between 1.8 and 1.4 mm in diameter

(3) Small Seed - those between 1.4 and 1.0 mm in diameter.

The seedlots identified by cone size and seed size were kept separate and sown in separate compartments of a seedbed. The seedlots were allocated to compartments at random.

The larger cone size classes produced a higher percentage of larger seed (by weight) than the smaller cone size classes and vice versa (Table 1). Within each cone size class the average number of cotyledons tended to vary directly as the size of the seed (Table 2). There did not appear to be much difference between the average number of cotyledons per seedling produced by similar seed size classes from different cone size classes (Table 2). Unfortunately seedling weights were not found for samples of the seedlings from each seedlot (Table 3A). Therefore the average weight per seedling for each of the cone size classes or for each of the seed size classes could not be found for comparison. Within each seed size class of each cone size class, however, the average weight per seedling tended to vary directly as the number of cotyledons (Table 3A). This tendency was also expressed when all the data were lumped (Table 3B). Within the small cone size class the average weight per seedling of each seed size class varied as the size of the seeds (Table 3A).

From the results of this small experiment it is obvious that differences in methods of seed cleaning could seriously affect the results of studies of seed weight and cotyledon numbers of seedlots. It is possible that differences in cone collecting techniques might also affect these results. For instance, if the openings in the upper screen in a seed screening machine were too small the larger seed would be lost; and if the openings in the lower screen were too big the smaller seed would be lost. The loss of large seed would tend to lower the average number of cotyledons per seedling and therefore lower the average weight per seedling of the seedlot. The reverse would be true if the smaller seeds were lost. Although not conclusive, it appears that if only larger cones were picked during cone collecting that more large seed would be collected than if cones of all sizes were collected. This in turn would affect the cotyledon number and also the seed weight of the seedlot.

Spiral grain was observed in some of the young black spruce seedlings which were used in this study. Such early recognition of this characteristic might reduce the time element in breeding for straight grain.

Table 1

Percentage of Seed by Weight

	Large Cones	Medium Cones	Small Cones	Control Cones Seed classified
	%	%	%	%
Large Seeds	58	56	25	38
Medium Seeds	34	32	47	31
Small Seeds	8	12	28	31
	100	100	100	100

Table 2

Average Number of Cotyledons per Seedling

	Large Cones	Medium Cones	Small Cones	Control Cones Seed classified	
					Seed unclassified
	Cot's.	Cot's.	Cot's.	Cot's.	
Large Seeds	4.66	4.63	4.68	4.68	
Medium Seeds	4.60	4.69	4.42	4.58	4.51
Small Seeds	4.44	4.42	4.40	4.38	

Table 3A

Average Weight Per Seedlings in Cotyledon Classes Within Cone and Seed Size Classes

	Cotyledon classes	Large Cones Seedlings f	Large Cones Seedlings Avg. wt. gms.	Medium Cones Seedlings f	Medium Cones Seedlings Avg. wt. gms.	Small Cones Seedlings f	Small Cones Seedlings Avg. wt. gms.	Control Cones Seed classified Seedlings f	Control Cones Seed classified Seedlings Avg. wt. gms.
Large Seeds	6			4	.0181	8	.0162	6	.0120
	5			15	.0155	13	.0146	18	.0119
	4			12	.0172	14	.0134	13	.0110
	3			1	.0098				
				32	.0163	35	.0145	37	.0116
Medium Seeds	6	2	.0114	4	.0103				
	5	10	.0143	12	.0104	12	.0146		
	4	11	.0106	13	.0087	12	.0121		
	3								
		23	.0123	29	.0096	24	.0134		
Small Seeds	6					4	.0106		
	5					7	.0125		
	4					14	.0096		
	3								
						25	.0106		

Table 3B

Summary of Above Data Showing Average Weight of Seedlings in Cotyledon Classes

Cotyledon classes	Seedlings f	Seedlings Avg. wt. gms.
6	28	.0136
5	87	.0134
4	89	.0118
3	1	.0098

Vegetative Propagation

Air Layering Black Spruce and Red Spruce Branches

An attempt was made to see if air layering would be a practical method of propagating superior black spruce and red spruce trees. Air layers were applied to the branches of these species during the last of May and the first of June, 1954. Air layers were applied to suppressed or shaded branches and dominant or exposed branches of each tree, except on the immature red spruce. The immature red spruce were overtopped by hardwood and therefore had no truly dominant branches.

Three methods of air layering were employed:

(1) Plain: Moist, green sphagnum moss was placed around a branch. The moss was held to the branch with polythene film. The film was secured to the branch with plastic tape (Scotch Electric Tape).

(2) Girdle: This method was the same as (1) above except that a narrow ring of bark, about 1/18 of an inch wide was removed from each branch. The moss was applied over the girdle.

(3) Hormone: This method was the same as (2) above except that the girdle was dusted with a commercial rooting hormone mixture (Stim-root).

This resulted in each black spruce tree having one of each type of air layer on dominant branches and the same on suppressed branches, or six air-layered branches per tree. The treatment of red spruce was somewhat similar but was less complete (Table 4).

Table 4
Number of Rooted, Living and Dead Black Spruce and Red Spruce Branches Air-Layered in May-June 1954

		Air-layer treatment	Black Spruce				Red Spruce			
			Rooted	Living	Dead	Total	Rooted	Living	Dead	Tot.
Immature Trees	Suppressed branches	Plain	4	1	0	5	1	2	2	5
		Girdle	3	0	2	5	2	0	3	5
		Hormone	5	0	0	5	1	0	1	2
		Total	12	1	2	15	4	2	6	12
	Dominant branches	Plain	0	5	0	5				
		Girdle	0	2	3	5				
		Hormone	1	2	2	5				
		Total	1	9	5	15				
Mature Trees	Suppressed branches	Plain	1	3	1	5	0	5	0	5
		Girdle	0	0	5	5	0	2	3	5
		Hormone	0	4	1	5	0	1	0	1
		Total	1	7	7	15	0	8	3	11
	Dominant branches	Plain	0	4	1	5	0	2	0	2
		Girdle	0	1	4	5	0	2	0	2
		Hormone	0	0	5	5	0	0	0	0
		Total	0	5	10	15	0	4	0	4
	Total	Plain	5	13	2	20	1	9	2	12
		Girdle	3	3	14	20	2	4	6	12
		Hormone	6	6	8	20	1	1	1	3
		Total	14	22	24	60	4	14	9	27

Living: Branch alive but had not developed roots.
Dead: Branch dead. Branch either broken off or still attached to tree.

This resulted in each black spruce tree having one of each type of air layer on dominant branches and the same on suppressed branches, or six air-layered branches per tree. The treatment of red spruce was somewhat similar but was less complete (Table 4).

Table 4
Number of Rooted, Living and Dead Black Spruce and Red Spruce Branches Air-Layered in May-June 1954

		Air-layer treatment	Black Spruce				Red Spruce			
			Rooted	Living	Dead	Total	Rooted	Living	Dead	Tot.
Immature Trees	Suppressed branches	Plain	4	1	0	5	1	2	2	5
		Girdle	3	0	2	5	2	0	3	5
		Hormone	5	0	0	5	1	0	1	2
		Total	12	1	2	15	4	2	6	12
	Dominant branches	Plain	0	5	0	5				
		Girdle	0	2	3	5				
		Hormone	1	2	2	5				
		Total	1	9	5	15				
Mature Trees	Suppressed branches	Plain	1	3	1	5	0	5	0	5
		Girdle	0	0	5	5	0	2	3	5
		Hormone	0	4	1	5	0	1	0	1
		Total	1	7	7	15	0	8	3	11
	Dominant branches	Plain	0	4	1	5	0	2	0	2
		Girdle	0	1	4	5	0	2	0	2
		Hormone	0	0	5	5	0	0	0	0
		Total	0	5	10	15	0	4	0	4
	Total	Plain	5	13	2	20	1	9	2	12
		Girdle	3	3	14	20	2	4	6	12
		Hormone	6	6	8	20	1	1	1	3
		Total	14	22	24	60	4	14	9	27

Living: Branch alive but had not developed roots.
Dead: Branch dead. Branch either broken off or still attached to tree.

Some branches rooted by September 1954 and were planted that fall. Other branches required a longer period. These were removed and planted in the fall of 1955.

It was apparent in black spruce that suppressed branches of immature trees would root much more readily than dominant branches on immature trees or any branch on mature trees. The same may be true for red spruce. A comparison of the rooting of suppressed branches on immature black and red spruce indicates that black spruce roots more readily than red spruce. The sample in this experiment was too small to use in judging the value of the different methods of air layering.

Air layering may have a place in tree breeding. As described here, however, it does not appear to be effective on mature trees. It is therefore not a substitute for grafting in the propagation of mature black and red spruce trees.

<u>Rooting Balsam Fir Cuttings</u>

Cuttings from young balsam fir trees have been successfully rooted. The cuttings were vigorous 1954 shoots which were collected from a number of open-grown trees, in mid-February, 1955.

Eight cuttings, each about seven inches long were selected from this collection. The needles were stripped from the lower three or four inches of each cutting. The lower portion of each cutting was planted to a depth of about two inches in pots containing moist, coarse vermiculite. The potted cuttings were placed in a shaded rooting chamber which was located in a greenhouse. The cuttings received this treatment the same day that they were collected.

In the rooting chamber the cuttings were sprayed with a fine mist of water. This mist was automatically controlled to spray the cuttings for two-minute period, three times per hour, 24 hours a day, for three months, from mid-February until mid-May. The temperature of the water varied but generally it was about 50° F. The temperature of the greenhouse was generally between 50 and 60° F.

Vigorous root growth was observed on four of the cuttings in mid-May, 1955. Decay had attacked the lower two inches of the cuttings which had failed to root. The successfully rooted cuttings were planted in soil and placed outdoors in an open coldframe during the first week in June, 1955. These cuttings produced only short shoots and buds during 1955. This was probably caused by improper breakage of dormancy or because most of the stored food was used in the production of roots. They will no doubt produce more normal branch growth next summer.

This method has a practical application in the propagation of desirable Christmas tree genotypes.

Grafting

Attempts were made to field graft balsam fir and white spruce scions onto balsam fir and white spruce saplings during the spring of 1955. Polythene film and kraft paper bags were used to protect each graft. This resulted in only about 20 per cent success in each case.

Another small experiment was started in the fall of 1955. This was an attempt to graft red, black and white spruce scions onto white spruce root stocks in the greenhouse. To date this appears to be quite successful.

Comparative Study of the Morphology of Red and Black Spruce in New Brunswick

The purpose of this work was to study (1) the relationship between red spruce and black spruce and (2) the possibility of the occurrence of natural hybrids between these species.

Previously red spruce and black spruce characteristics, from several keys and descriptions, were used to describe trees growing along a transect at Acadia. Several measurements were also made for each of these trees. This work was continued in 1955 on some red spruce growing in a hardwood stand.

A preliminary analysis of some of these data for the Acadia trees was attempted. The method was similar to that used by Anderson* in his work on introgression.

A pictorialized scatter diagram was constructed by plotting average cone-length over weight per 1000 seeds for each tree. A circle was drawn around each of these plotted points. The characteristics for each tree were represented by rays drawn outward from the circumference of these circles, as follows:

No ray:	characteristic typical for red spruce
Short ray:	characteristic intermediate between that for red spruce and that for black spruce
Long ray:	characteristic typical for black spruce.

The tentative conclusions drawn from this preliminary analysis were that:

(1) The ranges of variation for several characteristics of each species overlap

or

(2) Red spruce and black spruce have not been properly described

or

(3) Hybridization between red spruce and black spruce is fairly common in New Brunswick.

*Anderson, E. 1954. Introgression in Adenostoma. Annals of the Missouri Botanical Garden 41:339-350.

APPENDIX "M"

CYTOGENETIC STUDIES IN CARAGANA 1955

R. J. Moore
Botany & Plant Pathology Division
Science Service, Department Agriculture, Ottawa

No extensive changes have been made in the plantings of Caragana in the Dominion Arboretum.

Pollen Germination

Germination tests of pollen of C. arborescens were carried out to determine whether the percentage of germination is in agreement with the percentage of visibly normal pollen. The percentage of normal pollen was first determined from counts of grains stained in aceto-carmine and then samples from the same flower were germinated on smears of agar on glass slides in a moist chamber for 6 hours at room temperature. Several agar media were tested: 2% agar plus 0, 1%, 2%, 5% sucrose. In general, it was found that the agar plus 5% sucrose was the best medium for germination and that the percentage of germinable pollen corresponds reasonably well with the percentage of visibly normal pollen. Pollen of 3 trees tested appeared to be 98% normal by staining methods. Germination figures of 98%, 92% and 98% were obtained for these samples. Flowers of these trees were bagged and tripped by hand. A low percentage of self-fertility was found: 2.2, 7.8 and 6, respectively. This low fertility cannot be attributed to the condition of the pollen. Germination tests made on the same trees after a period of cool wet weather gave lower percentages of germination. It appears that the high humidity may injure the pollen. Tests made near the end of the flowering period of the species also gave lower figures.

Colchicine Treatments

Colchicine-induced polyploid branches of 2 large bushes of C. arborescens have retained their polyploid characteristics for a year. These bushes were treated in May, 1954 by placing capsules of 1% agar plus 1% colchicine over the terminal bud of a branch. Growth of the branches was arrested for the remainder of the year but was resumed in 1955. The growth rate was abnormally slow. The bush was in full leaf before the buds of the treated branches began to open. No flowers were borne on the treated branches - the bush otherwise bore a normal crop of flowers. Leaflets on the treated branches were more pubescent and soft to the touch and slightly larger than normal foliage. The spiny stipules were 2-3 times larger on the polyploid branches. Squashes of leaf tissue of these branches show the tetraploid chromosome number.

APPENDIX "N"

REPORT TO COMMITTEE ON FOREST TREE BREEDING

A. L. Orr Ewing
B. C. Forest Service

A co-operative seed provenance study of Douglas fir has been inaugurated by the Oregon State Board of Forestry for the purpose of investigating the climatic and geographic limitations of the different races that undoubtedly exist. The study involves the testing of at least sixteen seed sources at different elevations in Oregon, Washington and British Columbia. Plantations will be established in the vicinity of each seed source and will be representative of all the sources. Seed from four of these has now been collected, including one of the four proposed in British Columbia.

A study was initiated in 1954 to demonstrate the need for careful selection of parent trees in seed collection. Cones were collected from a number of the best and poorest phenotypes within a stand of young open grown Douglas fir. The seed from twelve trees was sown in the nursery in 1955 and the seedlings will be planted out in 1957. Scions from each of these trees willbe grafted on to root stock this spring and it is hoped that the results will effectively vindicate the arguments against cone collection on a contract basis.

Another study has been initiated to investigate the effects of site on two high elevation stands of Douglas fir and the seed from these two stands was sown in 1955.

The effects of self-pollination on the Douglas fir have been investigated, the study has included a cytological examination of the ovules at different dates of development and an investigation into the development of the seedlings. This study has now been completed and will be published in due course.

APPENDIX "O"

1955 REPORT TO COMMITTEE ON FOREST TREE BREEDING IN CANADA

Covering the Studies in British Columbia up to December 31st, 1955. Carried out by W. A. Porter, Forest Biology Laboratory, 409 Federal Building, Victoria, B.C.

Blister Rust

Grafts and disease garden plantings were made on seven new selections and several replacements of coastal *Pinus monticola*. Eight selections of *P. strobus* from C. Heimburger were grafted and planted. Artificial inoculations continued.

Seed from crosses made by R. T. Bingham between Idaho (seed parent) and coastal British Columbia (pollen parent) pines was received and planted.

Rooted grafts previously received from Dr. Riker (Wisconsin strobus) and R. T. Bingham (Idaho monticola) remain free of rust in field plantings.

Preliminary results from 1952 graft plantings show all (32) susceptible non-graft controls are cankered but only 4 of 28 susceptible graft controls are infected. Either inoculation has failed or grafting *per se* is influencing infection. A total of 4 of the 14 initial selections now show cankers in the disease garden. There are 9 cankers among 224 grafts.

Other Studies

Sitka spruce pollen was supplied to Ontario for crossing with *P. glauca*. The cross with pollen received from Dr. Mark Holst was made at Cowichan Forest Station and the seed supplied to Dr. Holst.