Proceedings of the thirteenth meeting of the committee on **Forest Tree Breeding in Canada: Part I**

Comptes rendus de la treizième conférence du comité **Canadien D'amélioration des Arbres Forestiers: Partie I**

Prince George, B.C.
24-27 August 1971

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

With the compliments of the Committee.

Please file permanently in your institution library.

Enquiries may be addressed to the authors or to Mr. K. Illingworth, Executive Secretary, C.F.T.B.C., Research Division, British Columbia Forest Service, Victoria, B.C., Canada.

The Fourteenth Meeting of the Committee will be held at Fredericton, New Brunswick in August 1973. Canadian and foreign visitors will be welcome. Detailed information will be distributed early in 1972 to all members and to others upon request.

If your name, title or address is incorrect or incomplete, please complete and return this correction slip.

TO: Mr. K. Illingworth, Executive Secretary, Committee on Forest Tree Breeding in Canada, British Columbia Forest Service, Victoria, B.C., Canada.

NAME: Prof.
Dr. Mrs.
Mr. Miss .... Title ....

INSTITUTION: ....

ADDRESS: ....

....

Please correct my name and address as above.

Signed ....

PROCEEDINGS OF THE THIRTEENTH MEETING OF THE COMMITTEE ON FOREST TREE BREEDING IN CANADA: PART I

COMPTES RENDUS DE LA TREIZE CONFÉRENCE DU COMITÉ CANADIEN D'AMELIORATION DES ARBRES FORESTIERS: PARTIE I

Minutes and Members' Reports

Colloque sur la Conservation des Resources Forestières, Facteurs d'hérédité

Editors: D.P. Fowler and C.W. Yeatman

Part 1, Minutes and Members' Reports received. Distribution restricted to Committee members only.

Part 2, Symposium, Conservation of Forest Gene Resources, received wider distribution to persons and organizations actively engaged or interested in forest genetics and tree improvement.

Partie 1, Procès-verbaux et Rapports de membres. Distribution exclusivement limitée aux membres du Comité.

Partie 2, Colloque sur la Conservation des ressources forestières, facteurs d'hérédité. Plus ample distribution aux personnes et organisations activement engagées ou intéressées dans la génétique forestière et l'amélioration des arbres.

Produced by the Canadian Forestry Service
Department of the Environment for the
Committee on Forest Tree Breeding in Canada
Ottawa 1971

CONTENTS

LIST OF ACTIVE MEMBERS ON THE COMMITTEE ON FOREST TREE BREEDING IN CANADA, APRIL 1972

Mr. F.A. Armitage	Canadian Forestry Service Pacific Forest Research Centre 506 West Burnside Road Victoria, B.C.
Dr. M.G. Boyer	York University Department of Biology 4700 Keele St. Downsview 463, Ont.
Dr. A. Carlisle	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ont.
Dr. L.P. Chiasson	St. Francis Xavier University Antigonish, N.S.
Mr. A. Corriveau	Le Service Canadien des Forêts Centre de Recherche Forestière des Laurentides C.P. 3800 Québec 10, Qué.
Dr. W.H. Cram	Department of Regional Economic Expansion Prairie Farm Rehabilitation Administration Tree Nursery, Indian Head, Sask.
Mr. B.W. Dance	Ontario Ministry of Natural Resources Research Branch Maple, Ont.
Dr. A. D'Aoust	Le Service Canadien des Forêts Centre de Recherche Forestière des Laurentides C.P. 3800 Québec 10, Qué.
Dr. Yves Desmarais	Jardin Botanique de Montréal 4101 est, rue Sherbrooke Montréal, Qué.
Dr. D.J. Durzan	Canadian Forestry Service Forest Ecology Institute Montreal Road, Ottawa, Ont.
Mr. W.G. Dyer	Ontario Ministry of Natural Resources Resource Products Division Parliament Buildings Toronto, Ont.
Dr. M.H. El-Lakany	University of British Columbia Faculty of Forestry Vancouver 8, B.C.

Mr. K.C. Eng	Ontario Ministry of Natural Resources Tree Seed Plant Angus, Ont.
Mr. E.R. Falkenhagen	University of British Columbia Faculty of Forestry Vancouver 8, B.C.
Dr. J.L. Farrar	University of Toronto Faculty of Forestry Toronto 5, Ont.
Dr. D.P. Fowler	Canadian Forestry Service Maritimes Forest Research Centre P.O. Box 4000 Fredericton, N.B.
Dr. D.A. Fraser	Sir George Williams University Department of Geography 1435 Drummond St. Montréal 107, Qué.
Dr. R. Girouard	Le Service Canadien des Forêts Centre de Recherche Forestière des Laurentides C.P. 3800 Québec 10, Qué.
Dr. A.G. Gordon	Ministry of Natural Resources Research Branch P.O. Box 490 Sault Ste. Marie, Ont.
Dr. J.W. Green	Laurentian University Department of Biology Sudbury, Ont.
Mr. M.C. Heaman	British Columbia Forest Service Research Division Victoria, B.C.
Mr. M.J. Holst	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ont.
Dr. M. Hubbes	Le Service Canadien des Forêts Centre de Recherche Forestière des Laurentides C.P. 3800 Québec 10, Qué.
Mr. K. Illingworth	British Columbia Forest Service Research Division Victoria, B.C.
Mr. I. Karlsson	British Columbia Forest Service Prince George B.C.

Dr. M.A.K. Khalil	Canadian Forestry Service Newfoundland Forest Research Centre P.O. Box 5430 St. John's, Nfld.
Mr. G.K. Kiss	British Columbia Forest Service Research Division Prince George, B.C.
Dr. J.I. Klein	Canadian Forestry Service Northern Forest Research Centre 5320-122 St. Edmonton, Alta.
Dr. J.L. Ladell	Ontario Research Foundation Sheridan Park Ont.
Mr. M. Lalor	Alberta Department of Lands and Forests Alberta Forest Service Edmonton, Alta.
Mr. Y. Lamontagne	Ministère des Terres et Forêts du Québec C.P. 80 Berthierville, Qué.
Mr. C.H. Lane	Ontario Ministry of Natural Resources Timber Management Branch Parliament Bldgs. Toronto, Ont.
Mr. H.C. Larsson	Ontario Ministry of Natural Resources Research Branch Maple, Ont.
Mr. C.H. Lindquist	Department of Regional Economic Expansion Prairie Farm Rehabilitation Administration Tree Nursery Indian Head, Sask.
Mr. K.T. Logan	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ont.
Mr. H.G. MacGillivray	Canadian Forestry Service Maritimes Forest Research Centre P.O. Box 4000 Fredericton, N.B.
Mr. M. Meagher	University of British Columbia Faculty of Forestry Vancouver 8, B.C.
Mr. S.A.M. Manley	Canadian Forestry Service Maritimes Forest Research Centre P.O. Box 4000 Fredericton, N.B.

Mr. J.A. McPherson	Kimberly-Clark Pulp and Paper Co. Ltd. Longlac, Ont.
Dr. E.K. Morgenstern	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ont.
Dr. D.B. Mullick	University of British Columbia Faculty of Forestry Vancouver 8, B.C.
Dr. A.L. Orr-Ewing	British Columbia Forest Service Research Division Victoria, B.C.
Dr. Louis Parrot	Universite Laval Faculté de Foresterie et de Géodésie Québec, Qué.
Mr. R.F. Piesch	Canadian Forestry Service Pacific Forest Research Centre 506 West Burnside Road Victoria, B.C.
Dr. D.F.W. Pollard	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ont.
Mr. G.R. Powell	University of New Brunswick Department of Forestry Fredericton, N.B.
Miss R.M. Rauter	Ontario Ministry of Natural Resources Research Branch Maple, Ont.
Dr. L. Roche	Le Service Canadien des Forêts Centre de Recherche Forestière des Laurentides C.P. 3800 Québec 10, Qué.
Dr. K.J. Roller	Canadian Forestry Service Maritimes Forest Research Centre P.O. Box 4000 Fredericton, N.B.
Mr. J.B. Santon	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ont.
Mr. R.L. Schmidt	British Columbia Forest Service Research Division Victoria, B.C.
Mr. D.A. Skeates	Ontario Ministry of Natural Resources Research Branch Maple, Ont.

Dr. C.R. Sullivan	Canadian Forestry Service Great Lakes Forest Research Centre P.O. Box 490 Sault Ste. Marie, Ont.
Dr. O. Sziklai	University of British Columbia Faculty of Forestry Vancouver 8, B.C.
Dr. A.H. Teich	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ont.
Dr. G. Vallée	Le Service de la Recherche Ministère des Terres et Forêts du Québec 875 rue St-Amable Québec 4, Qué.
Mr. B.S.P. Wang	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ont.
Dr. C.W. Yeatman	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ont.
Dr. L. Zufa	Ontario Ministry of Natural Resources Research Branch Maple, Ont.

MINUTES

A. Attendance

B. Welcome

2:1 Address by the Honorable Ray Williston

C. Symposium on Conservation of Forest Gene Resources

D. Field Trips

E. Business Meeting

144 Minutes of last meeting

145 Membership

146 Tabulation of Selected Phenotypes of Forest Trees

147 Report on the Committee on Forest Tree Breeding in Canada

148 Date of Next Meeting

149 Election of Officers

150 Policy Statement on Conservation of Forest Gene Resources

153 Appreciation

F. Members' Reports

A. ATTENDANCE

A.H. Bamford	B.C. Forest Service
A. Carlisle	Canadian Forestry Service
W.G. Dyer	Ontario Dept. Lands and Forests
E.R. Falkenhagen	U.B.C. Faculty of Forestry
D.P. Fowler	Canadian Forestry Service
J.W. Green	Laurentian University
P.G. Haddock	U.B.C. Faculty of Forestry
C. Heaman	B.C. Forest Service
K. Illingworth	B.C. Forest Service
I. Karlsson	B.C. Forest Service
G. Kiss	B.C. Forest Service
J.I. Klein	Canadian Forestry Service
M.K. Lalor	Alberta Forest Service
Y. Lamontagne	Quebec Dept. Lands and Forests
H.C. Larsson	Ontario Dept. Lands and Forests
G. Lemieux	Laval University
J.S. Maini	Canadian Forestry Service
W.L. McMillan	Rayonier of Canada
D.G. McRea	U.B.C. Faculty of Law
H. Nienstaedt	Institute of Forest Genetics
A.L. Orr-Ewing	B.C. Forest Service
E. Peterson	U.B.C. Faculty of Law
R. Piesch	Canadian Forestry Service
R.M. Rauter	Ontario Dept. Lands and Forests
L. Roche	Canadian Forestry Service
R.L. Schmidt	B.C. Forest Service
R.H. Spilsbury	B.C. Forest Service
H.S.D. Swan	Pulp and Paper Research Institute
O. Sziklai	U.B.C. Faculty of Forestry
B.C. Wilson	Washington, Dept. of Natural Resources
C.W. Yeatman	Canadian Forestry Service
B. Zobel	North Carolina State University

B. WELCOME

The meeting was opened at 9:00 am 24 August, by the vice-chairman, Mr. G. Kiss. Mr. B. Young, District Forester, Prince George, then introduced the Honourable Ray Williston, Minister of Lands, Forests and Water Resources, B.C., who gave the opening address of the symposium.

2:1 Address by the Honourable Ray Williston

"It gives me great pleasure to welcome you, the members of the Committee of Forest Tree Breeding in Canada, to the City of Prince George which we modestly refer to as the "White Spruce Capital of the World." It is an appropriate place for your annual meeting because Prince George is the centre of a large, integrated forest industry operating within this province's policy of sustained-yield management.

Of particular interest to you in this area will be the British Columbia Forest Service's Red Rock Nursery and Research Centre which you will be visiting on Thursday. Red Rock, which serves this area, has 130 acres in nursery beds and a potential annual production of 15 million seedlings.

We are very serious about our tree-breeding program and at this time, with eight Forest Services nurseries in the province responsible for providing the seedlings for British Columbia's entire artificial reforestation program, we are paying special attention to the question of tree-breeding.

Red Rock, for example, has sections devoted to lodgepole pine and spruce tree improvement; and at Cowichan Lake Experimental Station on Vancouver Island the Forest Service is concentrating on improvement of the coastal Douglas-fir.

Although our reforestation program is not necessarily allied with your work, I nevertheless would like to outline briefly some of the expectations we have of our forest nursery program.

As I already have said, the Forest Service has eight nurseries in operation and is supplying all seedlings for our reforestation needs. Our present objective is to have an annual production of 75 million seedlings by 1975 through these present nurseries. However, this probably will not be the ultimate figure as, even with their present total area, the nurseries have a potential production of up to 130 million seedlings a year.

However, we are not restricting ourselves to meeting our requirements with the present nursery and experimental station acreage. For example, just last May the government passed an Order-in-Council incorporating the reforestation nursery and seed orchard at Red Rock into a reserve to be known as Red Rock Forest.

The total of the reserve is over 5 1/2 thousand acres. The nursery, as I have said, is 130 acres and the balance of the area is being developed for seed orchards and clone banks. The clone banks will contain seedlings and grafted stock from plus trees selected from throughout the Interior of British Columbia, as well as exotic selections obtained from tree breeders in other parts of the world. Similar forest reserves have been made in connection with other nurseries in the province.

The need for constant development of our reforestation and research programs can readily be recognized in the reading of F.A.O. economic studies which show the world demand for wood products is compounding at an annual rate of about 5 per cent. This means that demand will have quadrupled by the year 2000.

Where will this wood come from?

In British Columbia's case our production between 1949 and 1969 increased from an initial rate of 4 per cent to 6 1/2 per cent by 1969. And we now are increasing our cuts through imposition of a close utilization policy which, in the not too distant future, should increase our present annual cut of 1.8 billion cubic feet to the 3.4 billion cubic feet estimated as our annual allowable cut at close utilization.

Further increases above the 3.4 billion cubic feet figure must come from intensified management, thinning, fertilization and so on. Not the least important activity will be tree-breeding.

This then is the challenge.

We are going to have to rely on research to determine the best thinning prescriptions to maximize yield and to determine the best fertilizer treatments to use. We are going to have to plant the most productive species for each site and we are going to have to control losses from insects and disease by scientific management.

You tree-breeders must tell us what selections, races or strains to use in seed orchards for the production of genetically improved seed. You must tell us quickly for the need is urgent. We must have this seed at the earliest possible time.

I understand the theme of your meeting this year is the conservation of the gene resource. I am not a geneticist but I can fully appreciate that the gene is the unit that controls the development of the characteristics of the individual. As our mature forests are cut we lose some of this gene resource and we therefore must be careful to preserve some of these forests to retain a reservoir of useful genes for future tree-breeding.

I am optimistic that British Columbia's Ecological Reserve Act, passed at this year's legislative session, will prove to be a useful means of preserving gene resources of those tree species indigenous to the reserves. Obviously these reserves will have other values in scientific research on ecosystems which also will be useful to the tree-breeders.

Through this Act, areas established as ecological reserves are withdrawn from any further disposition that might otherwise be granted under any other Act.

Twenty-five reserves already have been established by Order-in-Council and studies are being continued to discover additional areas to serve as examples of the range of natural ecosystems characterizing the province.

The Ecological Reserve Committee, which is comprised of scientific representatives from our universities, our provincial resource departments and other interested groups, has indicated that it will probably require several more years to complete the program of field work at which time it is anticipated over 100 ecological reserves will have been created.

Now, as I know you have a busy schedule ahead of you, I want to wish you well in your deliberations. I trust that your discussion will be profitable and that you will enjoy your visit to our Central Interior."

C. SYMPOSIUM ON CONSERVATION OF FOREST GENE RESOURCES

Following Mr. Williston's address, the symposium, under the chairmanship of D.P. Fowler was opened. The following papers were presented:

T. Rajhathy (read by L. Roche) Conservation of plant gene resources.

B. Zobel. Tree breeding programs and the conservation of forest gene resources.

C.W. Yeatman. Gene pool conservation in relation to forestry practice.

B.S.P. Wang (read by C.W. Yeatman) The role of seed storage in gene conservation.

G. Lemieux. Conservation of forest gene resources within the IBP-CT framework.

C.F. Weetman (read by S. Swan) The Canadian Institute of Forestry proposals for a national system of natural forested areas.

J.S. Maini. The conservation of forest gene resources in Canada: an ecological perspective.

R.T. Franson, D.G. McCrea and E.B. Peterson. Legal and regulatory aspects of gene pool maintenance in ecological reserves.

In addition the following paper was accepted for publication in the symposium proceedings: M. Hagman. The Finnish Standard Stands for forestry research.

These papers constitute Part 2 of the Proceedings of the Thirteenth Meeting of the Committee.

D. FIELD TRIPS

Two field trips were arranged by personnel of the British Columbia Forest Service, one to Aleza Lake (26 August) and the other (27 August) to the Red Rock Nursery. A number of white spruce-lodgepole pine site types were visited at Aleza Lake. Data pertaining to these types was given by W. Arlidge and G. Kiss. Zones of introgressive hybridization between white and Engelmann spruces were also observed. The British Columbia Forest Service's Red Rock Nursery and Research Centre has 130 acres in nursery beds, and a potential annual production of 15 million seedlings. The nursery is highly mechanized, and the principles of forest genetics and tree improvement guide all aspects of seed harvesting, processing, and seedling production.

E. BUSINESS MEETING

The business meeting was held on the afternoon of 25 August.

144. Minutes of the Last Meeting

With permission of the mover and seconder, the motion by L. Roche seconded by D.P. Fowler (page 12 of the minutes) was corrected to read:

Motion: Moved by L. Roche, seconded by D.P. Fowler that the report "Forest genetics and tree improvement research in Canada: A critique" be accepted by the committee for discussion and study by the members.

Motion: Moved by O. Sziklai, seconded by J. Klein, that the minutes be accepted as corrected. Carried.

145. Membership

a) Honorary Member

Attention of the committee was drawn to the recent retirement of A.J. Carmichael. Mr. Carmichael was, for many years, an active member of the Committee and contributed to the tree improvement program of the Ontario Department of Lands and Forests.

Motion: Moved by A.L. Orr-Ewing, seconded by W. Dyer that Mr. Carmichael be made an honorary member of the Committee. The chairman was instructed to write to Mr. Carmichael and inform him of this change.

b) New Members, Changes in Status, Resignations

The following new members were duly elected:

Active:

Dr. M.H. El-Lakany, University of British Columbia.
Dr. J.W. Green, Laurentian University.
Mr. I. Karlsson, British Columbia Forest Service.
Dr. M.A.K. Khalil, (formerly corresponding) Canadian Forestry Service.
Mr. M. Lalor, (replaces Kennedy) Alberta Forest Service.
Mr. Y. Lamontagne, Quebec Dept. Lands and Forests.
Mr. C.H. Lane, (formerly corresponding) Ontario Dept. Lands and Forests.
Mr. M. Meagher, University of British Columbia.
Dr. B. Mullick, University of British Columbia.
Mr. D.A. Skeats, (formerly corresponding) Ontario Dept. Lands and Forests.
Mr. E.R. Falkenhagen, (reinstated) University of British Columbia.

Corresponding:

Mr. A.H. Bamford, British Columbia Forest Service.
Mr. D. Burton, Ontario Dept. Lands and Forests.
Mr. R. Grinnell, Ontario Dept. Lands and Forests.
Dr. P.G. Haddock, University of British Columbia.
Mr. W.L. McMillan, Rayonier of Canada.

Sponsoring:

Mr. A.J. Herridge, (replaces Dixon) Ontario Dept. Lands and Forests.

Resignations:

Mr. R.M. Dixon, (replaced by Herridge) Ontario Dept. Lands and Forests.
Mr. L.L. Kennedy, (replaced by Lalor) Alberta Forest Service.
Mr. J. Nicholson, (replaced by Khalil) Canadian Forestry Service.
Mr. W.A. Reeks, Canadian Forestry Service.

146. Tabulation of Selected Phenotypes of Forest Trees

Mr. C. Larsson brought the following letter to the attention of the Committee:

> "The Northeast Forest Tree Improvement Conference is in the process of compiling a tabulation of selected phenotypes of forest trees. This will include selections made on private, State, Provincial, and Federal land in northeastern United States and eastern Canada.
>
> If you are willing to cooperate in this program would you please tell us the number of trees you have selected by species and state or province. The NEFTIC will make this tabulation available to other cooperators, but will not assume responsibility for collection of plant materials or obtaining permission to do so. It is

the cooperator's responsibility to contact the owner for requests for cuttings or seed or for permission to make such collection.

We would like this information as soon as convenient so that we can have it compiled before the next NEFTIC meeting."

It was decided that Mr. Larsson would contact committee members and solicit the necessary information on an individual basis.

147. Report on the Committee on Forest Tree Breeding in Canada

This report was submitted by the sub-committee appointed at the Business Meeting of the CFTB in Canada at Quebec City, 1970. It was prepared by Dr. A. Carlisle (chairman), Dr. H.S.D. Swan and Mr. L.L. Kennedy.

The report considered that the history, terms of reference, structure, and activities of the Committee and presented 25 proposals for consideration. Each proposal was presented and discussed and the Committee was asked to accept in principal, reject, or modify each proposal.

The following is a resume of the action taken on these proposals:

Proposal 1

It is proposed that these terms of reference be rewritten explicitly to include:

a) Promotion of liaison between geneticists, tree breeders and others concerned with tree improvement in Canada. Approved.

b) Promotion of liaison among these scientists and those people concerned with the collection and production of seed, establishment of trees by planting and sowing, the management of plantations; and the processing of wood for pulp and lumber. Approved.

c) Invite the views of managers, practising foresters and representatives of the forest industries to participate actively in problem analysis and priority designation in the field of tree improvement on both a National and Regional basis. Modified and Approved.

d) Collection and distribution of basic information for geneticists and breeders on the current planting and sowing policies, plantation production, seed production, and costs of operations, to provide a basis for planning a tree improvement policy closely tied to National and Regional needs and priorities. Rejected.

e) Participation of members in setting up and contributing to a tree genetics and tree breeding information bank for use by all interested parties in Canada. Rejected.

(It is recorded that Mr. R.H. Spilsbury objected to Proposal 1. He suggested the terms of reference should be: The primary purpose of the CFTBC is to foster discussion on scientific and technical matters, and to review programs for the benefit of the active members.)

Proposal 2

It is proposed that the title of the Committee is left as it is unless major changes in the structure of the body make the title no longer applicable. Rejected.

Changed to:

It is proposed that a more suitable title for the Committee be found.

Proposal 3

The Chairmen are elected biennially, and it is proposed that this should remain unchanged. Accepted.

Proposal 4

It is proposed that the Executive Secretary should be elected every two years as at present. An editor is to be appointed biennially by the executive. Modified and Accepted.

Proposal 5

It is proposed that no change is made in the membership classification, unless there is a major change in the Committee's structure. Accepted.

Proposal 6

It is proposed that a sub-committee be set up to define and propose rules of order in keeping with Parliamentary usage. These rules should be kept to a minimum but be sufficient to safeguard the Committee from abuses arising from misrepresentation at business meetings. Accepted.

Proposal 7

It is proposed that the business meeting should be held on the first morning of any Committee session or meeting; all classes of members should retain voting rights; and all members participating in a meeting or session of the Committee should attend the business meeting. Accepted.

Proposal 8

It is proposed that provisions should be made for voting by proxy on constitutional or policy issues. Modified and Accepted.

Proposal 9

It is proposed that the Committee should initially consider holding its meetings (when geographically possible) in conjunction with those of the CIF as a precursor to the establishment of closer, more formal affiliations with the CIF or any other body the members propose and accept. Accepted.

Proposal 10

It is proposed that for the time being the Committee retains its present status, but considers long term advantages of becoming an independent Society. Accepted.

Proposal 11

It is proposed that a Constitution and Bylaws state that the Committee speaks for those involved in forest genetics and tree improvement work in Canada equally, regardless of affiliation or extent of sponsorship. Modified and Accepted.

Proposal 12

Consequently it is proposed that an elected Sub-Committee draw up a constitution and Bylaws defining, 1. The Name of the Organization, 2. Its Object, 3. Classes of Members, 4. Officers, 5. Types of Meetings, 6. Types of Sub-Committees or Working Parties, 7. Parliamentary Authority for Rules of Order (see RRO 1970 p. 10-11). Modified and Accepted.

Proposal 13

Full-scale Committee meetings, including a business meeting, are held at not less than two-year intervals. Accepted.

Proposal 14

At least two regional sub-committees are established, each with its elected chairman, to hold interim meetings as frequently as is necessary to deal with essentially regional problems of tree genetics and breeding research, development and implementation. Rejected.

Proposal 15

Initially two such sub-committees be set up, one for eastern Canada (Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland), and another for the west (Manitoba, Saskatchewan, Alberta, N.W. Territories, Yukon and British Columbia). Rejected.

Proposal 16

Changed to:

The national meetings include a special session to discuss Active members' progress reports. Reports are to be tabled but not necessarily discussed in detail. Accepted.

Proposal 17

Members' progress reports and lists of their publications are distributed prior to a meeting, and the progress reports published later. Modified and Accepted.

Proposal 18

The progress reports are published separately from associated reports on seminars and working parties and all types of reports are written in consistent formats. Accepted.

(It is recorded that Dr. C.W. Yeatman considered Proposal 18 to be incomplete in its accepted form. He submitted the following modification for consideration by the Committee.

a) Progress reports be written in a consistent format.

b) Progress reports be published in Part 1 of the Proceedings, together with other items of business (minutes, reports, discussions and field trips) for distribution limited to Canadian members and libraries of Canadian institutions.

c) Papers presented in symposia, or their equivalent, be published in Part 2 of the Proceedings, together with a listing of active members of the Committee and reference to their current work.)

Proposal 19

An active member should report in full only when he has some significant progress or change in policy or organization to report. Rejected.

Proposal 20

The reports on progress, working parties and seminars be given a greater degree of editing than is at present the case, by an editor elected every two years. (See Proposal 4). Rejected.

Proposal 21

That the editor should have a power of veto of reports which can only be exercised with approval of the Chairmen of the Committee. Rejected.

Proposal 22

The reports on symposia should continue to be given a wide circulation to selected people concerned with research and forest management policy outside the Committee membership. Accepted.

Proposal 23

Greater emphasis be given to Symposia, Working Party reports and problem analysis. Modified and Accepted.

Proposal 24

After each meeting the Chairman, together with any members he may select to assist him, should prepare and publish one or more papers summarizing the main points raised by the Committee's reports on progress, working parties and symposia, in a journal, or journals serving those responsible for managing forests and related research policy. Modified and Accepted.

Proposal 25

Members should submit proposals for studies of problems prior to the meeting, giving the background facts and figures to support the proposals, so that the Committee can give the problems full consideration prior to voting. Members, however, should be able to submit to the Chairman proposals during the meeting (on matters which arise from the current meeting); it will be for the Chairman to decide whether or not these latter proposals should be put to the vote. Modified and Accepted.

After the discussion of the "Report on the Committee on Forest Tree Breeding in Canada", the following members were elected to the working party (Sub-Committee): A. Carlisle, (Chairman), H.S.D. Swan and A.L. Orr-Ewing.

It will be the duty of this working party to draw up a constitution and by-laws (Proposal 12) based on the proposals accepted above.

148. Date of Next Meeting

The desirability of holding annual meetings in conjunction with meetings of national organizations such as the Canadian Institute of Forestry were discussed. It was the general consensus of the Committee that such joint meetings would be desirable whenever feasible.

Motion: Moved by C.W. Yeatman, seconded by J. Maini that the next meeting of the Committee be held in August 1973 at Fredericton, N.B., but that the executive be allowed to select another site if it so wishes. Carried.

Dr. H. Nienstaedt suggested that a joint meeting of the CFTBC and the LSFTIC be considered in the future. It was the general consensus of the Committee that this would be desirable.

149. Election of Officers

To avoid confusion in regard to electing biennial officers where the CFTBC was changing from an annual meeting to a biennial meeting schedule, all the present executive tendered their resignations to be effective at the end of the 1971 annual meeting.

Motion: Moved by C.W. Yeatman, seconded by S. Swan that D. Fowler be elected Chairman, 1971-73. Carried.

It was proposed by J. Klein and seconded by J. Maini that L. Roche be elected Executive Secretary. L. Roche declined the nomination because of other commitments. He has been nominated as Chairman of the IUFRO Working Party on the Conservation of Forest Gene Resources and would also be at the Commonwealth Forestry Institute during the coming winter.

Motion: Moved by G. Kiss, seconded by C.W. Yeatman that K. Illingworth be elected Executive Secretary. Carried.

It was agreed that the executive would appoint a Co-chairman before the next meeting.

150. Policy Statement on Conservation of Forest Gene Resources

In the evening of 25 August, the Committee held a special session to discuss the CFTBC's role in the conservation of forest gene resources.

After discussion, the following policy statement was drawn up.

COMMITTEE ON FOREST TREE BREEDING IN CANADA

STATEMENT ON CONSERVATION OF FOREST GENE RESOURCES

No Canadian tree species is, at present, in danger of extinction. However, some populations of valuable species are endangered to a point where serious gene depauperation may result. These populations should be protected *in situ* or, where this is not possible, *ex situ*.

Canada contains about 2 million square kilometers of productive forest land. It is projected that man-made forests will make up less than 2% of Canada's productive forests by 1985. It is evident, that only under exceptional circumstances will contamination of the native arboreal flora by non-native species or populations pose serious problems.

A few exceptionally valuable tree populations have been identified as a result of, or in conjunction with, forest genetics studies. Identification of more of these populations can be expected in the future. These populations should be protected *in situ* and steps should be taken to assure that these populations are perpetuated. Unfortunately the means of perpetuation, especially of competition-intolerant species, now conflict with the policies of most preservation and conservation programs (e.g., National Parks, International Biological Program-CT and the proposed Canadian Institute of Forestry Natural Forested Areas Programs). Efforts should be taken to eliminate this conflict.

The CFTB supports in principal the proposed CIF Natural Forested Areas proposal. This program, if acted upon, with the IBP-CT and National Parks programs will contribute to the preservation and conservation of a wide array of forest gene resources *in situ*. It would be undesirable for the CFTB to undertake a separate program for the preservation of such natural populations.

Where specific populations of trees are recognized as being endangered or are recognized as being of special interest in tree improvement, efforts should be made to assure their continued existence. The federal and provincial governments should be urged to take whatever action is necessary to protect such populations.

The CFTB will establish a standing Working Party called the "Working Party for the Conservation of Endangered Arboreal Germ Plasm". The duties of the Working Party will be as follows:

a) to monitor the status of Canadian arboreal species and to identify which species or populations are endangered;

b) to report biennially to the CFTB on the existence of unprotected endangered populations; and

c) to recommend to the CFTB appropriate action to provide protection for endangered species or populations.

Tree breeding and forest genetics programs play a major role in the *ex situ* conservation of valuable genetic materials (e.g., provenance tests, progeny tests, seed orchards, and breeding gardens). All tree breeders should recognize their responsibilities in regard to conservation of endangered populations. Where practical, the conservation or preservation of such populations should be considered as a part of tree improvement programs.

Seed banks (and possibly in the future, pollen banks) offer a relatively inexpensive means of preserving genetic material *ex situ*. Using existing techniques, seed of some tree species can be stored for 25 to 30 years without serious loss of viability. It is probable that, under optimum storage conditions, some tree seeds could be stored successfully for 50 to 100 years or more. The CFTB urges that greater effort be placed on research in this field.

Motion: Moved by A.L. Orr-Ewing, seconded by J.I. Klein that the (above) policy statement be accepted by the Committee. Carried.

Motion: Moved by A.L. Orr-Ewing, seconded by J. Klein that the Working Party for the conservation of endangered arboreal germ plasm be composed of C.W. Yeatman (Chairman), W. Dyer and K. Illingworth. Carried.

153. Appreciation

On behalf of all Committee members, L. Roche thanked the British Columbia Forest Service for hosting the 13th meeting of the CFTBC. Special appreciation was expressed for the efforts of G. Kiss, R.H. Spilsbury, B. Young and the staff of the Red Rock Nursery.

F. MEMBERS' REPORTS

Members' reports were presented and discussed during the morning of 25 August.

TREE BREEDING AT THE MARITIMES FOREST RESEARCH CENTRE, 1970

D.P. Fowler, H.G. MacGillivray,
S.A.M. Manley and J.M. Bonga
*Canadian Forestry Service,
Maritimes Forest Research Centre
Fredericton, New Brunswick*

INTRODUCTION

For a detailed review of the objectives of the tree breeding program at the Maritimes Forest Research Centre, the reader is referred to the 1968-69 report to the Committee (Fowler *et al.*, 1971).

Dr. Kalman Roller joined the Canadian Forestry Service, Maritimes Forest Research Centre in August 1970. Dr. Roller had previously been with the CFS in Winnipeg. He will be working primarily on problems of regeneration in western Nova Scotia. This work will include species evaluation as well as intra species selection and other aspects of regeneration.

Mr. S.A.M. Manley began work on his Ph.D. at Yale University in September 1970. His dissertation problem will be a continuation and expansion of his work on the genecology of the red spruce - black spruce complex.

BREEDING AND BREEDING SYSTEMS OF FOREST TREES - D.P. Fowler

The objective of this project is to obtain the necessary information and breeding materials to make possible the mass production of genetically superior trees for the Maritime Provinces. Understanding of the natural and potential genetic variability of native and promising exotic species is essential if genetic improvement is to be maximized. Because of the present importance of *Picea* species and the potential importance of *Larix* species for reforestation, work has been concentrated of these genera.

Picea

1970 was a moderate flowering year for spruce in central New Brunswick. White spruce (*P. glauca*), red spruce (*P. rubens*), black spruce (*P. mariana*), and Koyamai spruce (*P. koyamai*) were used as pollen parents on white and black spruce. In addition, black and Koyamai spruce were used as pollen parents on Norway spruce. The results of these controlled pollinations are given in Table 1.

Spruce hybrids and controls produced in 1968 and 1969 were transplanted from the greenhouse to the Acadia Forest Experiment Station nursery. Several putative hybrids between white spruce and red and black spruces were outplanted. The authenticity of the hybrids will be determined by taxonomic studies when the seedlings are larger.

Table 1. 1970 Interspecific Hybridization of *Picea*. Results of controlled Pollinations - Number of Full Seeds Per Cone (Total of Full Seeds).

Female Parent	Male Parent			
	P. koyamai	*P. glauca*	*P. rubens*	*P. mariana*
P. glauca				
St 553	<1 (7)	14 (1156)	0	0
St 554	<1 (2)	30 (2098)	0	0
St 557	<1 (4)	36 (2535)	0	<1 (1)
St 558	<1 (1)	23 (1937)	0	0
St 559	<1 (7)	12 (1342)	0	<1 (2)
P. mariana				
1	0	-	-	28 (836)
5	<1 (4)	-	-	38 (1256)
7	<1 (10)	-	-	2 (64)
12	<1 (7)	-	-	23 (208)
13	0	-	-	13 (176)
15	<1 (1)	-	-	18 (127)
P. abies				
St 645	2	2 (2)	-	-

In 1970, the CFS joined in a contract with the Province of New Brunswick to locate and evaluate superior stands of black spruce in the northern part of the province. Six good stands were located, mapped, and reserved from cutting. One or more of these stands will be used as seed production areas until superior strains of black spruce can be developed. The search for superior stands of black spruce will be continued in 1971.

Initial steps were taken in 1970 to assist in the development of a clonal seed orchard of black spruce. Plantations located on the limits of J.D. Irving Ltd. near Black Brook, N.B. were examined. On the basis of growth, form, and freedom from any deleterious attributes, 50 plus trees were selected; cuttings were taken from them in May and placed in a greenhouse rooting chamber under regulated mist. The success of rooting was disappointing in that only 37 out of 50 clones produced one or more rooted cuttings. This work will be repeated in 1971 using an improved misting system.

<u>Larix</u>

Due to their rapid juvenile growth, good form, high wood density, and ease of handling in the nursery, *Larix* species are of potential value for reforestation within the region. On the basis of species trials and provenance tests, it is evident that selected strains of *Larix laricina*, *L. leptolepis*, and *L. decidua* are promising. That interspecific *Larix* hybrids are often heterotic, has been well documented, thus species hybridization appears to be a most promising approach to *Larix* improvement.

The objective of the *Larix* improvement work is to determine the magnitude and pattern of variation in *L. laricina*, and to select or develop a superior strain or hybrid suitable for the Maritime Provinces. Over the past decade, a good collection of *Larix* species and strains has been accumulated at the Acadia Station. Much of this material is just beginning to produce ovulate flowers in the quantities required for controlled pollination work.

In 1970, the phenotypically best individuals of *L. leptolepis*, *L. decidua*, and *L. laricina* were selected for interspecific crossing trials. Of the 38 trees selected, only 10 produced ovulate strobili in the quantities required to make meaningful crosses. Each of these trees was used as female parent for interspecific crosses with four trees. Of the 40 crosses attempted, 31 produced enough seed to warrant further testing. This material has been sown for greenhouse experiments.

One of the most serious barriers to *Larix* breeding in the Maritime Provinces is the scarcity of plantings of exotic species from which selections can be made. In an effort to alleviate this problem for the future, *Larix* seeds were obtained from the good provenances of *Larix leptolepis*, *L. decidua*, *L. eurolepis*, and *L. sibirica*. These were distributed to the forest nurseries of the region to be raised and distributed throughout the region. The following seed lots were obtained:

Species	Number of populations	Amount of seed, kg
L. leptolepis	8	6.8
L. decidua	15	1.1
L. eurolepis	3	1.1
L. sibirica	1	.1

About 75 individual tree cone collections were made for *L. laricina*.

PROVENANCE AND PROGENY TESTING - H.G. MacGillivray

The objective of this work is to determine the amount and nature of genetic variation among populations of desirable tree species, and to use this variation to improve wood production in the Maritime Provinces. The objectives of the individual experiments are diverse, but each has its place within the overall objective. The experiments include tests for wood volume production, insect resistance, suitability for adverse sites, all-range variation, and suitability for Christmas trees.

In 1970, field plantings were established for three seed-source studies of Norway spruce (*Picea abies*) and one of Douglas-fir (*Pseudotsuga menziesii*):

(a) Surplus 2 + 3 Norway spruce from 17 seed sources in central and northeastern Europe, with native red spruce as control, were planted in nine areas in Nova Scotia by the Nova Scotia Department of Lands and Forests. These plantings were treated with various rates of N, P and K fertilizers. Replicated experiments using these and other provenances had been established by the Canadian Forestry Service in 1969.

(b) Observation plots of 4 + 0 Norway spruce from 39 seed sources mostly in Poland, Rumania, and Czechoslovakia, with native red, white and black spruces as controls, were planted in observation plots by cooperators in 12 locations in the Maritimes. A replicated test using 3 + 2 trees from these sources will be planted on the Acadia Station in 1971.

(c) Three replicated experiments using 20 populations of 2 + 2 Norway spruce from trees in Czechoslovakia, with native white, red and black spruces as controls, were planted in New Brunswick and Nova Scotia.

(d) A replicated test of Douglas-fir from 20 inland seed sources, with native balsam fir (*Abies balsamea*) as control, was established in a replicated Christmas-tree test. Twelve sets of observation plots, each containing trees from most of the seed sources, were established by cooperators. The trees in at least two sets of observation plots will be allowed to grow to timber size.

Some trends and relationships of seed source and of site quality to survival, growth, and insect damage in white spruce, from 24 seed sources scattered through most of its natural range, were demonstrated by data from two plantations at the Acadia Station. Juvenile growth of trees from these sources and the locations of the 24 sources are described by Neinstaedt[1]. Plantation A is on a moist-rich site, which is near optimum for white spruce. Plantation B is on a fresh-moderately rich site, one that is considered suitable, although not optimum, for white spruce.

Using pooled data from both plantations, survival within the provenances is positively related to average tree-height ($r = 9.87$, $N = 24$, significant at 0.01 level). The average tree-height for Plantation A was 17% greater than for Plantation B, a highly significant difference, $t = 48$. Average heights of the most vigorous provenances were between 15 and 42% greater in Plantation A.

[1]Neinstaedt, H. 1969. White spruce seed source variation and adaptation to 14 sites in Northeastern United States and Canada. *In* Proc. 11th Meet. Comm. Forest Tree Breed. Can. Quebec 1968: Part 2 183-194. Can. Dept. Fish. Forest.

The greater height growth in Plantation A was offset, to a small degree, by greater damage by the white pine weevil (*Pissodes strobi* Peck). The number of leaders killed in Plantation A was significantly greater ($t = 6.06$, significant at 0.01 level) than the number killed in Plantation B. To date, the damage is not heavy enough (9 and 1% respectively) to indicate possible influences of seed source factors on susceptibility or resistance to damage caused by the weevil. In Plantation A, most of the killed leaders occurred on trees from provenances with average tree-height above the plantation average.

GENECOLOGY OF RED AND BLACK SPRUCE - S.A.M. Manley

Red spruce is highly susceptible to defoliation by spruce budworm (*Choristoneura fumiferana* Clem.); black spruce is relatively resistant. An assessment of the hazard to defoliation by cover type is difficult because of the array of individuals intermediate between red and black spruces. Difficulties in distinguishing the two species have been attributed to extensive hybridization. The objectives of this project are to develop satisfactory field methods for distinguishing red, black, and intermediate spruces; to establish the frequency and distribution of natural hybridization in central New Brunswick and elsewhere in the Maritimes; and to evaluate ecological implications of hybridization.

In 1970, the controlled crosses were carried out with three sets of five trees of the following phenotypes: 100% black spruce, 75% black spruce, intermediate, 75% red spruce and 100% red spruce. The seeds from these crosses have been extracted and are being used in experiments at New Haven, Connecticut.

Transects and plots were established in southern New Brunswick and central Nova Scotia. Data from these indicate that widespread introgression in New Brunswick is restricted to areas within the Lowland Plain. Outside the Lowland Plain, hybridization is not frequent and is controlled by the extent of contact between the two species. In central Nova Scotia, hybridization is also influenced by the extent of habitat separation of parental species. Ground vegetation data collected from sample plots have strengthened the relationship described for central New Brunswick. Site factors which influence the success of parental species also influence the success of hybrid populations. The composition of the hybrid population depends upon the similarity of that particular set of site factors to environments which characterize parental populations.

HAPLOID AND HOMOZYGOUS DIPLOID TREES - J.M. Bonga

Young mega- and microsporangiate strobili of red pine (*Pinus resinosa*) were collected at weekly intervals in late spring and early summer. Megagametophytes and microsporophylls carrying immature microsporangia, were dissected aseptically and transferred to a variety of culture media.

Megagametophytes collected between 2 weeks before and 2 weeks after fertilization grew in culture. Most growth was obtained on White's medium supplemented with casein hydrolysate and coconut milk. On this medium, small calluses developed from the gametophytic tissues. Inside the gametophytes, layers of spindle-shaped cells were formed in various locations.

Abundant callus was obtained in cultures of the microsporophylls. Some of this callus originated from the diploid sporophylls and sproangial tissues, and some developed from the immature microspores. Smear preparations of samples of the calluses from the microspores showed haploid mitotic configurations. These haploid calluses grew better on Brown and Lawrence's medium than on the supplemented White's medium. Cultures of pollen matured on the tree failed to produce callus.

The calluses derived from the immature microspores did not show any differentiation, but were considerably larger than those from the megagametophytes.

Other possible sources of haploid tissue in conifers are poly- and reverse-embryos. Several poly- and reverse-embryos of Norway spruce were dissected and cultured on artificial media. Several of the embryos developed, and formed a short, often callusing, root and small needles. The ploidy of these small seedlings has not yet been established.

Vegetative Propagation by Culturing Buds

Dormant buds of balsam fir and white spruce were placed on an artificial medium. Some of the buds elongated to about three times their original length and formed normal length needles. At the base of these small shoots, a green callus was formed. Roots, however, have failed to develop.

PUBLICATIONS

Bonga, J.M. and D.P. Fowler. 1970. Growth and differentiation in gametophytes of *Pinus resinosa* cultured in vitro. Can. J. Bot. 48:2205-2207.

Fowler, D.P. 1970. Maternal effects in red pine, *Pinus resinosa* Ait. and their implications to provenance and progeny testing. *In* Sexual Reproduction of Forest Trees I. IUFRO, Sect. 22, Working Group Meeting, Varparantud, Finland.

Fowler, D.P. 1971. A technique for insect control in pollination bags. Can. J. Forest Res. 1: 66-67.

Fowler, D.P. and D.T. Lester. 1970. Red Pine. *In* Genetics of Important North American Forest Trees. U.S. Dept. Agr., Forest Service. Res. Pap. WO-8.

Fowler, D.P., H.G. MacGillivray, S.A.M. Manley and J.M. Bonga. 1970. Tree Breeding in the Maritimes Region, 1968-69. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. Aug. 1970. Part 2: 3-13.

McKenna, T.J. 1971. An inventory of nursery stock at the Acadia Forest Experiment Station in October 1970. Can. Forest. Serv., Maritimes Region, Fredericton, N.B. File Report.

FOREST GENETICS AND TREE IMPROVEMENT RESEARCH

L. Roche
Canadian Forestry Service,
Laurentian Forest Research Centre,
Ste. Foy, Quebec

In keeping with the program structure of the Canadian Forestry Service, research projects in forest genetics and tree improvement in the Quebec Region are now assigned to multidisciplinary Project Groups. Each Project Group has as its major objective either the solution of a problem or the exploitation of an opportunity in forest resource management. Thus, for example, research on genetic variation and improvement of yellow birch (*Betula alleghaniensis* Britton) is assigned to the Project Group dealing with the shortage of tolerant hardwoods in Quebec, and the research project entitled "Provenance trials of the genera *Picea, Pinus, Larix* and *Pseudotsuga*" is assigned to the Project Group dealing with the reforestation of abandoned farmland.

Since the last report, a provincial Committee on Forest Genetics and Tree Improvement has been established under the auspices of the Quebec Forestry Research and Development Council. Representatives of the provincial Departments of Lands and Forests, and of Industry, the University of Laval, and the Laurentian Forest Research Centre are members of this Committee which has met on seven occasions during the last year. Further progress has therefore been made to ensure that the Canadian Forestry Service research program in forest genetics and tree improvement in Quebec, which is detailed in the following reports, is directed as closely as possible to the needs of the Province.

At the request of the Society of American Foresters, two publications, one on Sitka spruce (*Picea sitchensis* (Bong.) Carr) and one on Engelmann spruce (*P. engelmannii* Parry), are being prepared for the series on the genetics of important forest trees of North America. Development of this series of publications is in accord with the resolution of the World Consultation on Forest Genetics and Tree Improvement at Stockholm in 1963, and of the Fifth World Forestry Congress in Seattle, 1960.

PAPERS ON TREE GENETICS AND BREEDING AND ALLIED SUBJECTS PRODUCED BY SCIENTISTS AT THE LAURENTIAN FOREST RESEARCH CENTRE

Bate, G.C., A. D'Aoust and D.T. Canvin. 1969. Calibration of infrared CO_2 analyzers. Plant Physiol. 44:1122-1126.

Corriveau, A. 1970a. Etude d'accroissement et de production des peuplements épinette-sapin de la péninsule gaspésienne résultant de chablis, exploités partiellement ou dévastés par le feu en 1941-42. Aire d'observation n° 8 - Petite Rivière Pabos (Québec). Serv. Can. For., Lab. Rech. For., Québec, Rapp. Inform. Q-F-X-4.

Corriveau, A. 1970b. Etude d'accroissement et de production des forêts du nord-ouest québécois après exploitation. Serv. Can. For., Lab. Rech. For., Québec, Rapp. Inform. Q-F-X-5.

Corriveau, A. 1970c. Effets de la Tordeuse (*Choristoneura fumiferana*) sur de jeunes peuplements de Sapin-Epinette-Bouleau blanc établis après coupe à blanc et coupe suivie de feu. Serv. Can. For., Lab. Rech. For., Québec, Rapp. Inform. Q-F-X-8.

Corriveau, A. 1971a. L'intensité de l'éclaircie sélective, ses effets sur un peuplement de sapin baumier de 40 ans. Serv. Can. For., Centre Rech. For. Laurentides, Rapp. Inform. Q-F-X-20.

Corriveau, A. 1971b. Etude comparative de coupes partielles effectuées en 1954 dans des peuplements de sapin baumier de différents âges de la rivière Epaule, Québec. Serv. Can. For., Centre Rech. For. Laurentides, Rapp. Inform. Q-F-X-21.

Corriveau, A. et M. Boudoux. 1971. Le développement des provenances d'épinette blanche de la région forestière des Grands-Lacs et du St-Laurent au Québec. Serv. Can. For., Lab. Rech. For., Québec, Rapp. Inform. Q-F-X-15.

D'Aoust, A., G.C. Bate and D.T. Canvin. 1971. Effect of CO_2 concentration and reference cell CO_2 content on the calibration of infra-red CO_2 gas analyzers. Can. J. Bot. 49:217-219.

Girouard, R.M. 1967a. Anatomical and biochemical studies of rooting in stem cuttings of *Hedera helix* L. Ph.D. diss., Purdue Univ., Lafayette.

Girouard, R.M. 1967b. Anatomy of adventitious root formation in stem cuttings. Proc. Int. Plant Propag. Soc. 17:289-302.

Girouard, R.M. 1967c. Initiation and development of adventitious roots in stem cuttings of *Hedera helix*. Anatomical studies of the juvenile growth phase. Can. J. Bot. 45:1877-1881.

Girouard, R.M. 1967d. Initiation and development of adventitious roots in stem cuttings of *Hedera helix*. Anatomical studies of the mature growth phase. Can. J. Bot. 45:1883-1886.

Girouard, R.M. 1969. Physiological and biochemical studies of adventitious root formation. Extractible rooting cofactors from *Hedera helix*. Can. J. Bot. 47:687-699.

Girouard, R.M. 1970a. Rooting cuttings of spruce in a greenhouse under intermittent mist. Proc. 1st N. Amer. For. Biol. Workshop, August 1970. Michigan State Univ., East Lansing, Michigan.

Girouard, R.M. 1970b. Rooting plain and heel cuttings of spruce. Plant Propag. 16:7-12.

Girouard, R.M. 1970c. Vegetative propagation of spruce. Can. Forest. Serv., Bi-m. Res. Notes 26:41.

Girouard, R.M. 1971. Bouturage de certaines espèces forestières. Serv. Can. For., Centre Rech. For. Laurentides, Rapp. Inform. Q-F-23, 73 p.

Girouard, R.M. 1971. Vegetative propagation of pines by means of needle fascicles - A literature review. Can. For. Serv., Laurentian For. Res. Centre, Inform. Rep. Q-X-23, 16 p.

Girouard, R.M. and C.E. Hess. 1964. The diffusion of root promoting substances from stems of *Hedera helix.* Proc. Int. Plant Propag. Soc. 14:162-166.

Girouard, R.M. and C.E. Hess. 1966. The distribution and mobility of rooting cofactors on juvenile and adult growth phases of *Hedera helix.* Proc. 17 Intern. Hort. Congr., Maryland. Vol. 1, summary paper No. 370.

Hubbes, M. 1969. Benzoic and salicylic acids isolated from a glycoside of aspen bark and their effect on *Hypoxylon pruinatum.* Can. J. Bot. 47: 1295-1301.

Hubbes, M. 1971. Biochemical factors in biological control. Proc. Int. Union For. Res. Organ., Gainesville, Florida. March 1971.

Hubbes, M. et R. d'Astous. 1968. Essais de rusticité et d'immunité des peupliers hybrides dans le Québec. Serv. Can. For., Lab. Rech. For., Québec. Intern. Q-8.

Hubbes, M. and R. Pomerleau. 1969. Factors in elm wood responsible for the production of coremia by *Ceratocystis ulmi.* Can. J. Bot. 47: 1303-1306.

Roche, L. 1970. Forest genetics and tree improvement research in Canada: A critique. Can. For. Serv., For. Res. Lab., Québec. Intern. Rep. Q-18, 24 p.

Roche, L. 1971a. The conservation of forest gene resources in Canada. For. Chron. 47:215-217.

Roche, L. 1971b. Variation, selection and breeding of tree species: An introduction. Can. For. Serv., Laurentian For. Res. Centre, Inform. Rep. Q-X-22, 74 p.

Roche, L. 1971c. Forest genetics and tree improvement research, Quebec. Proc. 12th Meet. Comm. For. Tree Breed. Can., Quebec, Aug. 1970. Part 2:23-24.

L'AMELIORATION DES ARBRES FORESTIERS AU QUEBEC, 1970-71

A. Corriveau[1]
Le Service Canadien des Forêts,
Centre de Recherche Forestière des Laurentides,
Ste-Foy, Québec

Les recherches en génétique forestière au Québec et particulièrement chez nous au Centre de Recherches forestières des Laurentides, sont encore très récentes, c'est pourquoi l'accent y a-t-il été placé sur l'étude des variations géographiques des principales essences forestières commerciales du Québec: épinette noire, épinette blanche, sapin baumier, et bouleau jaune. L'introduction d'essences exotiques: épinette de Norvège, épinette engelmann (*P. engelmannii* Parry), sapin de Douglas, *Larix*, et différentes espèces d'*Abies* est également notre préoccupation.

Les principaux points qui militent en faveur de cette orientation sont les suivants: Premièrement, le besoin urgent d'une délimitation de zones de récolte de graines, en vue de l'utilisation complète du potentiel génétique de chaque lot de semences destiné au reboisement. Deuxièmement, l'importance d'une connaissance précise des variations génétiques à l'intérieur des espèces avant la mise sur pied d'un programme de sélection et d'amélioration génétique. Troisièmement, constituer, à force de récoltes de provenances à travers l'aire de distribution de nos essences indigènes, une réserve de gènes "gene pool" et ainsi aider à la conservation de caractères naturels des essences faisant l'objet d'une exploitation accélérée, en vue de leur utilisation ultérieure. Finalement, la possibilité de découvrier, pour une région donnée, une essence exotique ayant une meilleure croissance ou rusticité supérieure à celle de nos espèces indigènes.

ESSENCES INDIGÈNES

Bouleau jaune (*Betula alleghaniensis* Britton)

Au cours des étés 1967 et 1968, les semences de quelque 400 arbres-mères représentant 48 provenances furent récoltées. Ces semences furent conservées séparément et semées selon un dispositif expérimental de six répétitions entièrement au hazard dans la pépinière de Valcartier au printemps de 1969. Dès le début de la saison de croissance de 1970, cinq semis de chaque descendance furent choisis au hazard dans chacune des répétitions (30 semis/descendance). Sur chacun d'eux on nota la date de débourrement, la croissance hebdomadaire, et la date d'entrée en dormance, et aussi chaque semis fut alors mesuré en hauteur totale et diamètre de tige au niveau de collet. Egalement un certain nombre de feuilles furent prélevées sur ces plants, divisées par caractères morphologiques et ont été mesurées

[1]Ingénieur forestier, présentement à North Carolina State University pour l'obtention d'un doctorat en génétique.

dans le but de continuer l'étude génécologique antérieurement entreprise. Le printemps dernier les plants (2 + 1) furent plantés en dispositif expérimental (rangée de 10 plants, 6 répétitions) à Fort Coulonge, Cté Témiscouata, Seigneurie de Lotbinière, Cté Lotbinière, et Amqui, Cté Matapédia.

Épinette noire (*Picea mariana* (Mill.) BSP

Un essai de provenances à grande échelle d'épinette noire fut entrepris en collaboration avec le Dr K. Morgenstern et trois autres chercheurs en 1968. Cet essai couvre la presque totalité de l'aire de distribution de l'épinette noire au Canada et dans les états américains des Grands-Lacs. Dans le cadre de ce projet de recherche, quelque 60 provenances furent récoltées en 1969 au Québec et échangées avec les collaborateurs. Au printemps de 1970, 100 provenances, dont 44 du Québec et 15 américaines furent semées en dispositif expérimental de six répétitions à la pépinière de Valcartier. A l'automne de cette même année, 10 semis furent choisis au hazard dans chaque répétition de chacune des provenances. Sur chacun de ces semis, les mesures suivantes furent effectuées: longueur de la tige, longueur des racines, diamètre au niveau du collet, poids sec à 75°F. A la fin de la saison de croissance de 1971, le même nombre de semis par provenance fut marqué en permanence, leur date d'entrée en dormance notée, et leur hauteur totale mesurée.

Six provenances d'épinette noire de latitude 44°50' à latitude 67°15' ont fait l'objet d'étude à différente photopériode. Des mesures de croissance en hauteur ont donné les résultats suivants (tableau 1) après 6 mois à température de 15°C la nuit et 20°C le jour, 70% d'humidité et une intensité lumineuse de 2,000 ft c.

Épinette blanche (*Picea glauca* (Moench) Voss)

A l'automne de 1970, deux plantations (Exp. 93-E-F) expérimentales comprenant 25 provenances d'épinette blanche plantées en 1958 furent remesurées en hauteur et la compilation des données effectuées. En avril 1971, un rapport d'information (Corriveau et Boudoux 1971a) concernant les essais de provenances 194-G, 194-H, 194-I-1, 194-I-2, 194-I-3 établis dans cinq localités distinctes du Québec fut publié. Les résultats mettent en évidence la vigueur supérieure d'une provenance du sud de l'Ontario, 2438 (Peterborough, lat. 48°18', long. 78°18'). Cette provenance a l'un des meilleurs taux de survivance et une hauteur, à l'âge de 10 ans, supérieure de 20 à 38% à la provenance locale dans chacune des plantations. La supériorité de cette dernière a également été notée par Teich (1970)[2] en Ontario où elle est de 17% supérieure en hauteur à la moyenne dans les 11 endroits où elle fut plantée. Quatre autres provenances ont une hauteur supérieure de plus d'un écart type de la moyenne, ce sont: 2445 (Cushing, P.Q.), 2446 (Beloeil, P.Q.), 2484 (Lac Mitchinamekus, P.Q.) et 2485 (Lac Simard, P.Q.) (Voir Fig. 1 et tableau 2).

---

[2]Teich. 1971. *In* Proc. 12th Meet. Quebec. August 70. Part 2: 95-100.

Une étude de provenance de l'épinette blanche a été initiée en 1970. Dans le cadre de cette étude, quelque 35 provenances ont été récoltées dans la partie sud-est de la province. Les graines ont été extraites, nettoyées, classées par ordre de qualité, le pourcentage de germination déterminé, le degré d'affectation par les insectes déterminé et le développement de l'embryon déterminé au moyen du rayon X. Les récoltes de semences seront reprises dès cette année dans les parties sud et ouest de la province. Également plusieurs provenances d'épinette blanche de Colombie Britannique furent plantées à Valcartier ce printemps.

Sapin baumier (*Abies balsamea* (L.) Mill.)

Quelque 50 provenances de sapin baumier du Québec on été établies en dispositif expérimental à Valcartier ce printemps.

ESSENCES EXOTIQUES

Épinette de Norvège (*Picea abies* (L.) Karst)

Les 1, 2 et 3 juin de cette année, 5,700 plants (2 + 2) d'épinette de Norvège, représentant 38 provenances de Bulgarie, de Yougoslavie, et de Pologne, furent plantés en dispositif expérimental de 25 plants et de six répétitions, à l'arboretum provincial de la Seigneurie du lac Matapédia, Gaspésie.

Egalement quelque 5,000 plants représentant 50 provenances d'épinette de Norvège des Balkans et de la Pologne furent reçus de Petawawa et plantés en dispositif expérimental (quatre répétitions de 25 plants) en collaboration avec le Dr Gilles Vallée à l'arboretum de Notre-Dame des Monts (Cté Gaspé ouest).

A la fin du mois de mai 1971, quelque 30 provenances d'épinette de Norvège de White Russia, Balticum et d'Europe Centrale, reçues par l'intermédiaire de M. Mark Holst (Petawawa) ainsi que 15 provenances de Finlande reçues du Dr. Eero Malmivaara furent semées en six répétitions à la pépinière de Valcartier.

Sapin de Douglas (*Pseudotsuga menziesii* (Mirb.) Franco)

Toujours en fonction de notre programme d'introduction d'essences exotiques, 10 provenances de sapin de Douglas des régions montagnardes de Colombie Britannique furent plantées en dispositif expérimental de 25 plants et six répétitions à Valcartier et à l'arboretum provincial de la Seigneurie du Lac Matapédia, au printemps 1971.

Sapins exotiques

Le printemps dernier quatre provenances d'*Abies sachalinensis*, une provenance d'*Abies homolepis*, une provenance d'*Abies veitchii*, une provenance d'*Abies procera*, et une provenance d'*Abies balsamea* d'Ontario furent plantées en dispositif expérimental de 25 plants et six répétitions à Valcartier.

Tableau 1. Effets de la photopériode sur la croissance en hauteur de six provenances d'épinette noire (Hauteur moyenne (mm) de 15 semis par provenance et photopériode)

Photopériode Heure 01 02 04 06 08 10 12 14 16 18 20 22 24 AM PM	Provenance 6902	341	6972	6970	6994	6998
————————————*	129	117	112	102	81	-
—— ————————	467	452	217	137	121	109
————— ————	1044	1178	799	725	122	95
—— — —— ——	1333	859	1084	643	820	171
Moyenne	743	650	553	401	286	125
Latitude	44°50'	50°08'	53°14'	56°03'	60°32'	67°15'
Longitude	78°05'	67°09'	105°46'	108°42'	134°27'	138°20'

*La période de noirceur.

Observations:
1. Diminution de croissance proportionnelle à l'augmentation d'altitude et de longitude quelle que soit la photopériode.
2. Diminution de croissance proportionnelle à la longueur de la période de noirceur, quelle que soit la provenance.

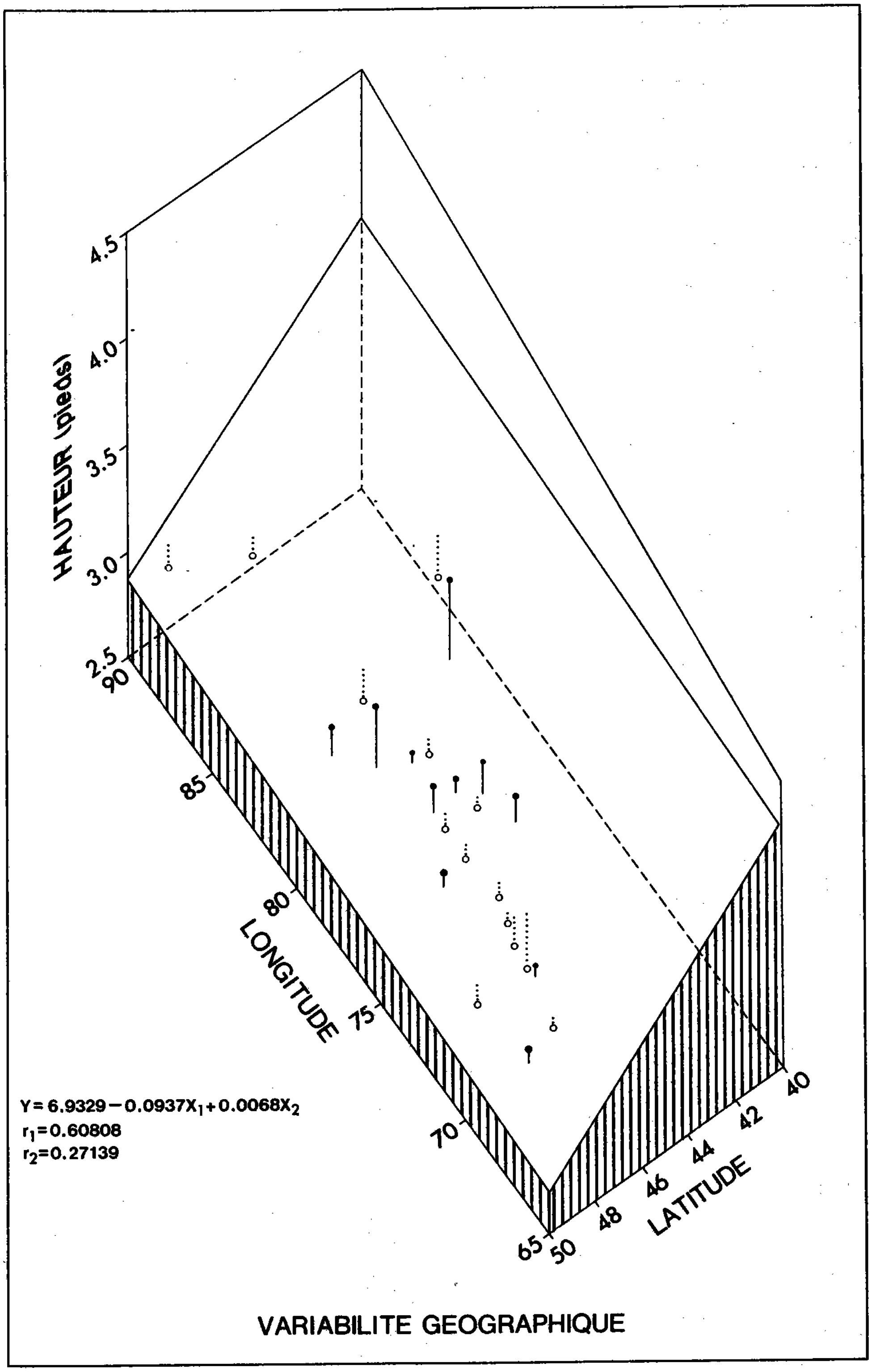

Figure 1. Hauteur 25 provenances d'épinette blanche.

Tableau 2. Hauteur totale moyenne des provenances dans chaque plantation comparative (pieds)*

N°	Provenances	Plantations comparatives: Harrington	Grandes Piles	St-Jacques des Piles	Baskatong	Casey	Moyenne
1	2469	-	3.2	4.0	-	2.8	3.3
2	2438	4.0	4.2	4.5	2.6	3.4	3.7
3	2446	3.8	4.1	4.2	1.5	3.1	3.3
4	2445	3.9	3.7	4.2	1.7	3.3	3.3
5	2453	3.7	3.2	3.8	1.8	3.2	3.1
6	2464	3.7	3.3	3.6	2.1	2.7	3.1
7	2463	3.5	3.1	3.8	-	2.5	3.2
8	2467	3.3	3.4	3.8	1.3	3.0	3.0
9	2470	-	2.8	3.9	1.4	2.9	2.8
10	2603	2.9	3.5	4.2	1.9	2.5	3.0
11	2447	3.4	3.5	3.7	1.7	2.6	3.0
12	2452	3.4	3.5	3.8	1.6	2.9	3.0
13	2454	3.4	3.2	3.7	1.9	2.7	3.0
14	2455	3.3	3.1	4.1	1.6	3.2	3.1
15	2449	3.4	3.7	3.8	1.4	2.7	3.0
16	2491	3.0	3.6	3.4	1.9	2.7	2.9
17	2471	3.6	3.6	4.1	1.3	3.0	2.8
18	2484	3.7	3.2	3.7	1.8	3.0	3.3
19	2473	3.5	3.0	3.4	1.5	2.7	2.9
20	2485	3.6	3.6	4.3	2.0	2.8	3.3
21	2450	3.3	3.7	3.9	1.6	2.6	3.0
22	2486	3.1	3.2	4.2	2.2	2.8	3.1
23	2480	3.1	3.5	3.7	1.3	2.7	2.9
24	2604	-	2.7	3.9	1.5	3.1	2.8
25	2472	3.3	3.2	3.8	1.4	2.9	2.9
Moyenne par plantation		3.45	3.39	3.92	1.69	2.81	3.06

*Provenances disposées par ordre croissant de latitude.

COMPARATIVE PHYSIOLOGICAL STUDIES ON BLACK SPRUCE PROVENANCES

A.L. D'Aoust
Canadian Forestry Service,
Laurentian Forest Research Centre,
Ste. Foy, Quebec

A comparative study of the physiology of black spruce (*Picea mariana*) from different provenances has been initiated. The main objectives are:

(a) To build up a body of information concerning the physiology of this species.

(b) To study geographic variations with special reference to morphology, growth characteristics, and physiological activity at the seedling level.

Preliminary observations were made on morphological characteristics of two Quebec provenances, one from the Nicauba Research Forest (B-1b, Rowe 1959) and the second one from the Valcartier Forest Experimental Station (L-4a, Rowe 1959) grown under identical conditions in the greenhouse. There was a significant height difference after one year of growth from seeds, with all of the Valcartier provenances always taller. Counts of the stomatal frequency showed no significant difference within or between progenies of single trees, or between provenances in the number of stomata per centimeter of needle length.

Although the initial plan was to begin gas-exchange analysis of the above material, this stage of experimentation will only be possible this coming year with acquisition of a "Sirigor" Gas-Exchange Chamber with temperature and humidity control.

PROPAGATION OF SPRUCE BY MEANS OF STEM CUTTINGS

R.M. Girouard
Canadian Forestry Service,
Laurentian Forest Research Centre,
Ste. Foy, Quebec

This study has three major objectives:

(a) To develop methods that will promote and hasten the rooting of cuttings from several species of spruce.

(b) To elucidate the anatomical and physiological factors that influence the initiation and development of adventitious roots in stem cuttings.

(c) To propagate trees by cuttings to establish clonal banks and seed orchards.

EXPERIMENTS IN A GREENHOUSE

(a) Experiments on rooting stem cuttings of spruce were started in late May 1967 using perlite and intermittent mist. Preliminary work involved cuttings from black spruce (*Picea mariana* (Mill.) BSP.), Norway spruce (*Picea abies* (L.) Karst.), red spruce (*Picea rubens* Sarg.), and white spruce (*Picea glauca* (Moench) Voss). The results suggest that only plain cuttings - those with a basal cut and no heel of old wood - should be collected from the lower part of trees no later than the beginning of shoot extension, that is, if the cuttings are to be rooted in a greenhouse within 1 year.

(b) In another experiment, cuttings were made from seedlings of the four species mentioned above to reduce to a minimum variables due to age of plant material, mineral nutrition, and exposure. Red spruce was one of the most difficult species to root, while Norway spruce was the easiest. In general, short cuttings (2 inches long) rooted more readily than long ones (4 inches long): the length of the cuttings did not influence the number of roots formed per rooted cutting. This information is useful for two reasons: 1) if a choice exists, those species which are difficult to propagate by cuttings can possibly be avoided; and 2) in those clones where the quantity of plant meterial is limited and ramets must be produced for clonal banks and seed orchards, short cuttings can be used without too much effect on the form and growth in height of the ortets.

(c) An intermittent mist system was modified to permit injection of carbon dioxide, without freezing the water at the point of injection, in part of the watering system. The purpose of this experiment was to compare the effects of carbonated versus non-carbonated water on rooting cuttings of *Picea glauca*. Information published in 1968 had indicated that carbonated water could reduce the rooting period and produce more vigorous plants in the case of *Juniperus* cuttings. Data from this work remains to be analyzed.

EXPERIMENTS IN OUTDOOR PROPAGATION BEDS

Outdoor propagation beds that require manual watering were prepared during June 1970 in a nursery at Valcartier, Quebec, to check the possible use of inexpensive propagation structures for mass production of rooted cuttings of spruce. About 10,000 semi-hardwood cuttings were made with and without a heel of old wood and/or auxin treatment. Results of this experiment will be available in late summer 1971.

PHYSIOLOGICAL STUDIES

(a) To study the physiological factors that influence the initiation and development of adventitious roots in stem cuttings of spruce, an investigation of rooting cofactors was performed. Preliminary work with total methanolic extracts indicated that few differences exist in the rooting cofactors of Norway spruce, which is easy to propagate from cuttings, and those of red spruce, which is difficult. Two-dimensional paper chromatography revealed a large number of fluorescent compounds in the total methanolic extracts. This finding clearly indicated that one-dimensional paper chromatography of these extracts, a procedure commonly used by most investigators of rooting cofactors, is inadequate. In the future, all extracts will require fractionation before chromatography and bioassay.

(b) An *Avena* coleoptile straight growth bioassay that is sensitive to plant growth regulators such as auxins, gibberellins and inhibitors, was tested and mastered. Poor germination of seed of the standard oat variety 'Brighton', available from only one source in North America, had to be replaced with another variety. Methods were developed to store and treat the seeds before germination to obtain reproducible results. Bioassay of total methanolic extracts of *Picea abies* revealed growth activity in a zone where indoleacetic acid, an auxin, is generally found. A comparison of methanolic extracts from Norway spruce (easy to propagate from cuttings) and red spruce (difficult) showed greater activity from the former. The fractionation of the extracts by liquid-liquid extraction remains to be done.

(c) A study of soluble sugar content of shoots in relation to rooting performance of cuttings was completed. Total sugar content was determined using a method described by Ebel (Phytochemistry 8:227-233, 1969). Extracted sugars were isolated by one-dimensional paper chromatography and their concentration determined by colorimetric and densitometric methods. Results of this work will be published with data which I hope to obtain in the near future from starch analyses of similar tissues.

ANATOMICAL STUDIES

Stem pieces were collected at various intervals from the basal end of cuttings, with and without a heel of old wood, that were rooting. The specimens were killed and dehydrated and then embedded in Tissuemat.

Sectioning of the stem pieces was started recently. At first, both transverse and longitudinal sections were difficult to make and stain, but gradually most of the problems, were overcome. The mounted sections will be studied to determine if differences in rooting capacity of cuttings are due to anatomical factors.

POPLAR DISEASES IN QUEBEC

M. Hubbes
Canadian Forestry Service,
Laurentian Forest Research Centre,
Ste. Foy, Quebec

The demand for rapidly growing trees increased considerably in the last four or five decades in Europe as well as in other parts of the world. In Europe and North America, this need was thought to be partially met by selecting and breeding poplar hybrids best adapted to populculture. However, the introduction of new plant material to a continent or a country, where endemic plant diseases might become very virulent, represents always a certain risk. Therefore, experiments were designed to select, in the shortest possible time, the species and varieties best adapted to the climatic conditions of Quebec and the most resistant against various pathogens of this province. Twenty-four plantations have been established in different areas of Quebec. The 64 poplar hybrids used for these plantations were obtained from Dr. E. Schreiner, Northeastern Forest Experiment Station, U.S.A.

The plant material is cultivated for 2 years in the nursery from cuttings 10 inches long. After the hybrids have completed their second year of growth, they are lifted and transported to the locality selected for a future plantation. The next spring, before planting, the soil is ploughed and planting holes are dug. The trees are kept 24 hours in water and then planted about 0.5 foot deeper than they were growing in the nursery.

The rapid growth, vigor and a certain degree of resistance of the poplar hybrids depend also of the conditions of growth:

a) A well drained soil favors roots respiration,

b) the water table between 2 and 5 feet guarantees a good water supply, and

c) an adequate mineral content with a high base exchange capacity is also very favorable.

In two localities, plantations were established simultaneously on grassland and on tilled soil to test the effect of cultivation. In six more localities randomized plantations were established.

Up to now, the following five hybrids proved to be the most promising in all of our plantations.

a) *P. c.v. Angulata* X *deltoides*
b) *P. c.v. Candicans* X *berolinensis*
c) *P. c.v. Angulata* X *trichocarpa*
d) Hybrid 57
e) *P. deltoides* *c.v. caudina*

The results of the two types of plantations on tilled soil and grass plots are presented in Tables 1 and 2. The hybrid *P. c.v. Angulata* X *deltoides* (39, NE 252) on cultivated soil, tripled its height from 6.6 to 17 feet and its diameter (DBH) went from 0.5 to 4.0 inches in 3 years. The superiority of the cultivated soil is obvious by comparing these data with those obtained from the grass plots.

In addition, our studies on different tree diseases show that extracts of resistant or susceptible host species influence considerably the development of pathogens *in vitro*. Growth fluctuation of the pathogens depends on the extracts obtained from the different parts of the stem of the trees, the season, and the provenance of the host. It is also evident that the production of host compounds inhibiting or promoting the development of plant pathogens are genetically controlled.

In general, one may assume that in the course of breeding improvements the genetic base of plants is narrowed and consequently the vulnerability is increased, and the slightest change in the pathogenicity of the attacking organism overthrows the plant resistance. Therefore, investigations of the biochemical nature of resistance and plant immunity would be not only profitable for a well founded, plant breeding program, but would also lead to the detection of new substances that can be used to combat fungal diseases. In addition, it is clear that if the plant breeder had more information about the factors that control the mechanisms of resistance he would know how many barriers were needed and which barriers of resistance have to be strengthened to ensure long term resistance. These results also emphasize the importance of a pool of gene resources as an indispensable reservoir for breeding improvements.

Table 1. Plantation on Grass Plots

Hybrid	Hybrid No.	Year	Living Trees	Height (feet)	Diameter (inches)	Cankers (%)	Leaf Spots (%)
P. c.v. Angulata X *deltoides*	39	1967	5	6.3	0.3	0	0
		1968	5	6.4	.4	35	25
		1969	4	7.5	.4	19	6.3
		1970	4	10	.6	12.5	0
P. c.v. Angulata X *trichocarpa*	6	1967	5	5.4	0.3	0	10
		1968	5	5.8	.4	30	25
		1969	4	6.6	.4	13	6.3
		1970	4	8.8	.5	18.8	0
P. c.v. Angulata X *trichocarpa*	34	1967	5	6.4	0.4	0	0
		1968	5	7.0	.5	0	0
		1969	5	7.8	.6	0	0
		1970	5	10.1	.7	5	0
Hybrid 57	57	1967	5	5.8	0.3	25	25
		1968	4	5.6	.4	37.5	37.5
		1969	3	5.5	.4	17	17
		1970	2	6.5	.3	25	0
P. deltoides X *c.v. caudina*	52	1967	5	8.5	0.5	0	0
		1968	5	8.5	.6	0	0
		1969	5	9.5	.7	0	0
		1970	5	12	1.0	5	0

Table 2. Plantations on Tilled Soil

	Hybrid No.	Living Trees	Height (feet)	Diameter (inches)	Cankers (%)	Leaf Spots (%)
P. c.v. Angulata X *deltoides*	39	5	6.6	0.5	0	0
P. c.v. Angulata X *trichocarpa*	6	5	6.6	.5	0	0
P. c.v. Angulata X *trichocarpa*	34	5	7.5	.6	0	0
Hybrid 57	57	5	6.7	.5	0	0
P. Deltoides X *c.v. Caudina*	52	5	8.2	.6	0	0
			1968			
P. c.v. Angulata X *deltoides*	39	5	8.8	1.0	0	0
P. c.v. Angulata X *trichocarpa*	6	5	8.1	.8	0	0
P. c.v. Angulata X *trichocarpa*	34	5	9.3	.9	0	0
Hybrid 57	57	5	8.2	.9	0	0
P. deltoides X *c.v. caudina*	52	5	9.8	.9	0	0
			1969			
P. c.v. Angulata X *deltoides*	39	5	11.0	1.4	0	0
P. c.v. Angulata X *trichocarpa*	6	5	10.6	1.2	0	0
P. c.v. Angulata X *trichocarpa*	34	5	11.6	1.1	0	0
Hybrid 57	57	5	10.0	1.0	0	0
P. Deltoides X *c.v. Caudina*	52	5	10.5	1.4	0	0
			1970			
P. c.v. Angulata X *deltoides*	39	5	17.0	4.0	0	0
P. c.v. Angulata X *trichocarpa*	6	5	15.1	2.8	0	0
P. c.v. Angulata X *trichocarpa*	34	5	17.4	3.4	0	0
Hybrid 57	57	5	15.4	3.2	0	0
P. deltoides X *c.v. caudina*	52	5	18.0	3.4	0	0

RESEARCH ON TREE GENETICS AND BREEDING AT PETAWAWA FOREST EXPERIMENT STATION 1970-71

A. Carlisle
Canadian Forestry Service, Petawawa Forest Experiment Station
Chalk River, Ontario

INTRODUCTION

The purpose of this report is to give a general outline of the year's progress in tree genetics and improvement and ancillary studies. Details of these studies are given in the following individual reports.

PROGRAM DEVELOPMENT

The consolidation of the reorganized program was completed. Emphasis remains on the genetics of white spruce, black spruce, jack pine, red pine and exotic species such as larch, Scots pine and Norway spruce. The highest priority is being given to tree species in greatest demand for planting and seeding programs, trees with known high genetic variability where the gains from selection and breeding are likely to be great, and trees which yield a product which has more than one use so that there is a lower risk of demands being unduly affected by changes in industrial technology. The main aim is to provide the basic information needed to enable the best known seed sources to be selected with confidence to meet the growing demands of planting and seeding programs. Secondary to this, but increasing in importance, is selection within provenances and subsequent breeding.

The genetics work is supported by empirical studies on tree propagation. There is also a tree physiology program which is designed to provide answers to practical problems raised by the genetics research. Studies of costs and benefits of the genetics and allied research are being made to calculate tangible returns from the genetics research investment. The Seed Unit, which is responsible for the Seed Bank, collation of information on seed availability and seed testing, works in cooperation with the geneticists.

RESEARCH PROGRESS AND RESULTS

During the period 1970-71 the highlights of the work have been:-

White Spruce

(a) Collection of scions from valuable seed sources (Douglas and Cobourg) in danger of depletion, and grafting onto root stocks in preparation for establishment in a seed orchard.

(b) Collection of a small quantity of seed from the valuable seed source of the Beachburg area: spruce budworm greatly reduced the cone crop.

(c) Discussion with cooperators in Canada and the United States of a proposed range-wide white spruce investigation.

(d) Completion of a review of white spruce genetics in cooperation with the United States Forest Service.

Black Spruce

(a) Establishment of the range-wide black spruce nursery test.

(b) Establishment of experiments to derive genetic parameters, including diallel crosses.

(c) Studies of general combining ability and genetic correlations were carried out in growth chambers.

(d) Visits to forest industry's seed orchards in Ontario to evaluate alternative methods of seed production and progeny testing.

(e) Preparation of a proposal for cooperative progeny testing of black spruce in Ontario.

Jack Pine

(a) Demonstration of growth differences at age 3 months among and within stands in the Upper Ottawa Valley.

(b) Preparation of a review of studies of jack pine genetics at Petawawa.

Seed Unit

(a) Acquisition, with the assistance of many cooperators, of a total of 183 seedlots of 25 tree species from 100 locations for the Seed Bank and research purposes. Scots pine seed of Orel, Kiev, and Woronesch provenances (known to grow well in Canada) were obtained from Russia, and Japanese larch seeds obtained from Japan.

(b) Confirmation that presoaking red pine cones considerably increases (43%) seed recovery from cones.

(c) Studies of seed yield per bushel of cones in 56 cone collections including six Canadian conifers.

(d) Completion of survey of information on hardwood seed storage.

Physiological Studies

(a) Demonstration that there are significant differences in the photosynthetic rates of different jack pine provenances.

(b) Development of a method for growing jack pine and white spruce seedlings rapidly in controlled environments.

In addition, a survey of tree genetics and improvement programs in Canada was completed and published (Carlisle 1970).

STAFF MOVEMENTS

Dr. A.H. Teich, who is responsible for white spruce genetics at Petawawa, departed on 1 May, 1971 for a 1-year leave of absence for work at the Volcani Institute of Agricultural Research at Bet Dagan, Israel. During his stay in Israel he will be studying the genetics of disease resistance and will be involved in citrus breeding.

RESEARCH FACILITIES

During the year the Station's PDP-8 computer's capability was increased by adding to the core memory. The controlled environment facility was increased by two units suitable for seedlings up to 6 inches high. An auditorium, complete with audio-visual aids, was completed at the station. Meetings of up to 150 people can be held in the new installation.

MEETING OF THE NORTH AMERICAN FORESTRY COMMISSION (NAFC) WORKING GROUP ON TREE IMPROVEMENT

The NAFC Working Group on Tree Improvement, including representatives from United States, Mexico, Canada and the Food and Agricultural Organization, met at Petawawa under the chairmanship of Dr. J.S. Maini of the Canadian Forestry Service. The meeting included discussion of Petawawa's genetics and breeding program, and visits to the Station's field experiments and arboreta.

PAPERS ON TREE GENETICS AND BREEDING AND ALLIED SUBJECTS PRODUCED BY SCIENTISTS AT THE PETAWAWA FOREST EXPERIMENT STATION FROM AUGUST 1970 TO AUGUST 1971

Carlisle, A. 1970. Tree improvement programs and their role in Canadian forestry. Chron. 46:439-444.

Carlisle, A. 1971. Tree genetics and breeding program at Petawawa Forest Experiment Station 1968-70. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part. 2:85-90.

Carlisle, A. and A.H. Teich. 1971a. Cost and benefit analysis of white spruce (*Picea glauca* (Moench) Voss) improvement. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2:123-124.

Carlisle, A. and A.H. Teich. 1971b. The economics of the genetic improvement of white spruce. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2:225-238.

Hegert, G.B., B.S.P. Wang and C.W. Yeatman. 1971. A belt cleaner for small samples of tree seed. Forest Chron. 47:40-41.

Holst, M.J. 1971 a. The genetic basis of improvement of red pine, Petawawa, 1968-70. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2:107-108.

Holst, M.J. 1971 b. The introduction and selection of exotic tree species, Petawawa, 1968-70. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2:109-114.

Holst, M.J. 1971 c. The stimulation of flowering in spruce and pine. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2: 125-128.

Logan, K.T. 1970. A multi-chamber cuvette for studying gas exchange of detached twigs. Can. Forest Serv., Petawawa Forest Exp. Sta., Inform. Rep. PS-X-18.

Logan, K.T. and D.F.W. Pollard. 1971 a. Physiological growth parameters for tree selection. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2:131-132.

Logan, K.T. and D.F.W. Pollard. 1971 b. Comparative investigations of dry matter production in young tree seedlings using classical growth analysis and gas analysis technique. Can. Forest Serv., Petawawa Forest Exp. Sta., Inform. Rep. PS-X-25.

Morgenstern, E.K. 1971 a. Forest tree breeders discuss silviculture. Forest Chron. 47:15.

Morgenstern, E.K. 1971 b. Research on the genetic basis of improvement of red and black spruce, Petawawa, 1968-70. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2:91-94.

Nienstaedt, H. and A.H. Teich. 1971. The genetics of white spruce. U.S. Forest Serv. Publ. (in press).

Pollard, D.F.W. 1971. Automatic watering and feeding of seedlings in controlled environments. Can. Forest. Serv., Petawawa Forest Exp. Sta., Inform. Rep. PS-X-28.

Pollard, D.F.W. and K.T. Logan. 1971. Mechanisms of seedling growth in improved environments. Proc. 12th Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2:129-130.

Santon, J.B. 1971. Tree propagation work at Petawawa, 1968 to 1970. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2:119-122.

Teich, A.H. 1971. Research on the genetic basis of white spruce improvement, Petawawa, 1968-70. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2:95-100.

Yeatman, C.W. 1970. Growth and stimulation of pine and spruce seedlings with carbon dioxide enrichment of air. Proc. 1st N. Amer. Forest Biol. Workship, Aug. 1970. Mich. State Univ., East Lansing, Mich. (Abstract).

Yeatman, C.W. 1971. Genetics of jack pine seedling response to CO_2 and pollination studies, Petawawa, 1968-70. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2:101-106.

Wang, B.S.P. 1971. The Forest Tree Seed Unit, Petawawa, 1968-70. Proc. 12th Meet. Comm. Forest Tree Breed. Can., Quebec, P.Q. 1970. Part 2:115-118.

BLACK SPRUCE GENETICS, PETAWAWA 1970-71

E.K. Morgenstern
Canadian Forestry Service,
Petawawa Forest Experiment Station
Chalk River, Ontario

During the review period, June 1970 to May 1971, studies basic to the development of breeding programs were continued. After the controlled pollinations in May 1970, experiments to derive genetic parameters were established. In addition, attention was paid to flowering and seed set as new variables in the consideration of alternative breeding and testing procedures. Some details of the findings follow.

The pollinations of 1970 resulted in a good seed set. Little insect damage occurred and sufficient seed for experimentation was obtained from each of three mating designs. The 7 x 7 diallel cross yielded an average of 19 mg of filled seeds per cone, the Design I (Comstock and Robinson, 1952) 21 mg, and open pollination 15 mg. Flowers in the diallel cross were pollinated twice because this cross is most informative; its lower seed set in comparison to the Design I is probably the result of the few seeds produced by the seven selfings included in the total of 49 combinations. The relative inefficiency of open pollination could possibly be explained by the rainy weather prevailing at the time of optimum flower receptivity. At the same time, one should note that the 15 mg of seed per cone corresponded exactly to the weight extracted per cone in our large Ontario collections of 1967, a good seed year. Extraction methods were the same in both cases. (To convert seed weight per cone to an approximate number of seeds per cone, we use the factor of 1 mg per single seed of black spruce.)

Seed from the diallel cross was sown in a replicated experiment in Japanese paper pots in two greenhouse environments to obtain estimates of general and specific combining ability. Germination and early growth were measured. The experiment will be transferred to the nursery for further observation.

In cooperation with Dr. C.W. Yeatman, an experiment with seed from 44 open-pollinated mother trees in Site Region 3E of Ontario (Hills, 1959) was established in three growth chambers. Each chamber was set to a different photoperiod. Control of light, temperature, humidity, carbon dioxide and nutrition accelerated growth so that final measurements could be made 13 weeks after sowing. Estimates of general combining ability and genetic correlations will be obtained from this study. The growth of these progenies will also be correlated with their performance in the nursery and field. All 90 one-parent progenies from this region were sown in the PFES nursery in the spring of 1971.

To evaluate alternative methods of progeny testing and seed production, the seedling seed orchard of Spruce Falls Power and Paper Company, near Kapuskasing, Ontario, and the grafted clonal orchard of Kimberly-Clark Pulp and Paper Company at Longlac, Ontario, were visited. Mr. R.H. Armstrong of Spruce Falls and Mr. J.A. McPherson of Kimberly-Clark were very helpful and provided unpublished information. In both orchards, flowering has started early and seed production is satisfactory. Given the possibility of short generation intervals, breeding in black spruce looks very promising.

A proposal for cooperative progeny testing of black spruce in Ontario was submitted through the Great Lakes Forest Research Centre at Sault Ste. Marie to the Ontario Ministry of Natural Resources, Kimberly-Clark Pulp and Paper Co. Ltd. and Spruce Falls Power and Paper Co. Ltd.

REFERENCES

Comstock, R.E. and H.F. Robinson. 1952. Estimation of average dominance of genes. pp. 494-516 *In* Heterosis, ed. by J.W. Gowen. Iowa State Coll. Press.

Hills, G.A. 1959. A ready reference to the description of the land of Ontario and its productivity. Div. Res., Ont. Dept. Lands Forests. Prelim. Rep. 142 pp.

WHITE SPRUCE GENETICS, PETAWAWA 1970-71

E.K. Morgenstern

Canadian Forestry Service,
Petawawa Forest Experiment Station
Chalk River, Ontario

Dr. A.H. Teich, who is responsible for white spruce genetics at Petawawa, started a 1-year leave-of-absence to work at the Volcani Institute of Agricultural Research at Bet Dagan, Israel, on 1 May, 1971. The following is a summary of his accomplishments during the past year.

The excellent performance in many provenance tests of white spruce provenances from southeastern Ontario, i.e. the Beachburg-Westmeath-Douglas area (Upper Ottawa Valley) and Cobourg (south of Peterborough) (Teich, 1971) has led to frequent requests for seed from the parent stands. Most of these stands are on private land and their continued existence is not assured. To avoid the loss of these valuable seed sources, scions from 130 clones were grafted on root stocks for eventual establishment in seed orchards. Ten of these clones were obtained from the Douglas source (King and Rudolf 1969) in the Nicolet National Forest, Wis., through the North Central Forest Experiment Station. Twenty clones were selected in natural stands in the Upper Ottawa Valley (Alice and Westmeath) and 100 clones came from the Cobourg source in a provenance plantation (Exp. 194-D) at PFES. Ottawa Valley and Cobourg materials was also provided to the North Central Forest Experiment Station and the University of Wisconsin.

In the Upper Ottawa Valley, only a small white spruce cone crop was produced in 1970 as a result of an infestation by the spruce budworm, *Choristoneura fumiferana* (Clem.). Plans for large seed collections could not be carried out; only seed from 25 trees in the Beachburg area was collected by the Forest Tree Seed Unit directed by Mr. B.S.P. Wang. One-parent progenies from these trees were established in a greenhouse experiment in cooperation with Dr. D.F.W. Pollard.

Preparations for a range-wide study of white spruce were continued by contacting several potential cooperators in the Lake States and Ontario.

A comprehensive review paper on white spruce genetics was written with Dr. H. Niestaedt of the North Central Forest Experiment Station. This will be published as one of the series on native species sponsored by the U.S. Forest Service and the Society of American Foresters. A paper by E.K. Morgenstern and A.H. Teich entitled "Stability parameters in provenance selection" using data from six Ontario white spruce provenance experiments was presented by Dr. Teich on March 18, 1971, at the meeting of the Working Group on Quantitative Genetics held during the XVth IUFRO Congress at Gainesville, Florida.

REFERENCES

King, J.P. and P.O. Rudolf. 1969. Development of white and Norway spruce trees from several seed sources 29 years after planting. U.S. Forest Serv., Res. Note NC-70.

Teich, A.H. 1971. Research on the genetic basis of white spruce improvement, Petawawa, 1968-70. Proc. 12 Meet. Comm. Forest Tree Breed. Can., Part 2:95-100.

EARLY SCREENING OF JACK PINE PROVENANCES BY GAS ANALYSIS, PETAWAWA 1970-71

K.T. Logan and D.F.W. Pollard
Canadian Forestry Service, Petawawa Forest Experiment Station
Chalk River, Ontario

The selection of a superior genotype is usually based on empirical studies. For the tree breeder, the conventional field trial has a major disadvantage: field trials with tree species take many years to complete. The selection and testing of progeny and hybrids could proceed more rapidly if physiologists could identify characters in a young seedling that correlated well with performance of the mature tree. At Petawawa, work began in 1969 on a project to identify such characters and to develop methods for their rapid appraisal in either parent or progeny.

Photosynthetic rate was the first character to be studied. Recently some success has been achieved in selecting superior genotypes of agricultural species by this character. A rapid method of measuring gas exchange of detached shoots of conifers was developed for determining their photosynthetic rates. For the initial study, 10 jack pine provenances were selected from an all-range trial sown in the nursery in 1962. The provenances represented a region from the Northwest Territories to the Atlantic Coast, and they differed markedly in height. The objective was to determine if differences in their photosynthetic rates could be detected, and if so, whether photosynthetic rates were related to height. This initial study demonstrated the feasibility of the technique. Significant differences in photosynthetic rates between provenances were found during only part of the growing season. In 1970, the results were confirmed in a study of jack pine provenances from a field trial planted in 1966.

A preliminary trial using nine jack pine provenances growing in the nursery showed that differences in photosynthetic rates could be detected at the end of the first growing season and that these differences were related to seedling dry weight. However, the small size of the slowest growing provenances and the influence of ground frost on photosynthetic rate caused some problems. Photosynthetic rates will be measured again in the second growing season. Plans are also underway to combine growth acceleration and gas analysis techniques to develop a suitable system for early screening of jack pine provenances.

It is recognized that other factors besides photosynthetic rate determine growth, and not all species could be screened by this character alone. However, for continental provenances of jack pine, gas analysis is showing considerable promise for early screening.

GROWTH ACCELERATION OF TREE SEEDLINGS

D.F.W. Pollard and K.T. Logan

Canadian Forestry Service,
Petawawa Forest Experiment Station
Chalk River, Ontario

The purposes of this project are to define, as closely as possible, the optimum environments for growth of important species of tree seedlings, and to develop culture methods from these definitions for rapid production of seedlings in tree breeding experiments. The emphasis on tree breeding application is manifest especially in the choice of containers, where some of the constraints of regeneration - reforestation techniques (such as container size) are less severe.

Original proposals called for concentrated effort on the manipulation of factors of the aerial environment, in particular temperature, photoperiod and light intensity, and CO_2 concentration.

An automatic irrigation system, designed to supply nutrients and water to seedlings in controlled environments (Pollard 1971), proved to be extremely effective in promoting seedling growth under a range of conditions. In the first experiment, white spruce seedlings attained a total dry weight of 0.7 g and were about 9 cm tall, 12 weeks after sowing; jack pine seedlings weighed 3.9 g and were 12 cm tall. A second experiment demonstrated the importance of rooting medium, but seedlings grew quickly in all the media tested (soil, sands, sand and peat, and "Turface"). In sand and peat and in "Turface", white spruce reached 0.8 g in 12 weeks, and jack pine 5.5 g. Accelerated seedlings grown from May to July and planted directly into a nursery from a growth cabinet in August 1970 survived the relatively severe winter of 1970-71.

The results above have been reproduced in a greenhouse and in large growth rooms. Good growth was obtained in the polystyrene plug moulds recently developed in British Columbia. The automated irrigation system has been adopted by tree breeders for growth cabinet experiments with jack pine, and for greenhouse experiments with white spruce.

Current research is proceeding on two fronts: the elaboration of the nutrient feed principle with special reference to container-planting of tree breeding material; and the original plan to investigate components of the aerial environment. Special attention is to be paid to the timing of seedling acceleration and growth cessation for high survival rate and future growth pattern.

REFERENCE

Pollard, D.F.W. 1971. Automatic watering and feeding of seedlings in controlled environments. Can. Dep. Fish. Forest. Petawawa Forest Experiment Station, Inform. Rep. PS-X-28. 5 pp.

FOREST TREE SEED UNIT, PETAWAWA 1970-71

B.S.P. Wang

Canadian Forestry Service,
Petawawa Forest Experiment Station
Chalk River, Ontario

INTRODUCTION

In forest research and forest practice, it is essential that only seed material of known origin and quality be used for species trials, tree breeding and genetics, or other silvicultural programs. To this end, the Forest Tree Seed Unit at Petawawa provides the Canadian Forestry Service establishments with a central source of information on seed acquisition, a central source of tree seed of known origin and quality for research purposes, and a seed testing service. The information on seed procurement and small quantities of tree seed are available to other research organizations in Canada and other countries. The Unit also carries out investigations into problems of seed extraction, seed quality and standards of testing, and seed storage. The demand for these services has increased steadily since the establishment of the Unit in 1966. This report covers briefly the progress of activities made by the Unit last year.

INFORMATION SERVICES

Twenty requests for information on procurement, collection, treatment, storage and testing of tree seed of native species were received and answered. The number of enquiries for information increased 20% over 1969-70.

SEED PROCUREMENT AND SEED DISTRIBUTION

The 1970-71 seed procurement was very successful, largely due to generous cooperation and assistance given by the Provincial Forest Services; universities; forest industries; the Canadian Departments of Industry, Trade and Commerce, of Agriculture and of Regional Economic Expansion; regional offices and institutes of the Canadian Forestry Service; and the Station staff.

A total of 162 bushels of cones or seeds of *Abies*, *Acer*, *Betula*, *Chamaecyparis*, *Castanea*, *Fagus*, *Juglans*, *Larix*, *Ostrya*, *Picea*, *Pinus*, *Populus*, *Quercus* and *Tilia* were collected from various forest regions of Canada. These seed collections represent 183 lots of 25 tree species from 100 locations. During the same period 25 seedlots of 10 tree species were procured to fulfill special requests for seeds for species trials, provenance research, or exchange. In connection with seed procurement, two important international contacts were made. One was with the State Committee for Forestry of USSR council of Ministers, from which 3.1 kg of *Pinus sylvestris* seeds of Orel, Kiev and Woronesh provenances were procured on an exchange basis. As the three provenances were proven to be growing well in an earlier provenance test at Indian Head, Saskatchewan, and at Chalk River, Ontario (Teich and Holst 1970) part of the seeds was provided to the Tree Nursery of the Department of Regional Economic Expansion, Indian Head, Sask., for use in establishing a seed orchard and to the Canadian Forestry Service at Prince Albert, Saskatchewan. The other contact was made with the Japanese Forestry Agency and a Japanese seed dealer for collecting large quantities of *Larix leptolepis* seeds from natural stands in Nagano Prefecture. After a vain effort to obtain a firm contract with the dealer, the Department of Industry, Trade and Commerce assisted in acquiring the required *Larix* seeds from Japan. The seeds are to be used for tree breeding in the Maritime Provinces.

In response to 69 requests for seeds for research from Canada and abroad, 404 packages of seeds of 54 tree species were distributed to nine countries and within Canada. Although the number of enquiries was only slightly increased over 1968-69, the number of seedlots requested was nearly quadrupled.

SEED EXTRACTION AND SEED YIELD

The Forest Tree Seed Unit's seed extractory processed 446 lots of single tree and bulk collections of which 331 lots were service extractions. Further assessment of soaking effect on seed yield of *Pinus resinosa* cones has confirmed previous findings that presoaked cones yield 43% more seeds by weight and 39% more seeds by number of seeds per cone than the unsoaked ones.

Laboratory germination tests of *Pinus resinosa* and *Picea mariana* seeds extracted from the second and third kiln showed a slower speed of germination than the seeds extracted from the first kiln in some lots although there was no difference in total germinative capacity (viability). This was especially true with seeds extracted from the third kiln. The slower speed of germination of the seeds extracted from the second and third kiln seems to be associated with seed size: seeds are usually smaller and lighter from the second and third kiln.

Seed yield of *Larix laricina*, *Picea glauca*, *Pinus divaricata*, *Pinus contorta* var. *latifolia*, *Pinus resinosa*, and *Pinus strobus* of 1970 collections varied greatly from location to location (Table 1).

An X-ray analysis of seed quality of the 1970 collections of *Pinus strobus* from Wawa, Ontario, and Sandy Lake, Newfoundland showed 85 and 96% of underdeveloped embryo and megagametophyte and subsequently germinated with 20 and 3%, respectively. Collections of cones with such poor quality of seed are not warranted. Embryo development could be checked by X-radiography or dissection before maturity to determine whether mass collection of cones of a given species in a given area is worthwhile. The

Table 1. Mean (range) of yields of filled seed for six species, 1970.

Species	Collections	Weight per bushel, g	Seeds per cone	Weight per 1000 seeds[1], g
Larix laricina	4	227(122-346)	-(-)	-(-)
Picea glauca	14	286(90-396)	18(7-31)	2.34(1.80- 3.37)
Pinus divaricata	17	155(51-213)	22(9-37)	3.37(2.90- 4.06)
Pinus contorta var. *latifolia*	3	120(82-146)	20(18-25)	4.09(3.75- 4.55)
Pinus resinosa	9	278(184-323)	35(26-40)	8.26(7.35- 9.42)
Pinus strobus	9	248(94-516)	34(12-64)	15.90(10.94-18.59)

[1]Weight of 100 seeds was based on 4 x 100 seeds for each seedlot.

underdeveloped embryo and megagametophyte of the *Pinus strobus* seeds may possibly have been caused by severe climate similar to the situation described by Andersson (1965) for some Norway spruce in Sweden.

SEED TESTING AND RESEARCH

In addition to year-round testing of stored tree seeds, 17 service tests were made for various agencies. Further investigation of laboratory germination criteria of *Pinus resinosa* seeds was carried out by a second nursery sowing of six lots and a second laboratory germination test at 25°C constant temperature without light (A.O.S.A. 1965). Two-year findings clearly indicated that the germination of *Pinus resinosa* seeds with vigour classes 1 to 3 after 2 weeks at 25°C constant or 20-30°C alternating temperature was significantly correlated with nursery germination. Studies of laboratory germination criteria of other seeds are also underway.

In some species, early collection does not seem to affect the germination of the seed, yet in other species the reduction in germination might be substantial. Seeds from green catkins of *Betula alleghaniensis* collected 1 month earlier than natural ripening showed nearly 100% germination, but seeds from *Pinus resinosa* cones collected on 24 August, 5 weeks before normal maturity, were not germinable.

Some of the *Picea glauca* seedlots collected in 1970 were tested without stratification and following four weeks cold, moist stratification. All showed definite requirements for stratification for maximum germination. The need for stratification after a period of dry, cold storage will be checked. In the course of routine testing, one seedlot of *Picea glauca* from Harbour Centre, N.S. germinated continuously with curled cotyledons. It is possible that this characteristic could be associated with an edaphic ecotype as there are pockets of calcarious soils in the seed collection area (D.P. Fowler, personal communication). Further lots of *Picea glauca* seeds from the Maritimes (supplied by Dr. Fowler) will be germinated this summer.

Further improvement was made on the accuracy and efficiency of follow-up studies of tree seed by X-radiography by using a combination of a plexiglass germination template and a partially wet Kimpak (K22, Kimberly-Clark products) germination medium. To facilitate counting and observing the germination course of each individual seed, a plexiglass template with holes was devised to hold the seed in its original position.

A feasibility study of germinability of *Quercus* acorns and *Carya* nuts by X-radiography was tested with encouraging results. Further work is planned.

REFERENCES

Andersson, E. 1965. Cone and seed studies in Norway spruce (*Picea abies* (L.) Darst.). Stud. Forest. Suecica 23.

A.O.S.A. 1965. Rules for testing seeds. Proc. Ass. Offic. Seed Anal. 54:71-77.

Teich, A.H. and M.J. Holst. 1970. Early survival and growth of Russian *Pinus sylvestris* L. in Canada. Forest. Chron. 46:453-457.

JACK PINE GENETICS, PETAWAWA, 1970-71

C.W. Yeatman

Canadian Forestry Service,
Petawawa Forest Experiment Station
Chalk River, Ontario

Genetic studies in jack pine have been described in earlier reports to the Committee. Broad geographic variation continues to be of major interest, and more attention is being given to studies of variation among stands within regions and among trees within stands. The best existing sources of seed for reforestation must be found and maintained for seed production to supply the large quantities required as increasing emphasis is placed on direct seeding of jack pine (Scott 1970). At the same time, further improvement will be sought through individual tree selection and breeding on the basis of heritabilities calculated from progeny tests.

In 1970, a controlled environment test of 50 Upper Ottawa Valley jack pine progenies demonstrated significant growth differences at age 3 months among and within stands. Top dry weight was highly correlated with mean seed weight at age 40 days from germination ($r = 0.6$), but not at age 90 days ($r = 0.1$). A three-fold enrichment of CO_2 in the atmosphere increased seedling growth by some 16%, but jack pine responded negatively to a further increase to a five-fold enrichment, as had been found previously. A three-fold CO_2 enrichment has been adopted as a standard practice for genetic tests of pine and spruce in the growth cabinets. The results of the laboratory test can be compared in a few years with data from three field tests of the same progenies planted in 1970-71 between Chalk River and Deux Rivieres, spanning the area of collection.

In a field test of 255 9-year-old jack pine progenies, tree height, cone characteristics, branch angle, and stem form were recorded for 15 progenies. Parent-progeny correlations were significant for cone shape ($r^2 = 0.34$) and cone angle ($r^2 = 0.57$), but not for cone opening, branch angle, stem form, or tree height. Progeny differences in height were significant, however. The results justify evaluation of all progenies in the experiment at age 10 years in 1971.

In the growth cabinets, equipment for automatic irrigation of nutrient solution was installed following the excellent results obtained by Dr. Pollard with this system. After 3 months from germination, dry weight of jack pine and black spruce seedlings were double that obtained by manual irrigation. The test also compared sterilised vs. non-sterilised sand in a sand:peatmoss, 3:1, rooting medium used with the manual irrigation. Better growth was evident in the sterilised medium during the latter third of the 90-day test and was associated with absence or limited development of green algae on top and sides of the soil mass.

X-ray analyses and germination tests confirmed the *in vivo* viability of spruce and pine pollens held in frozen storage over silica gel for up to 13 years. The relative failure of some fresh pollen used as control indicates that initial conditions of collection, extraction and drying are critical for both short- and long-term viability of conifer pollen. A review of genetic studies in jack pine started at P.F.E.S. was completed and will be submitted for Departmental publication.

LITERATURE CITED

Scott, J.D. 1970. Direct seeding in Ontario. Forest. Chron. 46:453-457.

SEED ORCHARDS AND SEED PRODUCTION AREAS IN ONTARIO

W.G. Dyer and K.C. Eng

Ontario Ministry of Natural Resources
Toronto, Ontario

SEED ORCHARDS

Two new seed orchards have been established in the past year. At Orono Nursery, silver maple clonal material was set out representing 12 superior phenotypes selected by H.C. Larsson in southwestern Ontario.

In Pearson Township, Thunder Bay District, an initial out-planting consisted of 285 ramets of 8 clones of white spruce selected in Site Region 4W.

The white and black spruce seed orchard at Camp 503, Thunder Bay District, was enlarged and now contains 18 blocks of white spruce and 16 blocks of black spruce, each block containing 144 trees.

The grafting programme at Angus for the 1970-71 season is summarized as follows:

Species	Total grafts	Clones	% Survival in greenhouse
White Spruce	1798	19	86%
Black Spruce	995	13	94%
White Pine	903	4	95%

To rationalize the supply of grafts to seed orchard planting, the number of grafts made from each clone was set at 100. The white pine grafts were made for the Phytotoxicology section of the Department of Energy and Resources Management for fume damage study.

PROGENY TEST

Second-year heights were measured in the unreplicated 1-parent progeny test of the timber type and Faulkner Scots pine sown in 1968 in Midhurst nursery. In both series, there were fair correlations between the first and the second year height. For example, in the timber type series, the shortest clone (#56) in the first year remained the shortest in the second year. The tallest clone (#173) in the first year was the tallest in the second year. The needle color of all the Faulkner clones was obviously greener than the timber type series. The Faulkner seedlings were distributed to a group of Christmas tree growers to plant out for further observation.

REPRODUCTIVE PHENOLOGY

In the spring 1970, reproductive phenology in the 3E black spruce seed orchard in Vespra Township was observed and recorded. The developmental sequence followed the pattern observed in 1969 and 1970. There was a fair crop of male flowers this year, as indicated by the following example:

Clone	Trees flowering	Male flowers	Female flowers
345	32	3691	174
440	14	2010	13
498	26	1095	69
344	21	982	53
346	17	773	22
499	15	738	451
388	5	539	19

Pollen was collected from these clones and turned over to the staff of the Tree Breeding Unit in the Research Branch who bagged the female flowers in this area and pollinated them with some of the local pollen.

SEED PRODUCTION AREAS

Red Pine

Two red pine seed production areas were established in the past year.

A 12-acre plantation in Clarence Township, a part of Larose Forest, Kemptville District and a 9-acre plantation at Orono Nursery were selected. Thinning and roguing have been carried out in both of these areas.

In the fall of 1970, 99 bushels of cones were collected from 510 trees in the red pine seed production area at Lynn Tract. This year, seasonal pickers were employed instead of using inmates and picking was going on 7 days each week. A modified pay scheme was tried out in which every picker was paid $1/hour for an 8-hour day and 1¢/cone. The Department-owned Uppups were used alongside with ladders for picking. Cones collected from each tree were kept separate and later counted and recorded. Number of cones from individual trees ranged from 17 to 960 (Tree #504). Although the average picking cost per bushel at $24.47 was more or less the same as that in 1969 ($24.16), we were able to pick all the cones before they started to open.

Also a total of 68 bushels of cones were picked from the timber type Scots pine seed orchard. It was noticed that cones from this orchard were usually smaller than those from general collections. The clones ranged from 1500 to 4500 cones per bushel. All trees in clone No. 95 persistently produced extremely small cones with an average cone volume of

4.1 cc. Two clones noted for the large cones they produced in 1967 also had larger cones in 1970 (9.3 and 9.4 cc., respectively). One clone rated as having small cones in 1967 was next to the smallest (4.9 cc.) in 1970.

A total of 532 bushels of cones were collected in 1970 from seven seed production areas and two seed orchards. The most productive of these was a 258 bushel collection from the 10-acre red pine seed production area in Haldimand Township, Lindsay District. It is estimated that 400 bushels could have been collected if all the trees had been picked.

White Spruce

A 1964 collection from the seed production area, Gurd Township, Parry Sound District yielded 90 bushels. All the white spruce seed sown at Midhurst, Orono and Kemptville nurseries for production of Site Region 5E stock in the fall of 1967, came from this source. In the spring of 1971, 5,000 super-seedlings were selected from the total production at the three nurseries. Minimum height for selection was 17 inches at age 3-0. The super-seedings were outplanted in Gurd Township to expand the seed production area there.

Jack Pine

There is a problem in collecting jack pine cones from standing trees. Damage to new growth by removal of the cones and the probability of only being able to make a collection every 3 to 5 years has discouraged the development of seed production areas. After discussion with Dr. C.W. Yeatman, it was agreed that the only practical method of jack pine cone collection is by the partial felling of selected plus stands and the regeneration of the cut portions with seed or stock from the same source. A number of superior stands are to be selected as seed collection areas. The first of these has been selected near Burchell Lake, Thunder Bay District. The method will require separation of the various seed lots representing superior stands and will permit the assessment of stand-to-stand variation in future outplantings.

Seed Collection

A record quantity of more than 25,000 bushels of cones and rough seed was collected in 1970. Of particular note was the collection of 8,350 bushels of red pine cones which more than overcame the serious shortage of red pine seed in storage.

On 1 April 1971, the metric system was instituted for measuring cones and rough seed. Containers holding 40 litres were distributed to all field offices. Although the 40-litre container is used for measuring quantities, all records will be in hecolitres (100 litres).

THE CONTRIBUTION OF GENETIC VARIATION TO PRODUCTIVITY SYSTEMS IN SPRUCE FOREST ECOSYSTEMS

A.G. Gordon

Ontario Ministry of Natural Resources,
Research Branch,
Sault Ste. Marie, Ontario

The objectives of this work are:

(a) to illucidate the contribution of species, forms, provenances, and hybrids in productivity systems;

(b) to collect and interpret information on genetic variability, crossability and heritability in regard to genecology and phylogeny of the genus *Picea*;

(c) to evaluate the effect of seed zones (site regions) in productivity systems; and confirm the validity of the limits of movement of spruce stock between regions.

GENECOLOGY

A study has largely been completed on the genecology of *Picea rubens*, and the variation in *P. rubens* as it comes in contact with *P. mariana*. Character coding of a range-wide sampling of *P. rubens* through several years has been completed and is currently being analysed. The extent of hybridization of *P. rubens* with *P. mariana* and the variation within *P. rubens* isolates is being examined. Comparisons have been made with the composition of mature stands and that of the regeneration for all sites. Plot systems cover all moisture regime sites to the limit of *P. rubens* occurrence and a good coverage of *P. mariana*. Data has been collected on ground vegetation, cover type, light, pedological and chemical characteristics of the sites, and vegetation.

Progeny of selected range-wide populations have been established in a small number of provenance experiments on different sites, and reciprocal crossing (not always successful) has been carried out. Hybrid progeny from selfing, and back-crossing hybrid types have been planted out.

PICETA

Studies are underway to evaluate growth and efficiency, nutrition, etc., of a large number of spruce species, forms, and provenances across a wide climatic range. Experimental spruce plantations called "Piceta" have been established on a complete range of all major climatic zones (Ouellet & Sherk 1967) in Ontario. One Picetum has been established in British Columbia in co-operation with the Research Division, B.C. Forest Service.

Seed zones in Ontario were delineated a number of years ago by A.J. Carmichael and the Tree Production Unit of the Timber Branch, and were largely based on the very definite, edaphic and climatic synthesis of G.A. Hills (1954). These zones are not incompatible with the climatic zones of Ouellet & Sherk (1967). Included in the Piceta are complete collections of *P. glauca* and *P. mariana*, representative of these zones, and reciprocally planted. Also included are a range of the rather discrete forms of *P. glauca* for subsequent heritability studies. *Picea mariana* exhibits more continuous variation.

Most of the Piceta have been established in the last 3 years, but a small preliminary one, set out in 1961, is already becoming available for interspecific crossing studies. Our crossing work has previously been done on separated individuals or groups of trees. A distinct advantage of most of the present stock in the Piceta is that they are from collections made in natural stands with known parent and stand data, thus providing opportunities for good estimates of heritability.

While the original collection and establishment of such material has been laborious and time consuming, the advantages are abundant. A whole array of spruce species, genotypes, phenotypes, etc., are becoming available for comparative morphological, physiological, and genetic studies in replicated plots, on carefully selected, uniform sites, under a wide range of climatic parameters. Timing for pollen collection, pollination, etc., and data collection can be more readily facilitated when the species and types are growing in close proximity under the same conditions. Maintenance is simplified since it may be concentrated on a few areas rather than scattered on a number of small experiments. Piceta have the disadvantage that much valuable material is concentrated in a few places if pest or other problems develop.

PROPAGATION AND GROWTH TECHNIQUES

Finally, a very limited amount of work is done on propagating and growth techniques. We have developed methods involving artificial temperature and day-length regimes to produce spruce stock from seed which is equivalent to 3-year-old nursery stock and suitable for out-planting in from 12 to 18 months. We have produced more than 70,000 experimental seedlings to date by these methods. We have also had some limited success with rooting techniques with several species.

REFERENCES

Hills, G.A. 1954. Field methods for investigating site. A. The detailed site description form. Ontario Dep. Lands Forests, Res. Div., Site Res. Man. 4.

Ouellet, C.E. and L.C. Sherk. 1967. Map of plant hardiness zones in Canada. Can. Dep. Agr.

SITE PREPARATION, SELECTION AND TREE BREEDING FOR THE ESTABLISHMENT OF HIGH QUALITY HARDWOOD SPECIES IN THE SWAMPS OF SOUTHERN ONTARIO

C. Larsson

Ontario Ministry of Natural Resources,
Research Branch,
Maple, Ontario

The objectives of the South Western Ontario Research Unit are the development of practical techniques for the selection, mass production, establishment and culture of fast growing veneer-quality phenotypes of the commercially important hardwood species in the lowlands and uplands of southern Ontario.

SITE PREPARATION

Mounding

Site preparation studies started in the fall of 1969 in the Luther and Elderslie swamps were continued in the autumn of 1970 in the Elderslie and Minesing swamps and on bottomland in the vicinity of Lake Simcoe. The mounding was done by a plow designed by the Kemptville District. This implement was pulled by either a D-4 or a Bombardier Muskeg model M tracted vehicle. The furrows were spaced about 3.1 m (10 ft) apart which is at present considered adequate for swamp hardwoods. Time studies have indicated that it is possible at such a spacing to prepare 1 acre/hour under scrub willow conditions at a cost of from $15.00 to $25.00 per acre. Assuming 20 working days per month such equipment could prepare 150 acres in that period.

Initial results of planting silver maple, Jackii poplar, and European willow in the spring of 1970 have indicated that this form of site preparation is suited and ideal for some swamps in southern Ontario. The Research Branch in cooperation with the Lake Huron and Lake Simcoe Districts is now building a modified model of the mounding plow which should be very effective in heavy shrub growth.

Drainage

Some of the swamps in the Southwestern Region have impeded drainage which prevents or partially prevents the normal growth of trees. A small drainage experiment was attempted in a stagnant swamp by preparing a ditch using ditching dynamite (Forcite 50%). About 45 m (150 ft) of ditch, 1.8 m wide and 0.9 m deep (6 ft x 3 ft was satisfactorily blown at a total material cost of $29.35. The operation took 2 men 2 hours to complete at a cost of $10.00 which gave a total expenditure of $39.35. This is slightly more expensive and less thorough than ditching with a 17-ton hydraulic back hoe which completed 305 m (1000 ft) on the same site at a total cost of $240.00. Dynamite is particularly effective in extremely wet conditions and is more economical than using heavy ditching equipment. Silver maple and willow were unable to grow satisfactorily in this swamp before ditching, but after ditching they grew up to 84 cm (33 inches) in height the first year.

SELECTION, PROPAGATION AND ESTABLISHMENT OF FAST-GROWING, VENEER-QUALITY, SWAMP SPECIES

Silver Maple

A second 9.1 x 1.2 m (30 x 4 ft) misting bed was built alongside the first bed permitting one misting control unit to service both beds. A total of 2,826 silver maple cuttings from 13 phenotypes were planted in the two beds.

The rooted material will be transplanted to the nursery in the spring of 1971 to build up the stooling bed at Maple and for planting in the main swamps of southwestern Ontario in the spring of 1973.

Most of the silver maple progeny produced in 1968 by the controlled crossing of seven selected parents from three populations were planted in the spring of 1970 in the Ellice, Beverly, Luther, and Elderslie swamps. There was considerable variation in the number of trees per progeny (8 - 168) as well as in the height within progenies, 0.6 to 1.8 m (2 to 6 ft). Half of each progeny were planted with roots and half had their roots removed leaving only the root zone.[1] There was excellent growth and survival of both types of planting stock in the swamps.

Height measurements were taken of the 1969 silver maple progeny produced by crossing eight parents from three populations. There was a total of 811 silver maple seedlings which varied in height from 0.6 to 1.8 m (2 to 6 ft) at the end of the second growing season. In addition 93 red x silver maple hybrids produced by crossing one tall merchantable high-quality female red maple with three select silver maple males ranged in height from 0.3 to 1.2 m (1 to 4 ft) at the end of the second growing season. All 1969 progeny will be field planted in the spring of 1971.

Eastern Cottonwood and Jackii Poplar

Five, fast-growing, lumber-type eastern cottonwood and five Jackii poplar were reproduced by hardwood cuttings in the spring of 1970. Cool, dry conditions during the early part of the growing season severely reduced rooting success. However, there will be sufficient rooted stock available to plant one cottonwood and two Jackii poplar clones in the Luther, Elderslie, and Minesing swamps and on bottomland in the vicinity of Lake Simcoe in the spring of 1971.

---

[1]Root zone is defined in this report as the central axis of the root system which supports the laterals.

Twenty rooted cuttings of the Jackii poplar (GrJ - 6) were planted directly in the Ellice and Beverly swamps and on mounds in the Luther and Elderslie swamps. Growth and survival of both rooted and unrooted tree-length cuttings were tested and observations indicated little difference in growth and mortality at the end of the first growing season between the rooted and the unrooted stock.

A total of 5,200 cuttings were prepared in the late fall of 1970 from five eastern cottonwood and five Jackii poplar clones. They were put in bundles of 25 and half were buried in sand and the other half in a mixture of sand and vermiculite. They will be planted in the spring of 1971.

European Willow

The 15 clones of unrooted European willow cuttings which had been planted in the spring of 1969 in a pure plantation and in a mixture with silver maple, were severely girdled by mice in the winter of 1969-70. Over half of the cuttings had to be replaced in the spring of 1970. Those which had not girdled were from 2.4 to 3.7 m (8 to 12 ft) tall at the end of the second growing season. Seventeen clones will be planted in the Luther, Elderslie, Minesing, Beverly, and Puslinch swamps as well as on bottomland on the south-east shore of Lake Simcoe in the spring of 1971.

Silver Maple Breeding Studies

The silver maple breeding program in 1970 was restricted to crossing only two silver maple and one reciprocal cross between red and silver maple. The cross between the female red maple and the silver maple male was significantly more successful than the reciprocal cross of the two parents.

Rodent and Deer Repellent Tests

Creosote treatments ranging from 5 to 50% by volume in mineral oil were effective against mice for 1 year after application. It was not possible to assess adequately the effects of this repellent on rabbits as they were at the bottom of their population cycle. A danger in using creosote is absorption of heat from the sun. It was noted that under full exposure the black creosote will build up the heat from the sun's rays and will kill the cambial layer on the south and west sides of the treated tree. The tests were continued in 1970 on silver maple and willow in the Ellice and Luther swamps using a mixture of alum, lanolin and mineral oil. It is hoped that this repellent will be effective for at least 3 years.

SPRUCE PROGRAM AT THE SOUTHERN RESEARCH STATION MAPLE, ONTARIO IN 1970

R. Marie Rauter

Ontario Ministry of Natural Resources,
Research Branch,
Maple, Ontario

The objectives of this long-term program have remained essentially the same as given in the last report, although progress in the program has permitted more emphasis to be placed on the preparation for the establishment of field tests.

As new hybrids are obtained, it becomes possible to compare their performance and relate this to the planting stock currently used. Several experiments were started last winter and preliminary nursery measurements for some of the hybrids are favourable, but field performance will be the criterion used to judge their value.

Since we produce many interspecific hybrids, it is necessary to confirm the hybridity of these trees. Some method must be devised which can readily identify a species or hybrid at an early age. At present, examination of cross-sections of primary needles seems promising.

The vegetative propagation trials have produced good results in rooting. It is now desirable to know how the rooted cuttings perform in the field, i.e. what kind of trees they will produce when raised as timber trees, and how they will compare to grafted stock when the cuttings are raised for breeding material. Rooted cuttings from several spruce species are presently being observed in the nursery and some will be ready for field trials in two years.

New Acquisitions

During the early months of 1970, the following seed lots were obtained: one population of *Picea schrenkiana* from Czechoslovakia, one population of *P. spinulosa* from Sikkim, India, one of *P. omorika* from Poland, three of *P. abies* and two of *P. omorika* from Yugoslavia, and two populations of *P. mariana* were received from Newfoundland. Recently, we acquired one population each of *P. abies, P. sitchensis* and *P. breweriana*.

Scions of five winter-hardy and weevil-resistant clones of *P. abies* were received for grafting from Petawawa. Scion and cutting material collected from Massachusetts consisted of 12 clones of *P. abies,* 6 clones of *P. glauca,* 15 clones of *P. glauca* interspecific hybrids, 6 clones of *P. omorika,* and 14 clones of *P. omorika* interspecific hybrids.

Hybridization

Parentage	Female clones	Cones	Seeds Full	Seeds Total
		CROSSES MADE IN 1970		
P. glauca x *pungens*	4	87	24	4059
P. glauca x *engelmannii*	4	68	167	3748
P. glauca x *koyamai*	4	39	0	2572
P. glauca x *abies*	4	74	0	5426
P. glauca x *omorika*	4	89	0	5495
P. glauca x *mariana*	4	101	0	4974
P. abies x *mariana*	4	26	0	6463
P. abies x (75% *mariana* x 25% *rubens*)	5	26	18	7012
P. abies x (25% *mariana* x 75% *rubens*)	5	26	0	6197
P. abies x *rubens*	4	19	0	4732
P. abies x *glauca*	4	19	0	4157
P. abies x *koyamai*	2	13	69	3110
P. schrenkiana x *engelmannii*	2	11	0	3117
P. schrenkiana x *pungens*	2	12	63	3107
P. mariana x *mariana*	4	104	433	4121
P. mariana x (75% *mariana* x 25% *rubens*)	4	73	82	1831
P. mariana x (50% *mariana* x 50% *rubens*)	6	113	85	2935
P. mariana x (25% *mariana* x 75% *rubens*)	6	111	35	3289
P. mariana x *rubens*	5	115	0	1802
P. mariana x *koyamai*	1	52	0	1438
P. mariana x *omorika*	7	87	6	2547
P. mariana x *glauca*	4	122	0	3543

Progeny Tests

All of the 1969 hybrid seed was sown. Those populations having a sufficient number of viable seed were put into randomized replicated experiments. One-parent progeny material obtained from several open-pollinated black spruce plus trees throughout Ontario was also used in three of the four experiments. These were established in January 1970 and height measurements first taken in August 1970.

In the first replicated experiment, there were four populations of *P. glauca* x *sitchensis*, three of *P. glauca* x *jezoensis*, and one control population of *P. glauca* whose seed was obtained from a general collection. The *P. glauca* x *jezoensis* populations averaged 4.57, 4.85, and 5.36 cm in height; the *P. glauca* control 4.87; and the *P. glauca* x *sitchensis* populations averaged 6.10, 6.62, 6.76, and 7.06 cm.

In a second replicated experiment of *P. mariana* x *mariana* and *P. mariana* x *rubens* hybrids, two intraspecific crosses of *P. mariana* were much taller than the remaining populations with heights averaging 12.00 and 11.25 cm. The female parents for these crosses were plus trees from Ontario with the male pollen from Newfoundland. The bulk seed lot of black spruce which was used as a control did quite well as the height averaged 8.88 cm. Five one-parent progeny seed lots from selected plus trees were also used in this experiment and the seedlings produced were the five shortest populations with average heights ranging from 5.58 cm to 6.92 cm. The hybrid of *P. mariana* x *rubens* was intermediate.

The third experiment using only one-parent black spruce plus tree progeny produced significant height differences among the ten populations. The average heights ranged from 6.66 cm to 8.52 cm.

The fourth experiment also consisted of plus tree progeny, but the seed was divided into three seed classes. An analysis of variance indicated that there were differences due to different populations, but no difference due to the seed size class.

Several of the same plus tree progeny populations were used in the three latter experiments. When their measurements were compared, the actual heights between experiments varied considerably, but their order of dominance was very similar.

The above results are based strictly on greenhouse conditions. Undoubtedly, many changes will occur in subsequent nursery and field performance.

Variation Study

The 2-year-old seedlings in the black spruce ecotype study were measured last summer and their heights compared to the material which was started in 1963. To date, there is no correlation between this set of measurements and that taken in the past. The seedlings were planted in the Maple nursery and several characteristics are being examined starting this year. Two features which are being recorded are time of bud break and bud dormancy and their relationship to height growth.

Morphological Study

Primary needles from seedlings of various available spruce species and hybrids were removed, embedded and sectioned. The cross-sections of these needles will be examined microscopically to determine whether the seedlings can be identified by this means, and then to determine whether the putative hybrids obtained in our crossing program can be confirmed as hybrids. Cursory examination of the sections to date seem promising. As seedlings of different hybrids become available, we will continue to examine the cross-sections of primary needles and try to build a reference collection of material.

Vegetative Propagation

In February 1970, cuttings were taken from 15-year-old spruce trees in Massachusetts from which we also collected scions. These cuttings were put into rooting experiments and those rooted will be outplanted and the development of these cuttings compared to the grafts of the same clone. Rooting percentages for this material 7 months after the establishment of the experiment appear quite low. Part of the reason for this is probably the time of year the cuttings were collected. Rooting of *P. omorika* populations varied between 4 to 71%, the overall percentage was about 30%. *P. omorika* x *orientalis* averaged 28%, and *P. omorika* x *Koyamai* averaged 53%. *P. abies* populations varied between 5 to 80% and averaged 41%. *P. glauca* and its hybrids with *P. jezoensis* and *P. engelmannii* had a population rooting range from 0 to 100% with the average about 35%. Little difference in rooting percentage was noted between *P. glauca* and either of the two hybrids. These results indicated that rooting ability is dependent upon the ortet rather than a particular species or hybrid.

Five *P. abies* ramets were collected in April from the same populations as the February material. The rooting percentage for these varied between 29 and 92% and averaged 56% after 5 months. In this instance, spring collections did produce better results, at least under the given conditions.

One white spruce and one black spruce experiment were established in May to determine whether beneficial results would be obtained if indole butyric acid (IBA) were used as a rooting hormone. In a 15-year-old white spruce seed production area, 2000 cuttings were collected from 20 trees. When cuttings were dipped in captan, rooting was 64% and IBA, 54%. Rooting of clones varied between 30 to 92%. In a single 5-year-old population of black spruce, 500 cuttings were taken from 10 trees. When cuttings were dipped in captan rooting was 42% and in captan and IBA, 58%. Rooting of clones varied from 8 to 88%. These two experiments indicate that the same treatment has different effects on the different species. The white spruce material, even though it was 10 years older than the black, attained a higher overall rooting average than the black spruce material.

During the past year, cuttings which rooted from 267 trees were cloned. The performance of these will be observed in the nursery. Many will be outplanted as comparative material for either grafted or seedling stock.

POPLAR AND PINE BREEDING AT THE SOUTHERN RESEARCH STATION, MAPLE, ONTARIO IN 1970

L. Zufa

Ontario Ministry of Natural Resources,
Research Branch,
Maple, Ontario

POPLARS

The work concentrated on the propagation and field testing of the best selections of hybrid poplars and native poplars. A major pilot project was initiated in co-operation with our Timber Management Branch for testing poplars for pulpwood production in short rotations in southeastern Ontario.

New Acquisitions

Seeds from a total of 30 populations of *Populus tremula, P. nigra, P. canescens, P. alba, P. trichocarpa* and *P. tremuloides* were received from Finland, France, Czechoslovakia, Hungary, Yugoslavia, Italy, British Columbia, and Northern Ontario.

Cuttings of 65 trembling aspen, largetooth aspen, cottonwood, and balsam-poplar clones were acquired from Wisconsin, New Hampshire, Newfoundland, and Ontario.

Selection

Many of the new aspen hybrid clones demonstrated excellent growth and satisfactory rooting ability. After 3 years of propagation and observation in nursery, the best 58 were selected for larger scale propagation and field testing. The stems of 1-year-old plants, raised in the Maple nursery, were straight and clean and had attained heights of 12 to 14 ft (4 to 4.5 m).

Hybrid and native cottonwood clones of Maple and European origin were kept under observation in plantations and nurseries. Of these clones, 60 were selected for further testing.

Selection for the Boreal Forests of Ontario

Work is underway to develop winter-hardy cottonwood and hybrid aspen clones which possess good rooting ability of the stem cuttings for the Boreal forests of Ontario.

The work was started at the Swastika and Thunder Bay nurseries where hybrid cottonwoods of European origin (Euramerican poplars) were tested for winter hardiness. All of the tested poplars suffered frost damage.

In the spring of 1970, 8000 cottonwood seedlings were planted in the Swastika nursery for winter hardiness testing. The seedlings originated in the Prairie provinces under conditions similar to those in the Boreal forests of Ontario, where cottonwood does not exist.

The winter-hardiness testing of the best new cottonwood and hybrid aspen clones developed at Maple was started.

The winter-hardy poplars will be propagated by cuttings and field tested in the Boreal forests of Ontario.

Hybridization

Parentage	Crosses made Successful	Unsuccessful	Total
P. (*tremuloides* x *tremula*) x *Jackii*[1]	0	3	3
P. (*tremuloides* x *tremula*) x *deltoides*[1]	0	1	1
P. deltoides x *Jackii*	3	0	3
P. deltoides x *nigra*	1	0	1
P. deltoides x *tremuloides*[1]	0	2	2
P. nigra x *Jackii*	0	2	2
P. nigra x *deltoides*	0	2	2
P. nigra x *balsamifera*	1	1	2
P. nigra x *trichocarpa*	1	0	1
P. alba x *grandidentata*	2	0	2
P. alba x *tremuloides*	2	0	2

[1]Irradiated intermediate pollen was used in these crosses.

Vegetative propagation

Propagation stools of the selected hybrid aspen and cottonwood clones were started in nurseries to produce planting stock for field testing.

Field Experiments

Euramerican poplar clonal tests were established in Kemptville and Lake Simcoe Districts with rooted cuttings in the spring of 1969. The objective was to select the best clones which would grow into pulpwood trees in 5 to 7 years. The 2-year-old plantations show promising development. In Lake Simcoe District plantation, the trees of the best clones reached 12 ft (3.7 m) in height and 1.5 in. (3.8 cm) in dbh. If this rate of growth is maintained the objectives for these plantations should be realized.

A pilot project was proposed to the Timber Branch for a larger scale test planting with similar objectives. The proposal was accepted.

Two more clonal tests of Euramerican poplar clones were established in the spring of 1970 using unrooted cuttings. At the end of the first growing season, more than 90% of the out-planted cuttings survived and the best clones attained an average height of about 2 ft (61 cm).

Seedlings of selected native and hybrid aspen strains were planted in comparative field tests at Pembroke and Swastika Districts in the spring of 1970. The expected rotation is 20 to 30 years. At the end of the first growing season the southern provenance (Maple) of *P. tremuloides* and the *P. tremuloides* x *sieboldii* hybrid were the best at Swastika, and the *P. alba* x *sieboldii* hybrid was the best at Pembroke. The average first-year height growth of the best strains was about 16 in. (40 cm).

Plantations of Poplar Exotics

A plantation of *P. alba* and *P. canescens* provenances of Hungarian and Italian origin and a plantation of interspecific hybrids, originating from more than two aspen species, some of which are extoics (multiple aspen hybrids, such as *P. alba* x *grandidentata* x *sieboldii*), were established in Kemptville District on National Capital Commission land (Ottawa Greenbelt). The objective is to maintain a gene pool of exotic species and hybrids and to test and select the best provenances and individual trees for future breeding and vegetative propagation.

WHITE PINE

The work concentrated on developing and testing *Pinus griffithii* x *strobus* hybrids, on vegetative propagation and on blister rust testing of the progenies of putatively resistant trees.

Significant progress was made in vegetative propagation of white pines. Good rooters were found among the tested trees and the development of white pine clones can now be expected.

Acquisitions

Scions of four *Pinus avacahuite* x *strobus* clones were obtained from Yale University Arboretum and grafted.

Seeds of *P. gerardiana*, *P. griffithii*, *P. pentaphylla* and *P. Koraiensis* were acquired from Japan, India, and U.S.A.

Hybridization

Parentage	Crosses	Seeds Total	Seeds Full
CROSSES MADE IN 1969			
P. griffithii x *strobus*	13	4636	1124
P. strobus x *griffithii*	4	820	0
P. strobus x (*griffithii* x *strobus*)	4	595	294
P. (*griffithii* x *strobus*) x *strobus*	5	2882	935
P. (*griffithii* x *strobus*) x (*griffithii* x *strobus*)	5	1642	580
CROSSES MADE IN 1970		Cones	
P. griffithii x (*peuce* x *strobus*)	5	23	
P. griffithii x *griffithii*	18	188	
P. peuce x (*griffithii* x *strobus*)	4	27	

Pollen of *P. griffithii* was received from U.S.A. *P. griffithii* trees were pollinated with *P. strobus*, *P.* (*peuce* x *strobus*), and *P. griffithii*; *P. peuce* was crossed with *P. griffithii* x *strobus*. The pollinated *P. peuce* (Balkan Pine) demonstrated weevil resistance in the Thessalon test. *P. griffithii* (Himalayan Pine) is known for blister rust resistance. The aim is to combine these properties and produce vigorous hybrids that are resistant to weevils and blister rust.

The hybrid seed obtained in 1969, which represents *P. griffithii* x *strobus* crosses and back-crosses, is being used for blister rust resistance and hybrid vigour testing in nursery and field conditions.

Blister Rust Resistance Testing

The regrafting of the putatively resistant *P. strobus* trees from the Connaught Ranges plantation, which was started earlier, is now completed. In 1970 alone, the blister rust inoculations of these grafts in our nursery disclosed 15 more susceptible trees. After the second thinning of the Connaught Ranges plantation in 1969, there were 129 putatively resistant *P. strobus* trees left. To date, 99 trees were found blister rust susceptible, 6 died of other causes, and 24 are left.

A partial survey of the data on blister rust testing of *P. strobus* progenies in the nursery was accomplished (Table 1). In nursery conditions, repeated blister rust inoculations of the 2- to 3-year-old seedlings and an observation period of 4 to 5 years were needed to reveal the resistant portion of the tested progenies (Table 2).

The progenies of *P. strobus* and its interspecific hybrids, raised and inoculated in tubes in 1968, were tallied for blister rust infection (stem cankers). Two replicated tests were analysed. In the first, significant differences were found between progenies as well as between replications. In the second, significant differences were found between the progenies while the variance due to the replicates was small. This means that the reliability of the technique of inoculation is still questionable.

The percentages of surviving (healthy) *P. strobus* seedlings after 2 years compared well to the percentages observed at the age of 7 years for populations raised and inoculated in the nursery (Tables 1 and 3). The blister rust testing of 1-year-old seedlings thus appear justified. Combined with the applied method of nursing, it results in a considerable shortening of the time for blister rust resistance testing.

The resistance of the *P. strobus* progenies did not relate to the putative resistance of their parent trees (Table 1). *P. strobus* trees with good blister rust transmitting ability were not detected in these tests.

The progenies of F_1 crosses and back-crosses of *P. griffithii* x *strobus* were blister-rust resistant to a higher degree than the progenies of *P. strobus* crosses. Significant differences appeared in the resistance transmitting ability of the parent trees in the test. The best results (40 and 44% of resistant off-spring) were obtained in two *P.* (*griffithii* x *strobus*) x *strobus* (Table 3).

The higher degree of blister rust resistance of *P. griffithii* x *strobus* crosses is often combined with vigorous juvenile growth. Therefore, further efforts appear to be justified with these hybrids.

Vegetative Propagation

In 1968, 1969 and 1970, several rooting trials were established with cuttings, needle facicles and fascicular shoots of *P. strobus* and *P. griffithii* x *strobus* trees.

The rooting of the same trees in different trials gave a good indication of the rooting ability and resulted in the selection of good-rooting types (Table 4).

Large variation in rooting was observed. The variation in rooting in subsequent years was probably due to the seasonal variations. It is hoped that perfection of the technique will result in better rooting of these ortets.

Table 1. Survey of data on blister rust testing of *Pinus strobus* progenies in the nursery.

Length of test, years	Total progenies tested	Parent trees putatively resistant								
		Both			One			Neither		
		Progenies tested	Resistance, %		Progenies tested	Resistance, %		Progenies tested	Resistance, %	
			Range	Mean		Range	Mean		Range	Mean
5	28	5	0	0	8	0- 2	0.3	15	0	0
3	12	6	1-13	5.3	6	4- 7.5	6.4	-	-	-
2	11	2	15-27	21.0	5	16-26	21.5	4	15-39	23.0
1	22	13	0-26.5	18.4	8	0-28.5	14.0	1	21	21.0

Table 2. The blister rust diseased portion of *Pinus strobus* seedlings in a 5-year observation period (approximate values).

Years since initial inoculation	Blister rust diseased seedlings, %
1	0
2	30
3	80
4	96
5	99

Table 3. Blister rust resistance of *Pinus strobus* and *P. griffithii* x *strobus*

Origin	Progenies tested	Seedlings tested	Blister rust resistance of progenies tested, %	
			Range	Average
P. strobus x *P. strobus*	31	4167	0–12	1.3
P. griffithii x *P. strobus*	11	917	0–19	7.8
P. griffithii x *P.* (*griffithii* x *strobus*)	7	352	0–26	11.1
P. (*griffithii* x *strobus*) x *P. strobus*	5	341	0–44	25.8
P. (*griffithii* x *strobus*) x *P.* (*griffithii* x *strobus*)	5	102	12–37	23.5

Table 4. Rooting of white pine clones

Clonal No.	Origin of tree	Age, years	Blister rust resistance tested	Rooting of propagules, %		
				1968	1969	1970
5-834	*P. griffithii* x *strobus*	15	yes	57	–	55
5-848	*P. griffithii* x *strobus*	15	yes	57	8	39
WP863-12	*P. strobus*	6	yes	–	25	52
WP864-15	*P. strobus*	6	yes	–	42	30
WP865-4	*P. strobus*	6	yes	83	20	67
WP980-5	*P. griffithii* x *strobus*	6	yes	100	–	20
WP1000-2	*P. griffithii* x *strobus*	6	yes	58	–	63
WP1085-5	*P. griffithii* x *strobus*	3	no	60	–	100
WP1087-4	*P. griffithii* x *strobus*	3	no	100	80	75
WP1087-7	*P. griffithii* x *strobus*	3	no	60	–	31
WP1092-7	*P. strobus*	3	no	80	–	40
WP1101-5	*P. griffithii* x *strobus*	3	no	50	–	29

HARD PINES

Selection and Breeding

Seedlings were raised of the crosses made in 1968. The attempts to produce interspecific hybrids of *P. resinosa* by using irradiated red pine pollen as intermediate gave viable seed in one *P. resinosa* x *P. nigra* combination. Two seedlings were produced. The authenticity of the hybrid remains to be proven.

The *P.* (*densiflora* x *sylvestris*) x *nigra* crosses gave abundant viable seeds, while the *P.* (*nigra* x *densiflora*) x *sylvestris* and the *P. tabulaeformis* x *leucodermis* crosses were unsuccessful.

The crosses made in 1969 were analysed. All interspecific crosses failed, except one *P. resinosa* x *densiflora* cross, which yielded one viable seed.

In 1970, the previously successful *P. resinosa* x *nigra* and *P. resinosa* x *densiflora* cross were repeated and further attempts were made to produce interspecific hybrids of *P. resinosa*.

Hybridization

Parentage	Crosses	Cones	Seeds Full	Seeds Total
CROSSES MADE IN 1969				
P. resinosa x *resinosa*	11	30	502	727
P. resinosa x (*nigra* + *resinosa* irradiated)	8	17	0	62
P. resinosa x (*densiflora* x *sylvestris* + *resinosa* irradiated)	10	33	0	164
P. resinosa x (*sylvestris* + *resinosa* irrad.)	7	0	0	0
P. resinosa x (*densiflora* + *resinosa* irrad.)	7	14	1[a]	70
CROSSES MADE IN 1970				
P. resinosa x (*densiflora* x *austriaca* mixed x *resinosa* irradiated)	1	7		
P. resinosa x (*densiflora* x *sylvestris* mixed x *resinosa* irradiated)	1	5		
P. resinosa x (*nigra* x *sylvestris* mixed x *resinosa* irradiated)	1	4		
P. resinosa x (*nigra* mixed + *resinosa* irradiated)	1	10		
P. resinosa x (*densiflora* mixed + *resinosa* irradiated)	1	4		
P. resinosa x *resinosa*	1	4		
P. (*nigra* x *sylvestris*) x (*resinosa* mixed + *resinosa* irradiated)	1	10		
P. (*nigra* x *sylvestris* x *resinosa* irradiated)	1	8		

[a]The authenticity of the hybrid is not yet verified.

The pollen was irradiated at 10,000r/min. A total of 200,000r was used.

Field Plantings

In the fall of 1970, thirty-two populations of *P.* (*densiflora* x *austriaca*) x *sylvestris*, *P.* (*densiflora* x *sylvestris*) x *sylvestris*, *P. leucodermis*, *P. sylvestris* (Siberia), *P. contorta*, and *P. rigida*, represented by 145 seedlings, were outplanted to the Maple Arboretum area.

PUBLICATIONS 1970

Zufa, L. 1970. Variation in rooting ability of *Pinus strobus* L. and *P. griffithii* McClelland x *strobus* L. Proc. 1st N. Amer. Biol. Workshop, Mich. Abstract.

Zufa, L. 1971. Summary report on poplar and pine breeding in 1968 and 1969. *In*: Proc. 12th Meet. Comm. Forest Tree Breed. Can. Part 2:53-63.

Zufa, L. 1970. Poplar breeding in Ontario. *In*: Prospects of Ontario's Poplar Timber Production, Papers presented at Poplar Workshop, Maple, Ontario, 2 Feb. 1970. Ont. Dep. Lands Forests Publ. pp 94-96.

Zufa, L. 1970. Poplar cultivation techniques and their application. *In*: Prospects of Ontario's Poplar Timber Production, Papers presented at Poplar Workshop, Maple, Ontario, 3 Feb. 1970. Ont. Dep. Lands Forests Publ. pp 97-105.

TREE IMPROVEMENT IN THE PRAIRIES REGION, 1970-71

J.I. Klein

Canadian Forestry Service,
Northern Forest Research Centre,
Edmonton, Alberta

The Canadian Forestry Service's tree improvement program in the Prairies Region is currently staffed by one scientist and one technician. Active projects include a jack pine breeding program for Manitoba and Saskatchewan and participation in several cooperative provenance experiments. A region-wide geographic variation study and a selection program proposed for white spruce are scheduled to start in 1972. Progress in the regional program since August, 1970 is reported here.

Tangible progress during the past year has been principally in the sowing of new trials. For the jack pine breeding program, 242 open-pollinated progenies of trees selected in Alberta and Saskatchewan were sown in the provincial nursery at Big River, Saskatchewan during October, 1970. In the same period, 80 jack pine populations of range-wide provenance were sown there. Until the Region is able to carry out plans for development of a research nursery at the laboratory, the Big River nursery seems to be the most suitable and convenient place to raise pine seedlings for the tree improvement program, despite its distance from the laboratory. The Prairies Region component of a cooperative range-wide black spruce seed source study was started in May 1971, when 100 seed lots were sown at Alberta's provincial nursery just north of Edmonton. The soil at this nursery is too heavy for jack pine, but with the addition of sand and peat, should allow satisfactory growth of black spruce.

About 700 potted grafts, ramets of the parent trees represented in the Big River nursery progeny sowing, were moved from Winnipeg to Edmonton, then planted during May near Edson, Alberta. The principal use of these ramets will be to provide scions for a permanent clone bank, to be sited and developed in the next few years.

Selection of jack pine parent trees, and collection of cones and scions were carried out in western Manitoba. Seed processing and grafting of these materials have been completed. One more collection trip, in eastern Saskatchewan, will complete the collection phase for the jack pine breeding program.

PUBLICATIONS

Klein, J.I. 1971. Selection and mating for production of second-cycle populations for a jack pine breeding program in western Canada. Proc. 15 Cong., Internat. Union Forest Res. Organ. Sect. 22, Working Group on Quantitative Genetics. Gainsville, Fla., 18-19 March 1971.

PROVENANCE TRIAL WITH WHITE SPRUCE OF DIFFERENT SEED SOURCES IN CENTRAL MANITOBA[1]

K.J. Roller

Canadian Forestry Service,
Maritimes Forest Research Centre,
Fredericton, New Brunswick

This experiment was designed to compare the performance in Manitoba of white spruce (*Picea glauca* (Moench) Voss) provenances from a number of locations in Quebec, Ontario, Manitoba, and Saskatchewan (Table 1).

In 1959, 14 western (Manitoba and Saskatchewan) and 16 eastern (Quebec and Ontario) provenances were available at the Riding Mountain Nursery. Transplants of eastern provenances (2-2 stock) were field planted in the spring of 1959 and of western provenances (2-3 stock) in the autumn of the same year. Centerhole planting was used to set out the transplants. Both plantations were laid out on completely randomized blocks at a 6 x 6 foot spacing and formed two trials in the same study area. The Quebec-Ontario trial was replicated four times with 7 x 7 transplants per plot; the Manitoba-Saskatchewan provenances were replicated three times with 6 x 6 transplants per plot. Two rows of local white spruce of the same age (obtained from the Manitoba Forest Service) were planted around each trial.

The trials were established on a southeast-facing slope. The previous stand, a second growth mixedwood stand of white spruce, trembling aspen (*Populus tremuloides* Michx.), and balsam poplar (*Populus balsamifera* L.), had been cut in 1953 and at the time of planting the overstory consisted of a few scattered trembling aspen with an understory of hazel (*Corylus cornuta* Marsh.). The ground was covered by reed grass (*Calamagrostis canadensis* (Michx.) Nutt.).

The experimental area, located at Riding Mountain (100.5°W, 50.8°N, elevation 2,200 feet above sea level), is within the Humid Microthermal Climatic Zone and is characterized by a rain-snow climate with cold winters and warm summers (Anon., 1957). The soils are Grey Wooded and have developed on moderately calcaresous loam to clay loam tills (Waldron, 1966). Forest sites predominate and occur on the upper slopes with moderately moist sites on the middle slopes.

During the period 1963-1970, when it was necessary, competing vegetation within a 3-foot radius of each surviving tree was removed. Aspen and

[1]Report based on work carried out when the author was employed by the Canadian Forestry Service, Winnipeg, Manitoba.

hazel suckers were treated with an aqueous solution of 2,4-D applied as a foliage spray at a concentration of 3,000 ppm in 1967.

Details of the early work carried out on this project have been reported by Wheaton (1960) and by Waldron (1960) and heights of surviving trees were assessed in 1965 (Roller, 1966). This report deals with the analysis of the data assessed in 1970, after the 15th growing season from seeding, and the compiled data are presented in Table 1.

Analysis of variance was applied to assess tree height and survival with respect to seed sources, separately in both trials. Differences in survival percentages were found at 1% level between provenances in the Quebec-Ontario trial but differences in height means were not detected. However, the within-seedlot variation, indicated by the standard errors ($S_{\bar{x}}$) in Table 1, was considerable. In the Manitoba-Saskatchewan trial, differences between height means were found at 1% level with larger standard errors than those of the Quebec-Ontario seed sources; a t-test between the means of standard errors of the eastern and western provenances indicated the differences at 5% level.

Height means for neither trial were significantly correlated with degree-days at the seed source. Survival was positively related at 1% level ($r = 0.68$, $n = 30$) to longitude (western seed sources have survived better) and negatively related at 1% level to both annual total precipitation ($r = -0.57$, $n = 30$) and mean temperature ($r = -0.60$, $n = 30$) at the site of seed origin.

In Manitoba-Saskatchewan trial, height growth followed much the same pattern as survival. The best of the 30 provenances on the basis of height and survival was from trees at Sandilands, Man. and the poorest from Riding Mountain, Man. Records of the Manitoba-Saskatchewan trial in 1965 (Roller, 1966) show that the lightest frost damage and the shortest height were recorded for the Sandilands seedlot. This may suggest that the early frost damage affected the growth and survival of the trees from other seed sources later and more heavily than those of Sandilands and that the trees of the Sandilands provenance outgrew the others during the past 5 years. However, the differences in climates between the zones of the different seed sources did not appreciably affect this order over the first few critical years after planting. On the other hand, the direct effect of soil variation on the different origins cannot readily be separated from the indirect effects operative through soil-local climate interactions. No explanation can, however, be found for the shortest height and lowest survival percentage of the Riding Mountain seedlot grown in the Quebec-Ontario trial. The same seedlot of Riding Mountain was used also in the Manitoba-Saskatchewan trial where the trees from this source were about average in height and survival. It is noteworthy that the Big River seedlot in the Quebec-Ontario trial shows the best survival and average height. It may indicate that the low survival of the eastern seedlots at Riding Mountain are not merely accidental and is attributable to the ecologic conditions of planting site following a climate-dependent cline that is related to the longitude from East to West.

TABLE 1

Source, survival, and height of the provenances of white spruce in 1970, 15 years after planting in Manitoba

Source of seed				
Place name	Long. °W	Lat. °N	% survival	Height, cm ($\pm S_{\bar{x}}$)
ONTARIO and QUEBEC TRIAL				
Riding Mt., Man.	100.5	50.9	15 c[a]	90.3(9.5) -[b]
Vankleek, Ont.	74.7	45.3	29 b	91.4(8.0) -
St. Maurice, P.Q.	73.5	48.2	25 c	99.0(10.9) -
Holland, Ont.	80.7	44.5	22 c	99.3(12.5) -
Nipissing, Ont.	79.7	46.2	27 c	101.5(10.0) -
Essa, Ont.	79.9	44.3	19 c	107.4(17.7) -
Rama, Ont.	79.5	44.5	26 c	108.6(11.8) -
Sand Lake, Ont.	79.1	45.6	20 c	109.5(16.2) -
Maniwaki, P.Q.	76.0	46.4	27 c	111.0(12.1) -
Big River, Sask.	107.2	53.9	69 a	111.1(5.4) -
St. Zenon, P.Q.	73.8	46.5	32 b	112.1(10.2) -
Denbeigh, Ont.	77.3	45.2	25 c	112.6(15.2) -
St. Charles, P.Q.	73.4	46.4	35 b	113.9(10.6) -
Potter, Ont.	81.0	48.9	24 c	116.1(13.6) -
Trois Pistole, P.Q.	69.0	48.2	32 b	122.7(12.5) -
Carnarvon, Ont.	78.7	45.2	20 c	123.7(14.1) -
MANITOBA and SASKATCHEWAN TRIAL				
Candle Lake, Sask. I	105.3	53.7	36 -	99.1(16.0) D
Bittern Creek, Sask.	109.7	50.2	47 -	103.5(15.6) D
Candle Lake, Sask. II	105.3	53.7	48 -	104.1(14.2) D
Swan Plaine, Sask.	102.0	52.3	50 -	106.9(11.5) C
Maloneck, Sask.	101.9	52.1	55 -	107.9(12.8) C
Torch River, Sask.	104.3	53.6	67 -	112.9(11.5) C
Prairie River, Sask.	103.0	52.8	69 -	113.0(10.6) C
Riding Mt., Man.	100.5	50.9	65 -	116.1(11.5) C
Kississing, Man.	101.0	54.5	57 -	116.9(15.2) C
Ochre River, Man.	99.7	51.2	57 -	119.1(11.3) C
Longlac, Ont.	86.3	49.5	64 -	127.9(10.9) B
Love, Sask.	104.1	53.5	47 -	128.0(15.2) B
Hodgson, Man.	97.5	51.5	57 -	132.1(14.5) B
Sandilands, Man.	95.5	49.5	70 -	162.9(13.5) A

[a] Different small letters denote significant differences (5-% level) in survival; different capital letters denote significant differences (1-% level) in height.

[b] Dash (-) denotes no significant difference between provenances.

Results after 15 growing seasons from seed strongly suggest that seed source is an important factor in performance of planted white spruce. The varying response to precipitation and temperature could be the result of selection produced by the differences in ecological factors at the different seed sources. Results of the trials indicate that white spruce seeds obtained from Saskatchewan and Manitoba, especially from Sandilands are more suitable for planting at Riding Mountain than seeds from eastern provenances.

REFERENCES

Anon. 1957. Atlas of Canada. Can., Dep. Mines Tech. Surv., Geogr. Br., Ottawa.

Roller, K.J. 1966. Tree improvement in the Manitoba-Saskatchewan region. Proc. 10th Meet. Comm. Forest Tree Breed. Can., Vancouver, B.C. 7 - 10 Sept. 1966.

Waldron, R.M. 1960. Provenance experiments with the white spruce of Manitoba and Saskatchewan. Can. Dep. N. Aff. Nat. Resources, Forest. Br., Forest Res. Div., Prog. Rep.

Waldron, R.M. 1966. Factors affecting natural white spruce regeneration on prepared seedbeds at the Riding Mountain Forest Experimental Area, Manitoba. Can. Dep. Forest., Forest. Br., Dep. Pub. 1969.

Wheaton, M.P.H. 1960. Provenance experiments with the white spruces of Manitoba and Saskatchewan. Can. Dep. N. Aff. Nat. Resources, Forest. Br., Forest. Res. Div., Prog. Rep.

SHELTERBELT TREE BREEDING

W.H. Cram and C.H. Lindquist

Prairie Farm Rehabilitation Administration, Tree Nursery, Indian Head, Saskatchewan

The tree improvement program has been limited by available resources since 1965 to:

a) propagation of superior parents for hybrid *Caragana* seed production;

b) the 'fused' cotyledon character of Siberian elm;

c) evaluation of poplar hybrids;

d) provenance testing and regional species evaluations;

e) propagation of hybrid spruce progenies.

A brief summary for these activities follows.

Caragana arborescens

Some 500 cuttings of two caragana selections (15-2 and 13-8) were rooted for establishing a second natural crossing block. Hybrid seed yields from the 1959 natural crossing block (A-1 X B5-1A) were low, but to date a total of 20 pounds have been harvested. Hybrid seedlings from this seed have been included in regional test plantings for comparisons with standard stock.

Ulmus pumila

A lethal abnormality of Siberian elm was first recorded for a 1968 germination test. This abnormality causes a tube-like fusion of the cotyledons with subsequent absence of a terminal leader development. It has tentatively been designated as 'fused' cotyledon. Data, collected over a period of 3 years from germination tests for 295 seed trees, indicate that 23% of the seed trees do not carry this character (Table 1). On the other hand, 28% of the trees which produced more than 20% seedlings with 'fused' cotyledons were identified for discard as seed trees. Controlled pollinations of such seed trees are in progress to investigate the bases for this characteristic.

Table 1. Incidence[1] of 'fused' Cotyledon Character for 295 Siberian elm seed trees.

% Frequency classes for fused cotyledons	Seed Years by Number of Seed trees 1968	1969	1970	Total	%, seed trees population
0	10	29	29	68	23
1 - 10	15	51	40	106	36
11 - 20	5	14	14	33	11
21 - 30	0	11	12	23	8
31 - 40	1	5	10	16	5
41 - 50	0	3	12	15	5
51 - 60	0	5	8	13	4
61 - 70	0	1	2	3	1
71 - 80	0	3	4	7	2
81 - 90	0	4	3	7	2
91 - 100	0	1	3	4	1
Totals	31	127	137	295	98
Mean (%)	2.8	11.5	12.4	-	-

[1]As percentage of seedlings from samples of 200 seed.

Populus hybrids

Thirty-eight poplar selections of 5-year-old hybrids were evaluated for vigor in comparison to Northwest, a standard production clone. These hybrid selections originated from 1962 crosses involving FNS 44-52 (*Deltoides* X Russian) pollinated by the Saskatchewan and Petrowskyana clones. Seven hybrid selections (6-10, 7-43, 6-22, 8-8, 5-3, 5-10, and 7-15) had equal or superior vigor to the Northwest clone. All, except one selection (8-8 from FNS 44-52 X Petrowskyana), showed evidence of *Septoria* leaf-spot. None of the hybrids manifested the vigor, resistance to *Septoria*, nor late defoliation characters of the FNS 44-52 female parent.

Pinus sylvestris

Provenance studies are in progress to evaluate several exotic tree species, including Scots pine, for selection of promising strains as shelterbelt material in the Prairies. Performance data, from a 1960 co-operative test with Mr. Holst of Canadian Forest Service at Petawawa, indicated that the Scots pine provenances from Orel and Kiev in Russia were superior to nine other sources. A seed production orchard was established in 1970 with 450 grafted plants of the Orel strain and 150 of the Kiev strain.

Pinus ponderosa

A co-operative provenance test with the U.S. Forest Service involving 70 seed sources of Ponderosa pine was planted in 1968. Planting survival was 93%, but subsequent losses have reduced the stand to 66%. Southern provenances from Arizona and New Mexico appeared unsuitable for Saskatchewan and the most vigorous provenances were from Nebraska. Provenances exhibiting the greatest vigor and survival were from seed sources with elevations of 1000 to 3000 ft.

Eleagnus angustifolia

Progenies of 33 Russian olive selections, from the Cheyenne Horticultural Station in Wyoming, were field planted in 1970 as a shelterbelt at Neudorf, Sask. Mean planting survival was 84% and the vigor of one progeny (D833) was outstanding.

Regional Species Trials

Regional tests are planted to evaluate the performance of tree and shrub species as potential shelterbelt material for various climatic and soil zones in the prairie region. Performance data for 1966 plantings of 16 species at three sites in Saskatchewan and one in Alberta are presented in Table 2. Planting survival for the deciduous species ranged from 72 to 84% in Saskatchewan and averaged 56% in Alberta. Top growth data in 1970 showed Russian olive to be the most vigorous species, followed in descending order by mountain ash, *Caragana*, mayday tree, red elder, and sea buckthorn. Russian olive suffered 'die back' in all areas, so that its future use may be restricted. Due to its rapid growth and tolerance to salinity, however, this species has considerable merit. Cotoneaster, chokecherry, hedge rose, and honeysuckle performed well at all sites. Of the conifers in these tests, Scots pine was superior at Hays, Alberta and Tonkin, Sask. whereas white spruce was superior at Langenburg, Sask. Both species of spruce suffered terminal bud damage due to spring frosts in 1969 at all sites. Conifer plantings at Lewvan in Saskatchewan failed completely due to flooding.

Performances of seven poplar and five willow clones in test plantings at the same four locations are listed in Table 3. Of the poplar, FNS 44-52 exhibited superior vigor at three sites but Gelrica was taller at Tonkin, whereas Berolinensis exhibited the lowest vigor. All clones, except FNS 44-52 and Gelrica, exhibited *Septoria* leaf-spot. Low survival of poplar and failure of willow at Tonkin and Lewvan was primarily due to prolonged flooding and soil salinity. Of the willow clones, Basford demonstrated greatest vigor despite considerable winterkill, followed by the Acute clone with no winter injury; Laurel performed poorly and appeared susceptible to chlorosis, while white and silverleaf lacked both vigor and density.

Performance of poplar and willow clones was recorded in 1969 for 1965 plantings at Carrot River, Indian Head, Buffalo Pound, Saskatchewan

Table 2. Performance of sixteen shrub and four coniferous species in the 1966 regional test plantings at Hays, Alberta and Lewvan, Tonkin, and Langenburg, Sask., 1970, as means for 25 single plant replications.

	Planting Survival, %				Height of Plants, cm				
Species	Hays	Lew.	Ton.	Lan.	Hays	Lew.	Ton.	Lan.	Mean
Shrubs:									
Russian oliver	12	88	91	62	180	136	219	224	190
Mountain ash	58	72	81	85	158	77	220	206	165
Caragana	82	80	88	77	148	118	202	191	165
Mayday tree	17	76	83	85	144	97	188	215	161
Red elder	42	80	86	62	150	91	203	201	161
Sea buckthorn	72	68	80	77	156	105	174	176	153
Native plum	33	32	68	54	142	71	182	171	142
Crabapple	89	60	83	100	135	78	186	166	141
Chokecherry	88	100	90	77	150	92	139	174	139
Honeysuckle	54	92	100	92	105	93	146	154	124
Hedge rose	83	92	91	100	110	99	133	152	124
Siberian currant	35	72	-	77	118	107	-	128	118
Villosa lilac	60	68	91	85	94	60	107	117	94
Nanking cherry	30	44	70	62	90	60	113	104	92
Korean cherry	95	32	80	77	98	69	98	88	88
Cotoneaster, Peking	-	100	85	100	-	66	85	107	86
Mean	56	72	84	80	132	89	160	161	134
Conifers:									
Scots pine	90	0	30	80	156	-	130	82	123
White spruce	10	0	60	90	52	-	74	90	72
Colorado spruce	10	0	80	56	56	-	59	56	57
Scop. juniper	0	0	80	80	-	-	56	56	56
Mean	28	0	62	82	66	-	80	71	77

Landing, and North Battleford, Sask. The Carrot River planting site in the aspen-spruce forest zone provided the most favorable conditions, followed by Indian Head, Buffalo Pound, Saskatchewan Landing, and North Battleford. The latter site had the most demanding environment being dry with little to no maintenance. Based on survival, height, and disease indicence the best four poplar clones for Carrot River were FNS 44-52, Gelrica, Sargentii, and Tristis; for Indian Head, P.B.L. #3, Brooks, P38, P38 and Volunteer; for Buffalo Pound, Cardeniensis, FNS 44-52, Vernirubens, and Northwest; for Saskatchewan Landing, Cardeniensis, Gelrica, Volunteer,

Table 3. Performance of seven poplar and five willow clones in the 1966 regional test plantings at Hays, Alberta, and Lewvan, Tonkin, and Langenburg, Sask., 1970, as means for 25 single plant replications.

Species and Clones	Planting survival, %				Height of plants, m				
	Hays	Lew.	Ton.	Lan.	Hays	Lew.	Ton.	Lan.	Mean
Poplar:									
FNS 44-52	100	65	83	94	4.5	2.7	4.9	6.1	4.5
Gelrica	85	55	33	82	3.5	2.2	5.6	4.8	4.0
Brooks #7	100	85	100	100	3.5	2.2	4.8	5.0	3.9
Saskatchewan	-	85	67	82	-	2.4	4.4	4.1	3.6
Northwest	95	85	67	88	3.4	2.4	3.5	4.5	3.4
Tristis	90	75	83	88	3.4	1.9	3.6	3.6	3.1
Berolinensis	75	35	50	65	2.6	1.4	3.5	3.6	2.8
Mean	91	69	69	86	3.5	2.2	4.3	4.5	3.6
Willow:									
Basford	100	0	0	100	3.1	-	-	2.9	3.0
Acute	100	0	0	100	2.8	-	-	2.8	2.8
Silver	100	0	0	75	2.6	-	-	2.4	2.5
White	100	0	0	65	2.3	-	-	2.4	2.4
Laurel	70	0	0	80	2.0	-	-	2.3	2.2
Mean	94	0	0	84	2.6	-	-	2.6	2.6

and FNS 44-52; and for North Battleford, Vernirubens, Saskatchewan, Cardeniensis, and FNS 44-52. Performance of willow clones was naturally not satisfactory in the semi-arid regions, and the most promising clones were Basford, Acute, Wilford, and Laurel.

Performance data in 1970, for a 1966 test planting of 33 poplar clones at Indian Head indicates the best clone on the basis of height growth was FNS 44-52 with 6.7 m, followed by Brooks #7, Cardeniensis and Angulata crecta with 6.1 m.

Picea pungens

Hybrid progenies involving 18,000 seedlings, from 193 crosses made in 1967 for 61 selections of Colorado spruce, were transplanted from the seedbeds in 1970. These progenies should be field planted in 1973 to evaluate the combining ability of the selections for vigor and needle coloration, lack of resources may prohibit this, however. The same applies for some 4,000 seedlings of 70 provenances, from seed collections made in Colorado, from 1960 to 1965. Loss of such test material will prevent improvement of Colorado spruce for future plantings in prairie Canada.

GEOGRAPHIC VARIATION IN PINUS CONTORTA

K. Illingworth

British Columbia Forest Service, Research Division,
Victoria, B.C.

By combining studies of quantitative variation in morphological characters within wild populations with studies of the variation in morphology and growth behaviour expressed in nursery and field trials, this investigation is designed to:

a) determine broad patterns of geographic variation in *Pinus contorta*,

b) locate populations with desirable traits,

c) establish criteria for provenance transfer for reforestation purposes,

d) provide background knowledge and material for a breeding programme with this species. Details of objectives and methods were reported to the Committee on Forest Tree Breeding in 1970.

Nursery Studies

Observations were continued on seedlings of 144 bulk provenances and 147 wind-pollinated families sown in May, 1969, at Red Rock Nursery near Prince George, and Cowichan Lake Nursery, Vancouver Island.

During the second growing season, determination of patterns of growth behaviour was of primary interest. The periodic enumeration of bud condition classes had previously been found to be an unsuitable technique for recording flushing and bud set. This is because, in the pines, spring shoot growth occurs through the extension of sub-apical, pre-formed stem and leaf initials, commencing with the extension of the proximal internodes of the bud. The first obvious changes in the external appearance of the bud are, therefore, preceded by a considerable period of growth activity. Consequently, growth periodicity was recorded by means of weekly or bi-weekly measures of height growth, and an index of periodicity was derived from measurements of secondary needles on two dates.

Autumn colouration was much less intense than during the first year, although stronger at Red Rock than at Cowichan Lake. Needles were bronzed or reddened among northern provenances, especially from continental sources. However, attempts to quantify these observations were not satisfactory and were discontinued. Similarly, in spite of early and marked lignification and the assumption of a pronounced lilac colour on stems from High Sierra-Cascade Mt. provenances, differences in stem colour among other sources, although present, were far less distinct and were not formally assessed.

Frost damage has not occurred at Lake Cowichan, but for the second year it was recorded at Red Rock, being most severe among coastal provenances from California, Oregon and southern Washington (in decreasing order).

Sample seedlings were lifted in October-November, 1970, and the following variables were recorded: stem diameter, needle- and shoot-length, fresh and over-dry weights of tops and roots. Analysis of these data has not proceeded beyond the descriptive stage.

Preliminary analyses of first year traits, and also of first- and second-year data from a 30 provenance pilot trial, include descriptive statistics, chi-square and anovas. Marked variation between provenances is apparent in such traits as germination pattern, length of cotyledons and hypocotyl, cotyledon number, epicotyl length, onset and intensity of autumn colouration (first year), first appearance of dwarf shoots and formation of terminal buds (indeed, at Cowichan, south coastal California provenances did not set terminal buds until April, 1970, more than ten months after sowing). Two-year seedlings showed significant variation in height, diameter, dry matter production and needle morphology. The magnitude and variability of a few of these traits are illustrated in Table 1.

Having ascertained the extent of variability within a large number of characteristics, analyses are now being directed towards discrimination between provenances or provenance groups and relating these to environmental variables.

Variation in Wild Populations

Wood core and foliage samples were obtained at the time of cone collection. The former have been turned over to Dr. J.H.G. Smith, Faculty of Forestry, University of British Columbia for use in dendro-chronological studies. Some of the resulting data will be used in the present study.

Tables 1 and 2 include results of preliminary examinations of variability in cone and needle morphology. Among the several characteristics examined in needles of 2-year-old plants grown at two nurseries (Table 2), stomatal density showed no provenance-nursery interaction, and it would appear that the determination of this trait has a strong genetic component.

Table 2 summarises results of an exploratory survey of variation in needles from mature trees in five geographically and ecologically diverse wild populations. Differences in stomatal density among provenances reflect those found among seedlings, but are more pronounced. The characteristics seems to be related to the moisture balance of the source environments, for which its adaptive value is obvious.

The study summarised in Table 2 included anovas of variation within and between trees. These results offer a promising basis for a more comprehensive survey of variation on a few selected traits within populations of wild- and nursery-grown needles from both bulk seedlots and half-sib families. This is currently being made.

Field Tests

Thirty provenances were planted at coastal, and northern and southern Interior test sites in May 1971. The trials will also afford a comparison of nursery effects.

Another series of 150 provenances was sown at Red Rock this spring for testing in four major climatic regions.

Breeding Arboretum

General proposals for a 160-acre breeding arboretum at Red Rock were outlined to the Committee in 1970. The area was rough-cleared during the winter of 1970-71, and, upon completion of site-preparation, will be staked to receive range-wide representation comprising 795 half-sib families and 91 bulk-provenances in May 1972. Coastal provenances will also be established in a 20-acre arboretum at Lake Cowichan.

The Red Rock arboretum will also include clonal material representing 75 plus trees from a range of elevations and latitudes north of the 55th parallel. These were obtained through co-operation with Dr. Stig Hagner, Swedish Cellulose Company (S.C.A.) and Dr. O. Sziklai, University of British Columbia.

In 1971 during February, and March, 3000 grafts, mostly side veneer, were made on potted 3-year-old plants at Red Rock. Wind-pollinated seed from each of the parent trees is to be used in half-sib progeny tests in northern British Columbia.

Table 1. Magnitude and variability of selected traits between and within provenances of *P. contorta*.

Sub-Expt. No.	Character	Nursery[1] no.	No. of provs.	Basis[2]	Grand mean	Range in means	L.S.D.[3]
04	% germination on day 63	1	144	3	54. 6	8. 2- 94. 0	14. 2
		2	144	3	65. 5	8. 3- 96. 3	14. 2
04	Germination, day 14 as % of germination, day 63	1	144	3	91. 0	60. 2- 99. 4	15. 7
		2	144	3	74. 6	15. 2-100. 0	15. 7
03	Days to 50% germination	1	30	4	24. 4	20. 4- 47. 4	5. 7
		2	30	4	22. 0	17. 6- 31. 3	1. 8
04	Cotyledon number	1	142	15	3.72	3.07- 5. 8	0.45
		2	142	15	3.69	3.07- 5. 6	0.45
04	Length of longest cotyledon (mm)	1+2	142	30	16. 4	12. 4- 27. 9	1. 6
04	Length of hypocotyl (mm)	1	142	15	10. 4	6. 8- 19. 0	1.55
		2	142	15	7. 7	5. 5- 14. 3	1.55
04	Epicotyl length, 1 year (mm)	1	140	30	32. 0	13 - 73	6. 5
04	Longest primary needle, 1 year (mm)	1	140	30	29. 5	19. 5- 41. 4	2. 7
04	% of seedlings with discernible terminal buds, day 134	1	140	3	67. 0	0 -100	23
04	% seedlings with dwarf shoots, day 134	1	140	3	7. 0	0.47	12
03	Epicotyl length, 2 year (cm)	1	30	40	54. 0	28 - 93	17
		2	30	40	102. 0	72 -144	17
03	Root collar diam., 2 year (mm)	1	30	40	2.45	1.95- 3.22	0.51
		2	30	40	3.62	2.14- 4.64	0.51
03	Dry weight of tops, 2 year (gm/tree)	1+2	30	80	1.34	0.85- 2.04	0. 4

Table 1 (continued)

Sub-Expt. No.	Character	Nursery[1] no.	No. of provs.	Basis[2]	Grand mean	Range in means	L.S.D.[3]
03	% total dry weight, 2 year	1	30	40	36	25 - 57	7
		2	30	40	30	24 - 37	7
03	Dry weight of primary needles (10 plants), 2 year (gm)	1	10	4	1.75	1.33- 2.16	0.58
		2	10	4	2.12	1.33- 3.80	0.58
03	Dry weight of secondary needles (10 plants) 2 year (gm)	1+2	10	8	7.40	3.98- 10.52	2.51
03	Secondary needle dry weight as % of total dry weight of needles	1	10	4	6. 4	39 - 78	12
		2	10	4	8. 3	78 - 89	12
03	Secondary needle length, 2 year (mm)	1	10	40	92	66 -108	11
		2	10	40	104	93 -118	11
03	Secondary needle width, 2 year (mm)	1	10	40	1.18	1.15- 1.29	0.07
		2	10	40	1.21	1.15- 1.33	0.07
03	No. of stomata/sq.mm	1+2	10	80	39	32 - 48	4
02	Absolute cone length (mm) (L)	-	44	75	40. 5	34. 1- 48. 2	3. 2
02	Maximum width closed cone (mm) (W)	-	44	75	20. 7	18. 7- 24. 0	1. 3
03	Cone shape, L/W	-	44	75	1.96	1. 8- 2. 2	0. 1

[1]Nursery No. 1 = Cowichan, 2 = Red Rock.
[2]Basis: Number of observations, items or replications per provenance, as appropriate.
[3]Least Significant Difference is given to facilitate crude evaluation of ranges.

Table 2. Comparison of some needle characteristics in five geographically diverse, wild populations[1].

Provenance no. and details[2]	Needle length, mm (L)	Needle width, mm (W)	Ratio L/W	Needle thickness, mm (T)	Ratio T/W	Resin canals, number	Abaxial stomata, no./mm
Least Signif. Diff.	1.3	0.02	0.001	0.02	0.006	0.11	2.3
87; Otter Point South Vancouver I. 48°22'; 0-5	38.5	1.30	.0345	.67	.191	.19	63.1
48; Mayer Lake Queen Charlottes 53°39'; 75	35.0	1.27	.0371	.68	.192	1.87	68.2
22: Telkwa (low) Central Interior 54°39'; 1700	48.1	1.24	.0268	.73	.189	.82	53.7
55; Telkwa (high) Central Interior 54°38'; 3300	50.3	1.57	.0321	.84	.153	1.00	39.6
30; Lower Post Northern Interior 59°59'; 2100	57.0	1.39	.0247	.79	.184	1.14	52.1

[1]Basis of means were 10 needles x 10 trees per provenance.

[2]Details in order: Provenance number; Provenance name; Location; Latitude; Elevation in feet.

IMPROVEMENT OF WHITE AND ENGELMANN SPRUCE COMPLEXES OF BRITISH COLUMBIA

G. Kiss

British Columbia Forest Service,
Research Division,
Victoria, B.C.

The primary objective of the project is the production of genetically improved seed of white and Engelmann spruces (*Picea glauca* (Moench) Voss and *Picea engelmannii* Parry) in commercial quantities at the earliest possible date. The timetable for the project was given by Kiss (1970).

The progress of the project is quite satisfactory. To date there have been 445 candidate trees selected in three selection units.[1]

A total of 181 trees have been selected in the Prince George selection unit. 172 of these trees have been successfully established in our clone bank. Five trees were lost before successful grafts could be made and four trees appear to resist our grafting efforts.

Cones were collected from most of the trees and the seedlings destined for progeny trials are 2 and 3 years old. Striking differences in germination percentages, growth rates, and certain phenological characteristics have been noted. Some of these differences are apparent at the nursery and research facilities at Red Rock.

Four progeny plantations will be established within the selection unit. The first of these plantations will be established in spring 1972 at Aleza Lake using a total of over 11,000 seedlings.

In the East Kootenay selection unit, 132 trees have been selected. Most of these trees also have been established in the clone bank at Red Rock. No cones have been collected yet for lack of a crop but we hope to collect some this year.

The third selection unit is located in the Smithers - Houston area, where 138 trees have been selected. Most of them were successfully grafted during the fall of 1970 and spring of 1971. Cones have also been collected from all but one of the trees. The 1-year-old seedlings from these trees will be demonstrated during our visit to Red Rock. Striking differences in germination percentages showed up in this experiment. Some lots had less than 1% germination out of 1000 stratified filled seeds sown. The probable

---

[1]A selection unit is an artificially designated area within which the climatic conditions are considered to be relatively uniform. The boundaries of these units may be revised in the future as experimental evidence requires.

reason for the poor germination of these lots may be the hybrid origin of the parent trees rendering them more or less sterile.

The Picetum established at Chilliwack in co-operation with Dr. G. Gordon is largely finished. The Picetum planned for the Prince George area is ready to receive the seedlings in the spring of 1972. The seedlings destined for this project are now at Red Rock. Some of the spruce species show very good growth rate (such as 1 + 2 black spruce, *Picea mariana* (Mill.) BSP, averaging over 50 cm).

It was interesting to see that some of the Prince George area clones grafted in the spring of 1969 flowered the next spring. Most of the flowers were males but one female and one hermaphroditic flower were also observed.

A number of fall-grafted clones from the East Kootenay area (Engelmann spruces) produced flowers in the greenhouse the same winter. These flowers have been pollinated using Sitka spruce pollen and now we are in possession of a number of hybrid seeds. Germination tests indicate that these seeds are quite viable. They will be sown next spring and they might supply us with valuable data on the crossability of individual Engelmann spruce parents with Sitka spruce. It will be interesting to see whether or not these hybrids will be sterile.

BREEDING PSEUDOTSUGA IN COASTAL BRITISH COLUMBIA

A.L. Orr-Ewing

British Columbia Forest Service,
Research Division,
Victoria, B.C.

INTRASPECIFIC CROSSES WITH DOUGLAS-FIR

General

Table 1 gives general details on the pollen parents used for the 1963-1968 intraspecific crossing program, their general locations being shown in Figure 1. Forty seed parents from Vancouver Island and the Lower Mainland were used for these crosses, 19 of them being selected plus trees. The 37,800 seedlings from the crosses made from 1963 to 1966 have already been planted on 19 test sites selected over a wide range of environments on Vancouver Island and the Mainland. Their locations are shown in Figure 2, and the details given in Table 2. In general, survival is high although there were some unexpected losses from *Rhizinia undulata*: The seedlings on the test sites at Squamish River and Salsbury Lake on the mainland, in particular, being heavily attacked the first growing season after planting. Browsing has also been a problem together with hazards from road and power line constructions which *so far* have been successfully countered.

Another nine test sites on Vancouver Island and the Mainland were selected and staked in 1970. The planting of these test sites with the more than 32,000 1 + 1 seedlings from the 1968 crosses was started in February and it is hoped that it can be completed by the end of May in spite of delays caused by snow.

Height Measurements on the Test Sites

The first height measurements on the test sites are made on completion of the third growing season after establishment. The results of those made on test sites 1 to 17, established from 1966-1968, are now being critically analyzed but some general observations can be made. Firstly, as regards number of seedlings per cross, the decision made in 1963 that wherever possible 100 seedlings per cross should be planted at every test site has been more than justified. Some unexpected mortality inevitably occurs with even the most careful planting, in addition snow and wildlife can cause further damage. There is considerable genetic variance within the crosses and this will be obscured if too few seedlings have been planted. The opportunities for further selection are also reduced while statistical comparisons between crosses are at best unreliable. Secondly, certain crosses have shown a definite superiority in the nursery which has been maintained on the test sites. Unfortunately, however, this is not an established pattern with every cross, so that nursery results have to be accepted with some caution. At present, very little culling of particular crosses is carried out in the nursery. And thirdly, most of the crosses with either Washington or Oregon pollen parents from the coast and west of the Cascades have performed extremely well to date on a wide range of test sites. They further appear extremely adaptable, one particular cross, for example, was outstanding, on both the Squamish and Ucleulet test sites which have widely different environments. The growth of certain individuals within some of these crosses is also exciting. One tree from a 1965 cross, for example, which was planted in 1968, was measured at Ucluelet in 1970 and found to be 8.5 feet tall.

The 1968 Crosses

These are the most interesting crosses made to date as plus trees selected in British Columbia were used as both seed and pollen parents together with other pollen parents from Washington, Oregon and California. In addition, progeny from wind-pollination of the plus trees themselves were raised wherever possible. The 1 + 1 seedlings were measured in the nursery in 1970 and the early results are most encouraging. It was found that the heights of the progenies from 11 of the 13 British Columbia plus trees when crossed with either Washington, Oregon, or California pollen parents were significantly taller than those from the same parents crossed with other British Columbia plus trees.

INBREEDING STUDIES WITH DOUGLAS-FIR

Nursery Development, 1970

Investigations into the occurrence of dwarfism in the Douglas-fir were continued. Seed from the 10 S_1 inbreds selfed to the S_2 generation in 1968 had all been individually numbered after sowing in 1969. Detailed records were kept of each germinant in the seedbeds and these were maintained after transplanting. Such procedures are necessary as there is some variation among the dwarf seedlings as they grow older. The identity of each seedling will be retained when they are planted in 1971. Segregation into dwarf and tall forms was again observed confirming the 1967 results. Nine S_1 inbreds from selfed family 11 have now been inbred successfully to the S_2 generation and eight of these segregate into dwarf and tall forms. There is no segregation in the one remaining inbred, which has been selfed in 1962, 1966 and 1968. This dwarf form first appeared in limited numbers in the S_1 inbreds from tree 11 which was selfed in 1954. The dwarfs are now 16 years old but are easily recognized as they still average 5 feet in height. Unfortunately, they have yet to produce either female or male strobili.

1970 Pollinations

With the knowledge obtained from previous studies, some more precise pollinations to investigate dwarfing could be made in 1970. Two S_1 inbreds were selected in both families 2 and 11, in each case one was known to segregate into dwarf and tall forms and the other not to segregate. As shown in Table 3, reciprocal pollinations were made with all four trees and in addition, backcrosses were made with the original parents. The pollinations were all successful (Tables 3, 4) and the seed will be sown this spring. Four other selfed families, 6, 8, 10, and 12, were also selfed to the S_2 generation with variable results.

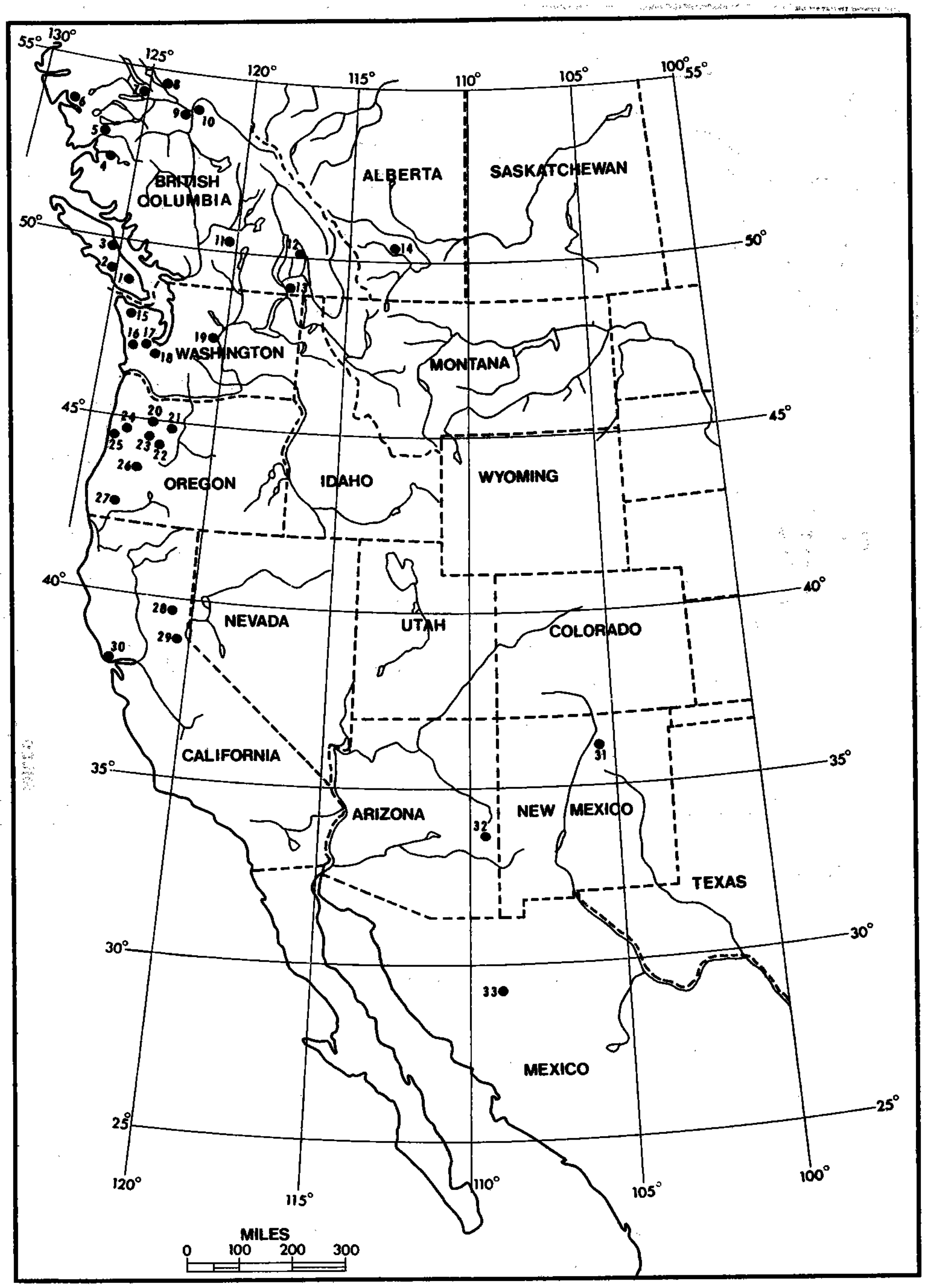

Figure 1. Origin of pollen parents used in intraspecific crossing program with Douglas-fir, 1963-68 (See Table 1)

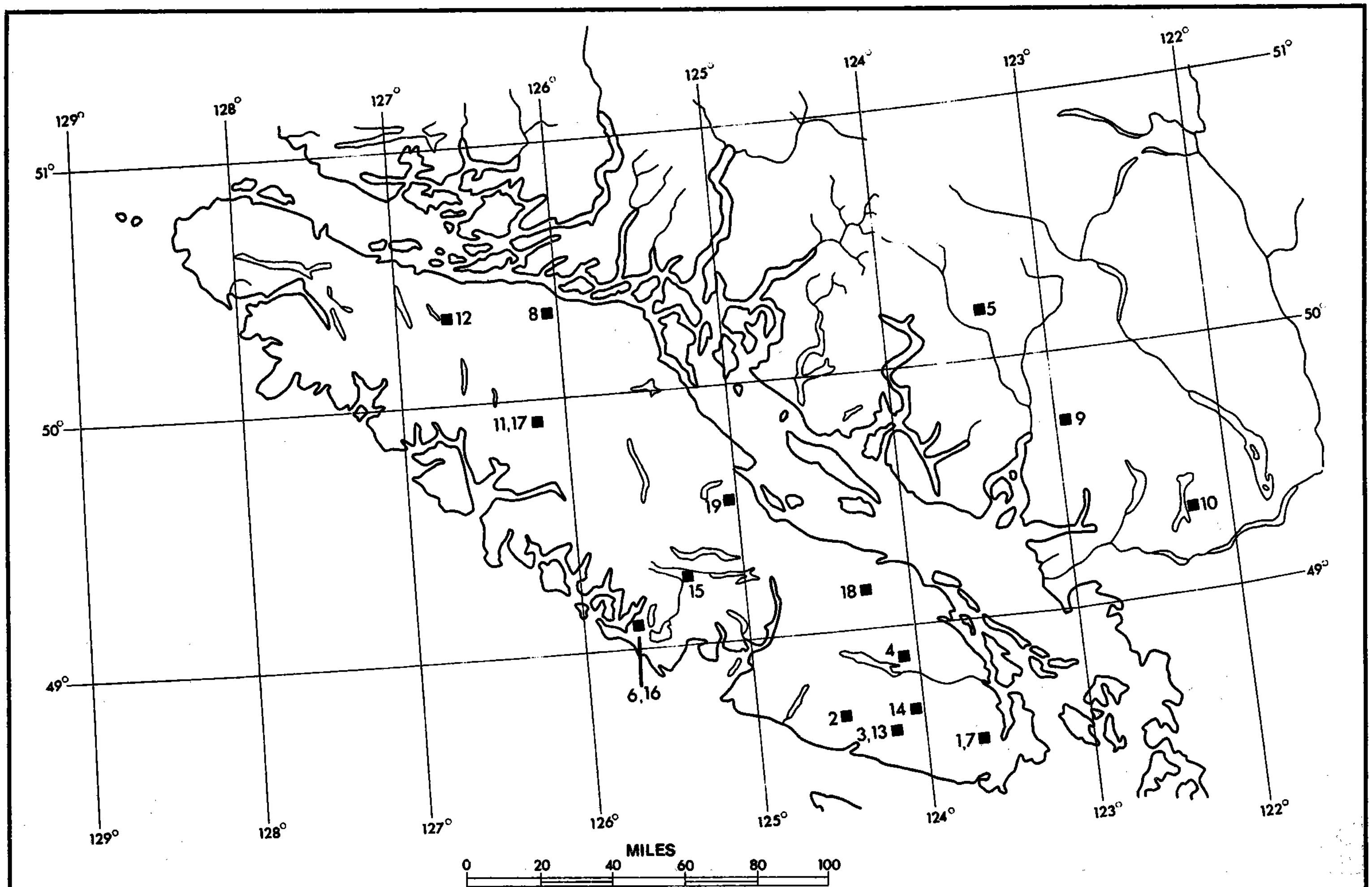

Figure 2. Test sites planted with intraspecific crosses of Douglas-fir, 1966-69

Table 1. Pollen parents used in the intraspecific crossing program with Douglas-fir, 1963-68.

Province or State	General location of pollen parents	Map[1] No.	Range of Elevation, ft	Crossing year
B.C.	Cowichan[2]	1	700-2800	1963,66,68
	Sproat Lake	2	200	1966
	Trent River	3	2300	1968
	Firvale	4	400	1965
	Niemamanous	5	200	1963
	Horetzky	6	500	1965
	Priestly	7	2200	1963
	Fort St. James	8	3150	1968
	West Lake	9	2750	1966
	Tabor Mt.	10	2750	1968
	Lac Le Jeune	11	3800	1963
	Zincton	12	3400	1963,66
	Stagleap	13	3825	1965
Alberta	Shaganappi	14	3500	1965
Washington	Sol Duc[2]	15	2400-2500	1964-68
	McLeary	16	250	1968
	Olympia[2]	17	100	1965
	La Grande	18	600	1965-66
	Teanaway Cr.	19	1200	1966
Oregon	Molalla[3]	20	1520	1966
	Metolius[2]	21	2700-4100	1965
	Clear Lake	22	3400	1965
	Lacomb[2]	23	900-2000	1965,66,68
	Pedee[2]	24	250- 550	1963,64,66,68
	Elk Creek[2]	25	150-1500	1965,68
	Springfield	26	1160	1968
	Wolf Creek	27	1200	1966
California	Meadow Valley	28	4000	1966
	Webber Creek[2]	29	1800-3000	1964,66
	Mt. Tamalpais[2]	30	1800	1968
New Mexico	North Easter	31	9500	1967
Arizona	Escudilla Mt.[2]	32	9850	1968
Mexico	Madera	33	7500	1968

[1]Figure 1.
[2]More than one pollen parent from general location.
[3]Seed Parent.

Table 2. Test sites planted with intraspecific crosses of Douglas-fir, 1966-69

General locality	Map No.[1]	Elevation range, ft	Planting year	Seedlings planted	Crosses[2] represented	Survival fall 1970
Water District 1[3]	1	650	1966	1552	22	97.6
Loup Creek	2	1500-1750	1966	441	5	91.0
Lens Creek 1	3	500- 600	1966	432	5	96.3
Chemainus River	4	1600-1800	1966	434	5	96.5
Squamish River	5	1300-1500	1967	2988	25	72.7
Ucleulet 1	6	100	1967	2679	22	89.7
Water District 2[3]	7	1000-1500	1967	2433	19	95.6
Adams River	8	900-1100	1967	2152	18	96.9
Mamquam River	9	2000-2300	1967	1953	16	86.6
Salsbury Lake	10	1500-1900	1967	1757	14	77.8
Oktwanch River 1	11	1000-1200	1967	1581	12	87.7
Bonanza Lake	12	1400-1700	1967	1414	12	92.8
Lens Creek 2	13	700- 900	1968	3403	27	96.4
Fleet River	14	2200	1968	3145	25	87.1
Taylor River	15	400- 600	1968	2399	20	86.5
Ucleulet 2	16	150	1968	2100	17	97.0
Oktwanch River 2	17	950	1968	2405	22	94.6
South Englishman R.	18	1600-1700	1969	2636	24	99.5
Trent River	19	1600-1800	1969	1897	16	95.0

[1]See Figure 2.
[2]Wind-pollinated controls not included.
[3]Greater Victoria.

The first pollinations were also possible on two S_2 inbreds which were raised from seed in 1963. Pollen was obtained from an S_2 inbred in selfed family 11 and the first single crosses between two S_2 inbred lines were successfully made. The cones were admittedly small and the yield of seed correspondingly low but the fact that S_2 inbreds can be crossed 8 years from seed is most encouraging.

Table 3. Crossing design for selfed families 2 and 11, 1970.

	S1.2.12	S1.2.21	So.2	S1.11.32	S1.11.85	So.11
S1.2.12		x	x	x	x	
S1.2.21	x	x	x	x	x	
S1.11.32	x	x		x	x	x
S1.11.85	x	x		x	x	x

Table 4. Yield of seed from S_2 Inbreds, 1970.

Inbred	Strobili		Cones produced	Seeds	
	Number	Colour		Total	Viable[1]
S2.26.4	29	Green	18	227	32
S2.26.5	37	Purple	11	156	51

[1]Determined by X-ray.

A PROVENANCE STUDY OF COASTAL DOUGLAS-FIR

R.L. Schmidt

British Columbia Forest Service,
Research Division,
Victoria, B.C.

This study (Experimental Project 599) is concerned with developing seed transfer rules for application in reforestation projects. It incorporates three related experiments:

a) Field testing in five contrasting climates to define the range of adaptability in 77 coastal provenances.

b) Field testing of a high and a low elevation provenance from each of five localities at representative elevations. This experiment is concerned with assessing effects of seed transfer over altitudinal gradients.

c) Field testing in many climatic and geographic situations of five provenances from contrasting climates along with a local provenance to assess the possibility of identifying provenance zone boundaries.

At present 130 acres of test site have been established within the Vancouver Forest District (Figure 1). The establishment phase will be concluded in 1973.

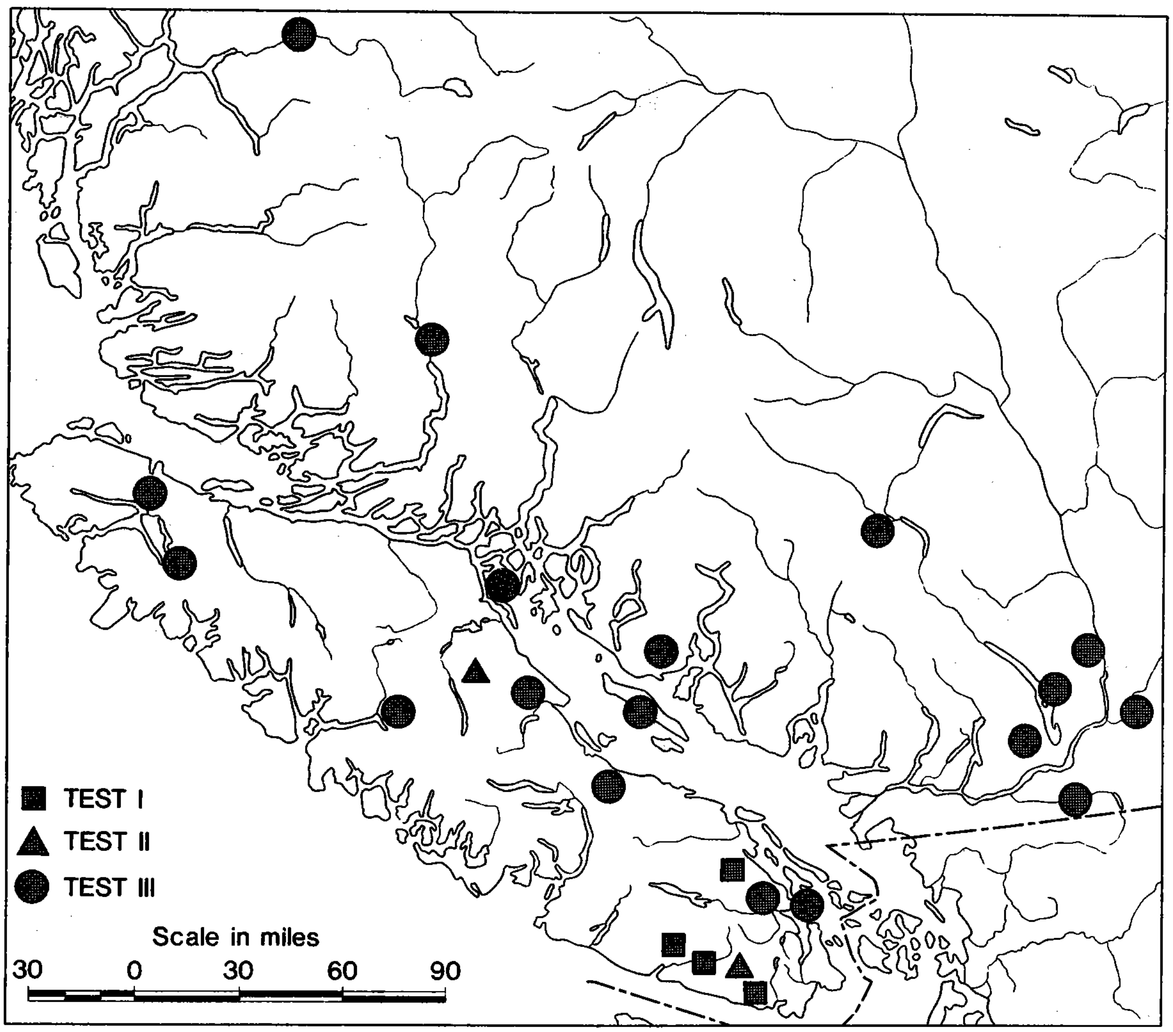

Figure 1. Location of Douglas-fir provenance test sites.

WESTERN HEMLOCK TREE IMPROVEMENT

R.F. Piesch

Canadian Forestry Service,
Pacific Forest Research Centre,
Victoria, B.C.

The objectives, approaches, and initial progress in this study were dealt with in the 1970 report to the Committee. This report deals with the test plantation establishment phase.

During the spring of 1970, the 1-year-old seedlings grown in bullets were transplanted into styrofoam plug moulds, each cavity of which contained twice the volume of soil than in the bullet container. The subsequent year's growth was excellent; it much exceeded that expected. Many seedlings reached a height of a foot or more, thus quadrupling their first-year heights.

During the spring of 1971, the seedlings making up the population test, were outplanted on four sites on forest industry lands as follows:

Area	Latitude	Longitude	Elevation, ft
Coal Harbour	50° 37'	127° 33'	200- 300
Franklin River	48° 55'	124° 55'	900-1200
Gold River	49° 54'	126° 08'	1200-1300
Beaver Cove	50° 27'	126° 53'	1700-1900

The 15 seed source populations were planted in a randomized block design, at an operational spacing of 8 x 10 ft. Plot size was 1/3 acre so that each block covered 5 acres. At each site, five 5-acre blocks were planted, i.e. a total of 100 acres in all. Due to a late spring and abnormally heavy snow accumulations, planting conditions were not optimal. The seedlings were flushing actively when planting was completed in mid-May.

A 150-acre tract of Crown land near Victoria has been reserved for field tests under the project by the B.C. Forest Service. Twenty acres were cleared for planting in 1971. A study involving 100 "half-sib" (wind-pollinated) families is being established on the area, with planting scheduled for completion by the end of May. First year nursery heights were recorded in the nursery and second year heights immediately after planting, enabling subsequent assessment of annual height increment.

For this study of 100 half-sib families, a complete randomized block design is being used with 6-tree plots, and 10 replications. This will be primarily a short-term study with initial spacing at 6 x 6 ft. However, the design will enable thinning at a later date to a 6 x 12 or 12- by 12-foot spacing while retaining all families in all replications, if desired. Thus, longer term studies such as those oriented toward assessment of juvenile-mature correlations could be undertaken. In addition to progeny test plantings, the area will serve as a clone bank and breeding arboretum. Nearly 2,000 rooted cuttings from the western hemlock seed trees used for the population and half-sib studies will be planted on the site in the fall of 1971.

Two publications are planned for completion this year: one dealing with the first-year nursery performance of western hemlock families or populations; and one reporting seed and cone yields of 1-year-old western hemlock rooted cuttings.

FOREST GENETICS AND TREE BREEDING AT THE FACULTY OF FORESTRY UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER

O. Sziklai

Faculty of Forestry,
University of British Columbia,
Vancouver, B.C.

ACADEMIC PROGRAM

The Forest Genetics undergraduate course was taken by 22 students during the spring term of 1970-71.

The following graduate students are majoring in Forest Genetics:

Mr. R. Ho, (Ph.D.) completed his course requirements and his comprehensive examination during 1970-71. He is presently working on his thesis, "Studies on pollen grains of selected species in Pinaceae" and expects it to be ready by the end of 1971.

Mr. M.D. Meagher, (Ph.D.) has also cleared his courses and comprehensive examination. He is working on "Morphological variations in *Tsuga heterophylla* (Raf.) Sarg." and expects to finish his work by early 1972.

Mr. H.G.D. Marshall, (Ph.D.) after his 2 years of residence at U.B.C. is preparing for his comprehensive examination scheduled for September 1971. He is working on economic evaluation of forest tree breeding programs.

Mr. E.R.A. Falkenhagen, (Ph.D.) after completing his first year residence, established a progeny test of Sitka spruce. The collection is part of IUFRO Section 22 expedition and includes 559 trees, representing 39 locations from B.C. and Alaska.

Mr. C. Yao, (M.F.) is completing his program and will present his thesis on "Geographic variation in 1,000-seed weight, in cone-scale morphology, and in seed germination of Douglas-fir".

RESEARCH PROGRAM

In connection with IUFRO Section 22 cone collection programs of *Pseudotsuga menziesii* (Mirb.) Franco and *Picea sitchensis* (Bong.) Carr., 15-20 cone samples were received from each of the 1,823 trees of Douglas-fir and 550 trees of Sitka spruce.

Biometrical investigations on cone and seed characteristics are included in Yao's and Falkenhagen's projects. A progeny test was established at the U.B.C. Research Forest March 1971. Dr. M.El-Lakany studied nuclear characteristics and DNA content on 21 samples of *Pseudotsuga* during his post-doctorate time. This project is now extended to include more samples to elucidate the variation pattern of this important species. We are also attempting to indicate the probable origins of Douglas-fir stands established in France, Germany, and Poland during the turn of this century.

Selection of 91 individual *Pinus contorta* var. *latifolia* trees was completed during the summer of 1970 for Svenska Cellulosa Aktiebolaget Sundsvall, Sweden. Scions were collected during October and shipped to Sweden in November. This gene pool will be preserved at Red Rock Nursery by the B.C. Forest Service while a clonal seed orchard will be established in Sweden.

Tree Improvement

The Douglas-fir cooperative progeny test that resulted from the 1968 intraspecific crosses representing 100 families is planted out in Caycuse, Courtenay and Gold River by the three Coastal forest companies. Single tree plots were used in an incomplete Latin square design (t = 100, k = 16 or more).

PUBLICATIONS

El-Lakany, M.H. and O. Sziklai. 1970. Effects of gamma-irradiation on some western conifers, Radiat. Bot. 10:411-420.

El-Lakany, M.H. and O. Sziklai. 1970. Variation in nuclear characteristics in selected western conifers and its relation to radiosensitivity. Radiat. Bot. 10:421-427.

El-Lakany, M.H. and O. Sziklai. 1970. Effects of gamma-irradiation on pollen, on seed and on seedling characteristics in Douglas-fir, 15 pp. Advancing Frontiers Plant Sc. 25:54-51.

Sziklai, O. and R. Ho. 1970. Development of male gametophyte of lodgepole in pine *in vitro*. IUFRO Section 22 Working Group Meeting on Sexual Reproduction of Forest Trees, Varparanta, Finland. Proc. 2(Sz):1-18.

Sziklai, O. and M.H. El-Lakany. 1970. Height growth of intraspecific Douglas-fir seedlings using gamma irradiated pollen. 5th Forest Biol. Conf., TAPPI. Raleigh, N.C. 11-13 May. 12 pp.

Sziklai, O. and M.H. El-Lakany. 1970. Results from diallel-cross of *Pseudotsuga menziesii* (Mirb.) Franco. Application of Quantitative Genetics in Forest Tree Breeding. Czechoslovakia, 22-27 June.

Sziklai, O. and M.H. El-Lakany. 1970. Intraspecific variation in nuclear characteristics of Douglas-fir. Part I. Interphase nuclear volume. 1st N. Amer. Forest Biol. Workshop. Mich. State Univ., East Lansing. 5-7 August.

Sziklai, O., and M.H. El-Lakany. 1970. Progress report on plus tree selection of *Pinus contorta* Univ. B.C., Fac. Forest.

A STUDY OF THE IUFRO SITKA SPRUCE PROVENANCES AND SINGLE TREE PROGENIES

E.R. Falkenhagen

Faculty of Forestry,
University of British Columbia,
Vancouver, B.C.

During the 1970 fall, the IUFRO Section 22 "Working Group on Procurement of Seed for Provenance Research" organized an expedition to collect Sitka spruce (*Picea sitchensis* (Bong) Carr.) cones from British Columbia and Alaska. In most cases, the collections were made from 15 trees in each location. The procedure of the collection was outlined by the "Working Group on Provenance Research and Testing" Meeting at Pont-a-Mousson, held in 6-9 September 1965.

The locations of the 39 provenances range from 48.38°N to 58.37°N latitude and from 121.93°W to 134.58°W longitude. The elevation varies from 0 to 2,200 feet above sea level, (Table 1).

Twenty cones from each of the 557 trees representing 39 locations were provided to Professor O. Sziklai. The seed was extracted by hand during the 1970-71 winter and stored at 32°F. This single tree progeny collection constitutes the material with which the author commenced the present study as part of his Ph.D. thesis.

Ten cones per progeny were randomly selected and the length of each cone measured to the nearest mm.

Five randomly selected seeds from each tree were mounted on a special sheet, and seed length, seed width, wing length and wing width were measured to the nearest 0.01 mm.

Nested analysis of variance and Duncan's multiple range test for all the characteristics studied have been performed using biogeoclimatic zones as defined by Krajina (1969). No definite pattern of variation has been detected by using univariate anova procedures and multivariate statistical techniques are being applied as each trait probably contains some useful information. A simple correlation matrix has been calculated between all the characteristics studied and longitude, latitude and altitude of the place of origin of the provenances, using the provenance means. Multiple regression analysis has been used for investigating this correlation matrix. The percentage of variation accounted for by the geographical coordinates is not too high, leaving much of the variation unexplained.

Seeds from each of the 557 trees have been individually sown in April 1971, using a randomized complete block design with 4 replications. Characteristics of these progenies will be studied in the nursery during the first two growing seasons.

Table 1. Geographical coordinates of the Sitka provenances (39 populations and 557 trees) studied.

Provenance No.		Lat.°	Long.°	Elev. ft.
1	Vedder	49.12	121.93	100
2	Squamish River	49.92	123.25	100
3	Big Qualicum River	49.38	124.62	0
4	Salmon Bay	50.38	125.95	0
5	Cranberry River	55.47	128.23	1700
6	Kitwanga	55.17	127.87	2200
7	Usk Ferry	54.63	128.40	450
8	Shames	54.40	128.95	100
9	Wedene River	54.13	128.62	550
10	Kitsumkalum Lake Park	54.72	128.77	450
11	Derrick Lake	55.68	128.68	800
12	Dragon Lake	55.35	128.95	850
13	Zolap Creek	55.15	129.22	50
14	Fulmar Creek	55.15	128.97	1300
15	Aberdeen Creek	54.20	129.92	0
18	Cedarvale	55.02	128.32	800
19	Kasiks River	54.28	129.42	100
20	Humpback Creek-Porcher Island	54.03	130.37	1000
21	Inverness	54.20	130.25	50
22	Hays Mtn., Prince Rupert	54.27	130.32	2100
23	Mosspoint, Annette Island	55.03	131.55	0
24	Craig	55.50	133.13	0
25	Old Hollis	55.47	132.67	0
26	Ward Lake	55.42	131.70	50
27	Ohmer Creek	56.58	132.73	25
28	Duck Creek	58.37	134.58	100
29	Allouette River, Haney	49.25	122.60	650
30	Muir Creed, Sooke	48.38	123.87	0
31	Port Renfrew	48.58	124.40	25
32	Tahsis 1	50.08	127.50	100
33	Tahsis 2	49.83	126.67	10
34	Holberg	50.62	128.12	100
35	Moresby Island, Skincuttle Inlet	52.28	131.22	50
36	Moresby Island, Sewell Inlet	52.87	132.08	50
37	Moresby Island, Cumshewa Inlet	53.05	132.08	200
38	Sandspit, Queen Charlotte Island	53.13	131.80	250
39	Iuskatla	53.50	132.17	300
40	Masset Inlet	53.92	132.08	0
41	Blenheim, Sarita	48.90	124.95	700

SUMMARY OF GENETICS STUDIES AT THE INSTITUTE OF FOREST GENETICS, FOREST SERVICE, RHINELANDER, WISCONSIN

Hans Nienstaedt, J.P. King, J.P. Miksche and Knud E. Clausen

U.S.D.A., Forest Service,
Rhinelander, Wisconsin

Since 1955, the research program has concentrated investigations on *Pinus*, *Picea*, and *Betula*. Less intensive efforts have involved *Abies*, *Larix*, and *Thuja*. The earlier efforts were provenance research, later individual tree progeny testing, using open- as well as control-pollinated seed, gained in importance. Species hybridization studies have also been carried out in *Betula* and *Picea*.

In the following, we outline briefly some of our most recent studies and present some of the more interesting results that we have not published previously.

JACK PINE

Insect and disease resistance research has been one of two main interests in jack pine. The plan for these studies was outlined by Jeffers (1970) and the results of studies of the variation in insect susceptibility in jack pine provenances collected and tested in the Lake States have been published by King (1971).

After some preliminary work in 1970, a second major, new study got underway in 1971. It is a study of provenance hybridization, and will involve six of the provenances in the rangewide jack pine test started by the Canadian Forestry Service, Petawawa Forest Experiment Station in the early 1960's. The objectives of the new study are:

a) To determine the relationship between the inheritance of quantitative characteristics of jack pine and the geographic separation of the parents.

b) To compare individual tree genetic variation with the between-provenance variation.

c) To determine the effect of test environment on the expression of quantitative characteristics.

c) To develop a more thorough understanding of the genetic control of interprovenance variation.

The six provenances to be used are from Durell Island, N.S. (3203)[1]; Petawawa Plains, Ont. (3246); Mosinee, Wisc. (3269); Fife Lake, Mich. (3272);

[1]Petawawa numbers.

Big River, Sask. (3288); and Fort Smith, N.W.T. (3296). They were chosen to include: (1) a large range of geographic diversity, and (2) at least one provenance local to the test planting sites. The selection of the second group required considerable compromise. After considerable discussion, it finally was decided to use full-sib families in the study, rather than to use pollen mixtures. This necessitated some limitation on number of crosses and the outcome was the following crossing scheme (Table 1).

Three to six pollen parents within each provenance will be selected and will be used as male parents only, but will be crossed with one female in each of the six provenances. We will, therefore, produce six intra-provenance and 15 inter-provenance combinations and their reciprocals. The actual number of full-sib families representing each combination will depend on the success of the individual crosses. If each of three cooperators can handle three pollen parents, there will be nine families per inter-provenance combination and 18 full-sib families per inter-provenance combination. The U.S. Forest Service, Rhinelander, Wisc.; Petawawa Forest Experiment Station, Ont.; and Michigan State University will cooperate on the pollinations. Test plantings will be established by these three cooperators and by the Canadian Forestry Service at Fredericton, N.B. and Edmonton, Alberta.

In Wisconsin, we did some preliminary crossing in 1970, and in 1971 attempted 108 full-sib combinations. With four 2-men crews and one supervisor, and all labels prepared in advance, we managed to pollinate 930 bags in 6 hours. We pollinated an average of 3.3 female strobili per bag. During the two seasons, we have experienced these problems:

a) Female and male production on trees is sometimes insufficient for the required number of bags, particularly in northern and northwestern provenances. Therefore, selection of parents which ideally should be random, required a compromise. We classed all trees (about 42 - 48 per source) as having "sufficient" or "insufficient" male or female strobili. Parents were than picked at random in the "sufficient" class.

b) Cone abortion rate averages about 50% for controlled pollination in jack pine. This should be considered when determining the number of females to pollinate.

c) Better estimates of the number of viable seed per cone is needed. Straight or slightly curved cones average 24 - 26 full seed per cone, while strongly curved cones, particularly from northwestern provenances, have an average of 14 full seed per cone after open pollination (Jeffers, 1971).

d) We have been unable to force pollen, and this has limited the number of pollen lots we have been able to handle.

It has been our experience that crossing schemes should be simple and flexible, and because female strobili production is low at least in younger trees, it is best to make full-sib crosses. From the simple standpoint of logistics, it is the most efficient method and yields more genetic information.

Table 1. Crossing Plan for Inter-provenance Study of Jack Pine.

Female Parents		Male Parents					
Provenance Number		03	46	69	72	88	96
	Tree Number	123....	123....	123....			
	101	x (03x03)					
	102	x					
	103	x					
	etc.	...					
	201		x				
03	202		x (03x46)				
	203		x				
	etc.		...				
	301			x (03x69)			
	302			x			
	303			x			
	etc.			...	etc.		
	101	x					
	102	x (46x03)					
	103	x					
	etc.	...					
	201		x				
46	202		x (46x46)				
	203		x				
	etc.		...				
	301			x			
	302			x (46x69)			
	303			x			
	etc.			...	etc.		
69 etc.							
etc.							

YELLOW BIRCH

Measurements during the 3-year nursery phase of a study of 55 provenances of yellow birch at Rhinelander determined:

a) Clinal variation in budbreak - northern provenances flush first.

b) Clinal variation in growth cessation - southern seed sources extend their height growth longer into late summer or early fall.

c) Low elevation sources from Tennessee, Ohio, as well as the Kentucky and Virginia seed sources, had much winter injury.

d) Variation in total height growth among sources appears to be random (Clausen, 1968, 1969).

Three-year height growth in three other nurseries, Houghton, Mich.; East Lansing, Mich.; and Syracuse, N.Y. has been added to this original information (Table 2). The random pattern of variation is verified and there is considerable evidence of genotype x environment interaction. There are no identifiable trends; however, a source that is good in one nursery may be poor, average or good in the others. This, to us, suggests that yellow birch nursery growth data will show little or no correlation with growth later in the life of the trees. Random variation in height growth might in time change, and the variation pattern becomes clinal, corresponding to the clinal variation in flushing and growth cessation.

BLACK SPRUCE

The cooperative range-wide black spruce provenance study involving Canadian and U.S. research organizations was started in the greenhouse February 17 - 23, 1971. The seed was germinated on perlite in petri dishes and the young seedlings were transplanted to tubes - 256 per source - during this phase of the study. On 3 June 1971, the seedlings were moved to our lathhouse where they were grown under natural daylength.

Preliminary data collected about 10 July 1971 consisted of:

a) survival,

b) percentage of surviving seedlings actively growing, and

c) total height of the tallest 5 seedlings in each of two replications per seed source.

We expected the variation patterns shown in Figures 1 and 2. Northern seed sources, particularly those from latitudes higher than 52°N, tend to cease elongation early, and the more southern seed sources with continued growth tend to be the tallest.

The seedlings were transplanted to the nursery beginning 16 August. We plan a 4-year nursery test of all 110 seed sources and two field tests of the 50 seed sources that perform best in the nursery.

Table 2. Height as a percent of the nursery means after 3 years in the nursery provenances for yellow birch

Provenance No.	State or Province	Location		Nursery			
		Lat.°N	Long.°W	Houghton	Rhinelander	Lansing[1]	Syracuse
3241	N.S.	46.6	60.5	85	122	102	114
3065	N.S.	45.4	61.8	89	85	96	94
3066	N.B.	47.4	65.2	112	102	111	100
3001	Que.	49.2	65.1	82	91	90	54
2997	Que.	47.0	70.3	88	86	93	58
2999	Que.	47.4	72.6	104	102	108	114
3000	Que.	47.5	75.0	99	91	114	94
2977	Me.	44.8	68.6	126	87	90	148
2956	Me.	43.7	70.9	98	100	114	112
2985	N.H.	44.0	71.4	100	96	123	81
2982	Va.	44.7	72.6	105	119	93	95
2971	Mass.	42.7	73.2	132	104	93	102
3312	Penn.	41.6	78.7	108	125	108	83
3299	Va.	37.8	79.1	107	84	117	195
2959	N.C.	35.7	82.3	96	114	108	71
2954	Tenn.	35.7	85.3	78	64	72	88
2958	Ind.	38.3	86.5	88	96	72	124
2983	Ill.	41.9	89.4	102	92	129	86
2960	Mich.	45.9	84.8	94	107	108	85
2987	Mich.	47.0	88.7	110	99	87	72
3298	Wisc.	45.7	89.0	107	92	102	124
2963	Wisc.	43.1	88.4	122	107	90	103
2964	Minn.	44.2	94.1	85	108	90	82
2966	Minn.	47.6	92.5	94	119	102	129
2967	Minn	47.8	90.2	92	108	93	91
Average height (cm)				37.3	45.9	101.8	29.5

[1]Based on the tallest tree in each row.

WHITE SPRUCE

Our range-wide white spruce provenance test is now completing the 10th season of growth and is due for measurement this fall. Since the 5-year measurements (Nienstaedt, 1969), we have scored an outbreak of spruce sawfly (*Pikonema alaskensis* (Roh.)) in a planting in northeastern Minnesota, and worked on the cytology of the species.

Sawfly damage was scored in 1968 and 1970 using 5 classes based on the amount of foliage damaged. Valued from 1 to 5 and 0 to 4 were assigned to the classes in 1968 and 1970, respectively. This difference is scoring accounts in part for the overall magnitude of the values in Table 3. The correlation between the two scorings was r = 0.838**. There was a weaker correlation between height growth and degree of injury (r = 0.599** in 1968 and r = 0.469* in 1970). The shorter sources are perhaps partly protected by the herbaceous vegetation. Nevertheless, there is considerable variation among the taller sources of which two Minnesota seed sources (1647, 1699) were highly susceptible, while two Ontario seed sources (1662, 1633) had average or slightly below average damage.

In another test planting, sawfly damage has been more severe and it has been impossible to demonstrate any difference in damage related to seed source. Is it then possible to breed for sawfly resistance? Perhaps - we cannot answer the question with the information we now have. First, we must know the impact of damage on growth and survival. Secondly, if damage does, in fact, reduce growth and lower survival, we must learn more about the causes of resistance and determine whether resistance can be increased by combining genotypes with different resistance factors (or lacking attractants or palatability). This is, perhaps, most likely to be the case if highly divergent types show resistance. A provenance from the Black Hills, S.D. (1628) and another from Summit Lake, B.C. (1677) are particularly interesting. Both are average in height, but rate low in damage, when sufficient flowering occurs these two sources should be crossed with the two low incidence Ontario sources as a first step toward the development of sawfly resistant white spruce.

Published cytological work at Rhinelander has shown significant differences in DNA content per cell among conifer species, and among provenances of some of our native species (Miksche, 1967, 1968). In an attempt to clarify these differences, we have studied base composition and the content of reiterated DNA in coniferous material.

Base composition was determined by analytical and preparative equilibrium centrifugation in cesium chloride solution, and by plots of thermal denaturation. No differences were found among six provenances of *P. glauca* or four of *P. sitchensis*, and there were no differences among these two species and 12 others of North American conifers. A possible explanation for speciation and provenance DNA differences was suggested by C_0t analyses on three provenances of *P. glauca* and on *Thuja occidentalis*, *Pinus divaricata* and *Pinus resinosa*. The differences in DNA were related to the content of repetitious DNA or reiterated sequences; the higher the DNA content per cell, the greater the proportion of such sequences (Miksche and Hotta, 1971).

Table 3. Spruce sawfly damage on 28 white spruce provenances growing in northern Minnesota

Seed Source No.	Location[1]	5-year height in.	Sawfly Damage as Percent of Mean 1968	1970
1628	S.D.	26.8	87	86
1630	Mont.	18.5	58	19
1631	Man.	32.9	117	112
1644	N.Y.	35.2	99	102
1645	Wisc.	32.9	125	142
1647	Minn.	36.8	141	162
1649	N.H.	29.9	91	77
1652	Alaska	9.2	66	30
1653	Alaska	14.8	82	86
1654	Alaska	11.3	54	51
1655	Maine	31.1	84	90
1657	Labrador	21.1	83	98
1658	Labrador	25.2	102	116
1659	N.B.	34.2	104	96
1660	Que.	34.4	102	121
1661	Que.	33.5	111	122
1662	Ont.	35.0	94	62
1663	Ont.	40.4	108	106
1664	Man.	25.6	154	136
1665	Sask.	20.4	107	155
1667	Yukon	12.3	71	78
1699	Minn.	35.9	158	136
1676	Mich.	32.2	98	107
1677	B.C.	25.9	78	45
1678	Man.	17.1	111	131
1686	Ont.	28.0	132	133
1687	Ont.	29.3	112	116
1697	Sask.	21.1	74	86
	Mean	26.8	18.98[a]	15.62[a]

[1]For provenance location details see Nienstaedt, 1969.

[a]Total average score for 10 replications. Details of the scoring systems are included in the text.

Table 4. Height growth of 35 Engelmann spruce seed sources grown five years in a Wisconsin nursery.

IFG No.	Roche's[1] thesis number	Source	Lat., °N	Elev., ft.	Height (2-3), cm
3238	25	Birch Island, B.C.	51.6	1400	62.1
3237	26	Fly Hills, B.C.	50.7	1500	48.4
3239	24	McGilvray Lake, B.C.	50.9	1500	40.7
3227	37	Cranbrook, B.C.	49.6	3800	38.2
3230	21	Baniere, B.C.	51.2	3800	20.6
3229	30	Kelownan, B.C.	49.9	4100	28.5
3233	40	Golden, B.C.	51.1	4300	20.2
3236	15	Big Bend, B.C.	51.0	4300	22.3
3240	33	Nelson, B.C.	49.3	4300	18.7
3228	39	Creston, B.C.	49.1	4600	15.7
3232	36	Canal Flats, B.C.	50.1	4600	33.4
3234	34	Fernie, B.C.	49.4	4600	21.0
3231	35	Cranbrook, B.C.	49.2	4700	27.9
3235	27	Westwold, B.C.	50.5	5100	23.4
3226	38	Cranbrook, B.C.	49.3	5500	19.2
3258		Okanoyan N.F., Wash.	48.5	4400	25.6
3259		Wenatchee N.F., Wash.	47.9	2500	26.1
3245		Lewis and Clark N.F., Mont.	46.8	7500	12.8
3253		Payette N.F., Idaho	45.1	6200	20.7
3261		Willow-Whitman N.F., Oreg.	45.0	4700	20.4
3260		Deschutes N.F., Oreg.	44.5	4200	28.8
3254		Sawtooth, Idaho	44.2	-	13.9
3257		Teton N.F., Wyo.	43.8	9000	9.5
3255		Cache N.F., Idaho	42.3	8500	11.5
3621		Larimer Co., Colo.	40.7	7900	35.9
3246		Roosevelt N.F., Colo.	40.7	9000	15.6
3622		Larimer Co., Colo.	40.6	9400	16.7
3247		Pike N.F., Colo.	38.9	8900	21.2
3249		Gunnison N.F., Colo.	38.6	10,400	18.6
3629		Mesa Co., Colo.	38.6	10,500	21.9
3248		San Juan N.F., Colo.	37.7	10,600	20.4
3256		Dixie N.F., Utah	37.6	9900	17.7
3250		Sante Fe N.F., N.M.	36.1	9500	36.9
3252		Coconino N.F., Ariz.	35.3	9400	30.3
3630		Gila N.F., N.M.	33.4	8200	51.1

[1]Roche, L. 1969. New Phytol. 68:505-554.

ENGELMANN SPRUCE

An Engelmann spruce seed source study was started at this Institute in 1965; 35 stand collections (15 from British Columbia, 20 from the U.S.) were grown for five years in a replicated nursery test near Rhinelander, Wisconsin. The 15 British Columbia seed collections were supplied by the British Columbia Forest Service. These sources were also included in the larger study carried out by L. Roche in the Cowichan Lake Nursery on Vancouver Island in 1964-65. Considering the 15 B.C. collections included in these two studies, there was a significant correlation between 2-year height in the B.C. nursery and 5-year height in the Wisconsin nursery (r = 0.79**). There were, however, striking differences between the nurseries in the amount of seed source variation. The three lowest elevation B.C. seed sources were the tallest at Cowichan averaging about 25 percent above the mean for all 15 B.C. sources. In Wisconsin, the same three sources averaged 72 percent above the 15 source mean (Table 4). The source from Birch Island, which Roche considered a product of introgressive hybridization between white and Engelmann spruce, performed most remarkedly in the Wisconsin nursery. At age 5, this source was over twice as tall as the average seed source in the study. As a matter of fact, it was taller than white spruce material of a comparable age.

Among the U.S. seed sources, the four tallest at age 5 included the three most southernly sources from New Mexico and Airzona. And while these three southern sources were from elevations ranging from 8200 - 9500 ft, these would still be considered relatively low elevation sources for Engelmann spruce in those latitudes. Unfortunately, this study was not designed to evaluate separately the effects of latitude and elevation.

When all 35 sources are considered, the five tallest sources grown in Wisconsin were from: Birch Island, Fly Hills, and McGilvray Lake, B.C.; and Gila and Sante Fe National Forests, N.M.

Within 12 of the U.S. stands, there were sufficient single-tree collections made so that genetic variance between- and within-stands could be evaluated. An analysis of 102 single-tree collections from the 12 seed sources showed significant 5-year height differences due to seed source, but no differences between individual trees within the sources. This may indicate that in future studies of Engelmann spruce provenance variation, only three or four trees per stand need be used as seed parents.

LITERATURE CITED

Clausen, K.E. 1968. Variation in height growth and growth cessation of 55 yellow birch seed sources. *In*: Proc. 8th Lake States Forest Tree Improvement Conf., Madison, Wisc. 12-13 Sept. 1967. 4 pp.

Clausen, K.E. and P.W. Garrett. 1969. Progress in birch genetics and tree improvement. Birch Symp. Proc. pp. 86-94.

Jeffers, R.M. 1970. Research at the Institute of Forest Genetics, Rhinelander, Wisc. *In*: Proc. 9th Lake States Forest Tree Improvement Conf. W.S. Dep. Agr. Forest Serv. Res. Pap. NC-47, pp. 18-22.

Jeffers, R.M. 1971. Cone characteristics and seed yield in jack pine. *In*: Proc. 18th Northeastern Forest Tree Improvement Comm. Aug. 1971. (In Press).

King, J.P. 1971. Pest susceptibility variation in Lake States jack pine seed sources. U.S. Dep. Agr. Forest Serv., Res. Pap. NC-53.

Miksche, J.P. 1967. Variation in DNA content of several gymnosperms. Can. J. Genetic. Cytol. 9:717-722.

Miksche, J.P. 1968. Quantitative study of intraspecific variation of DNA per cell in *Picea glauca* and *Pinus banksiana*. Can. J. Genet. Cytol 10:590-600.

Miksche, J.P. and Y. Hotta. 1971. DNA base composition and repetitious DNA in several conifers at interspecific and intraspecific levels. (In preparation).