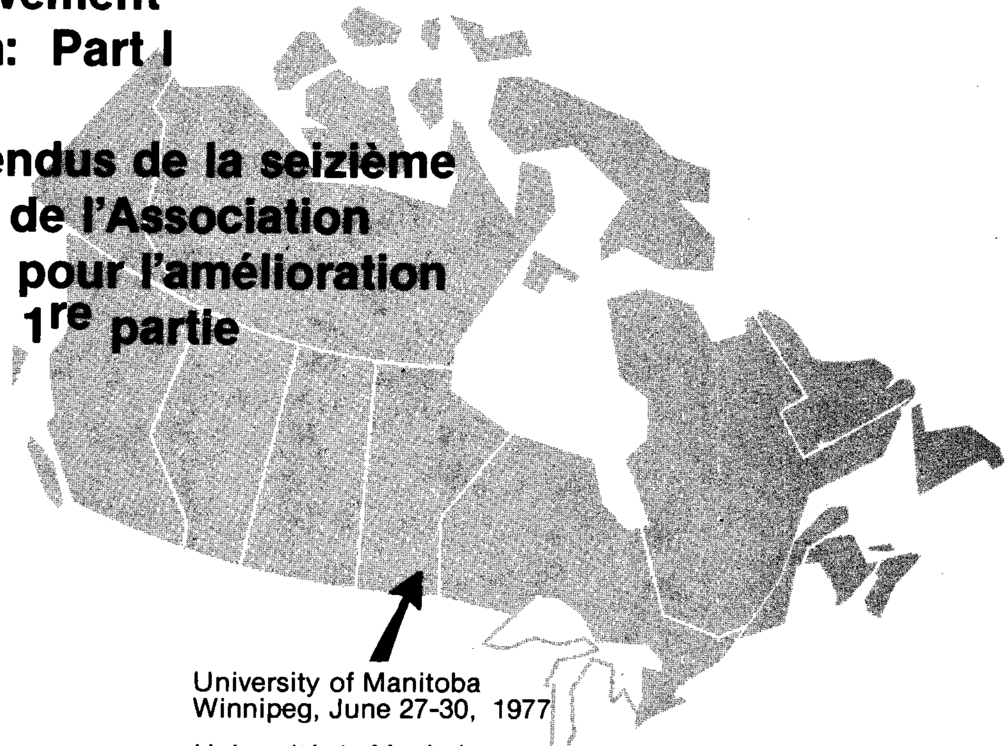
Ron Smith

Proceedings of the sixteenth meeting of the Canadian Tree Improvement Association: Part I

Comptes rendus de la seizième conférence de l'Association canadienne pour l'amélioration des arbres: 1re partie



University of Manitoba
Winnipeg, June 27-30, 1977

Université du Manitoba
Winnipeg du 27 au 30 juin 1977

Minutes and members' reports

Procès-verbaux et rapports

PROCEEDINGS

OF THE

SIXTEENTH MEETING

OF THE

CANADIAN TREE IMPROVEMENT ASSOCIATION

PART 1:

MINUTES AND MEMBERS' REPORTS

HELD JOINTLY WITH THE
CANADIAN BOTANICAL ASSOCIATION
AND THE
GENETICS SOCIETY OF CANADA

UNIVERSITY OF MANITOBA
WINNIPEG, MANITOBA
JUNE 27 - 30, 1977

EDITOR: C.W. YEATMAN

Part 1. Minutes and Members' Reports.

Distributed to Association members and to others on request to the Editor, C.T.I.A./A.C.A.A., Chalk River, Ontario, Canada, K0J 1J0.

Part 2. Symposium: The Contribution of Forest Genetics to the Urban Environment.

Distributed worldwide to persons and organizations actively engaged or interested in forest genetics and tree improvement.

Produced by
Canadian Forestry Service,
Fisheries and Environment, Canada,
for the
Canadian Tree Improvement Association,
Ottawa, 1978.

COMPTES RENDUS

DE LA

SEIZIÈME CONFÉRENCE

DE

L'ASSOCIATION CANADIENNE POUR L'AMÉLIORATION DES ARBRES

1RE PARTIE:

PROCÈS-VERBAUX ET RAPPORTS DES MEMBRES

RÉUNION TENUE CONJOINTEMENT AVEC
L'ASSOCIATION BOTANIQUE DU CANADA
ET
LA SOCIÉTÉ GÉNÉTIQUE DU CANADA

UNIVERSITÉ DU MANITOBA
WINNIPEG, MANITOBA
DU 27 AU 30 JUIN, 1977

RÉDACTEUR: C.W. YEATMAN

1re partie. Procès-verbaux et rapports des membres.

Distribués aux membres de l'Association et aux autres sur demande au rédacteur, C.T.I.A./A.C.A.A., Chalk River, Ontario, Canada, K0J 1J0.

2e partie. Symposium: la contribution de la génétique forestière au milieu urbain.

Distribué à l'échelle mondiale aux personnes et organisations activement engagées ou intéressées à la génétique forestière et à l'amélioration des arbres.

Publié par
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Pêches et Environnement, Canada,
pour
l'Association canadienne pour l'amélioration des arbres,
Ottawa, 1978

PROCEEDINGS OF THE SIXTEENTH MEETING OF

THE CANADIAN TREE IMPROVEMENT ASSOCIATION

With the compliments of the Association

Enquiries may be addressed to the authors or to Dr. N.K. Dhir, Executive Secretary, C.T.I.A./A.C.A.A.

The Seventeenth Meeting of the Association will be held in Grand Falls, Newfoundland, August 27-30, 1979. The theme of the C.T.I.A. symposium will be "Tree Improvement in the Boreal Forest - Today and Tomorrow". Canadian and foreign visitors are welcome. Further information will be distributed in fall, 1978, to all members and to others on request. Enquiries regarding the Seventeenth Meeting should be addressed to Dr. M.A.K. Khalil, Vice-Chairman, Symposium, or to Dr. J.P. Hall, Vice-Chairman, Local Arrangements, Newfoundland Forest Research Centre, Canadian Forestry Service, St. John's, Newfoundland.

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TO: Dr. N.K. Dhir, Executive Secretary
Canadian Tree Improvement Association
Alberta Forest Service
Energy and Natural Resources
Petroleum Plaza
South Tower
Edmonton, Alberta, T5K 2C9

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

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Signed ....

COMPTES RENDUS DE LA SEIZIÈME CONFÉRENCE DE L'ASSOCIATION

CANADIENNE POUR L'AMÉLIORATION DES ARBRES

Gracieuseté de l'Association

Les demandes de renseignements peuvent être adressées aux auteurs ou à Dr. N.K. Dhir, secrétaire exécutif, A.C.A.A./C.T.I.A.

La dix-septième conférence de l'Association aura lieu à Grand Falls, Terre-Neuve, du 27 au 30 août 1979. Le thème général du symposium de l'A.C.A.A. sera: "L'amélioration des arbres de la forêt boréale, aujourd'hui et demain". Les visiteurs canadiens et autres sont les bienvenus. De plus amples renseignements seront communiqués à l'automne 1978, à tous nos membres et aux autres sur demande. Les questions au sujet de la dix-septième conférence devraient être adressées à Dr. M.A.K. Khalil, vice-président du symposium, ou à Dr. J.P. Hall, vice-président, arrangements locaux, Centre de recherches forestières de Terre-Neuve, Service canadien des forêts, St-John's, Terre-Neuve.

Si votre nom, titre ou adresse, tels qu'inscrits sur l'étiquette d'envoi sont incomplets ou erronés, veuillez remplir et retourner le feuillet de corrections.

Les autres qui seraient intéressés à recevoir les comptes rendus, les avis de réunions, etc., peuvent retourner leur formule pour être reçus membres correspondants (Canadiens) ou être placés sur la liste postale pour les comptes rendus seulement (bibliothèques, institutions, destinataires étrangers).

À: Dr. N.K. Dhir, secrétaire exécutif
Association canadienne pour l'amélioration des arbres
Alberta Forest Service
Energy and Natural Resources
Petroleum Plaza
South Tower
Edmonton, Alberta, T5K 2C9

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M. Mlle .... Titre ....

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Signé ....

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MEMBERS' REPORTS/RAPPORTS DES MEMBRES

ACTIVE MEMBERS

1977

CANADIAN TREE IMPROVEMENT ASSOCIATION

Mr. M. Albricht	B.C. Forest Service Tappen, B.C.
Mr. J. Ambrose	University of Guelph Arboretum Guelph, Ontario
Dr. J.W. Andresen	Faculty of Forestry University of Toronto 203 College Street Toronto, Ontario, M5S 1A1
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Dr. M.G. Boyer	Department of Biology York University 4700 Keele Street Downsview 463, Ontario
Mr. G.P. Buchert	Forest Research Centre Ontario Ministry of Natural Resources Maple, Ontario, L0J 1E0
Mr. R. Calvert	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ontario, K0J 1J0
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Mr. K.C. Eng	Forest Resources Branch Ontario Ministry of Natural Resources Angus, Ontario
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Mr. C. Hewson	Reforestation Division Red Rock Nursery B.C. Forest Service R.R. 7 15 Mile Road Prince George, B.C.
Mr. K. Illingworth	B.C. Forest Service Research Division Victoria, B.C., V8V 1X5
Mr. Ingemar Karlsson	Cowichan Lake Forest Experiment Station Research Division B.C. Forest Service Mesachie Lake, P.O., B.C.
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Mr. J. Konishi	B.C. Forest Service Reforestation Division Victoria, B.C., V8V 1X5
M. Yves Lamontagne	min. des Terres et Forêts Service de la restauration 200 B Chemin Ste-Foy Québec, P.Q., G1R 4X7
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Mr. K.T. Logan	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ontario, K0J 1J0
Mr. D.M. Matthews	Canadian International Paper Co. Dalhousie, New Brunswick
Mr. J.A. McPherson	Kimberley Clark Canada Ltd. Longlac, Ontario
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Dr. E.K. Morgenstern	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ontario, K0J 1J0
Dr. B. Mullick	Canadian Forestry Service Pacific Forest Research Centre 506 West Burnside Road Victoria, B.C., V8Z 1M5

Mr. T.J. Mullin	Nova Scotia Department of Lands and Forests P.O. Box 68 Truro, Nova Scotia
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Dr. A.L. Orr-Ewing	B.C. Forest Service Research Division Victoria, B.C., V8V 1X5
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Miss Rose Marie Rauter	Ontario Ministry of Natural Resources Forest Research Centre Southern Research Station Maple, Ontario, L0J 1E0
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Mr. D.A. Skeates	Ontario Ministry of Natural Resources Forest Research Centre Maple, Ontario, L0J 1E0

Mr. R.D. Stevens	MacMillan and Bloedel Ltd. Forestry Division 65 Front Street Nanaimo, B.C.
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Mr. P. Sziklai	North Western Pulp and Power Ltd. Tree Improvement Office Hinton, Alberta, T0E 1B0
Dr. G. Vallée	min. de Terres et Forêts Service de la recherche 2700 Rue Einstein Ste-Foy, Québec, G1P 3W8
Mr. B. Vincent	Proctor & Gamble Cellulose Ltd. Grand Prairie, Alberta T8V 3A9
Mr. B.S.P. Wang	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ontario, K0J 1J0
Mr. N.C. Wheeler	B.C. Forest Service Red Rock Forest Nursery R.R. 7 15-Mile Road Prince George, B.C.
Mr. D. Winston*	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ontario, K0J 1J0
Dr. C.W. Yeatman	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ontario, K0J 1J0
Dr. F. Yeh	B.C. Forest Service Research Division 516 Government Street Victoria, B.C., V8V 1X5

Dr. Cheng Ying	Canadian Forestry Service Petawawa Forest Experiment Station Chalk River, Ontario, K0J 1J0
Dr. L. Zsuffa	Ontario Ministry of Natural Resources Forest Research Centre Southern Research Station Maple, Ontario, L0J 1E0

*Prospective Active Members

BUSINESS MEETING - MINUTES

Dr. J.I. Klein chaired the 16th Business Meeting of the C.T.I.A. which was called to order at 8:30 p.m. June 27th, 1977. Seventeen members were in attendance. The agenda was read by J.C. Heaman.

179. MINUTES OF THE LAST MEETING

Motion: That the minutes be adopted as published. Moved by G.H. Kokocinski, seconded by R. Piesch. Carried.

180. MEMBERSHIP

The names of prospective members and those changing status were presented as follows:

a) New Members

Sponsoring

Atkins, E.S.	Coordinator Planning Services Department Lands and Forests Nova Scotia
Barr, T.W.	Woodlands Manager Proctor and Gamble Cellulose Ltd. Grand Prairie, Alberta
Bruce, J.	Forester i/c Reforestation Division B.C. Forest Service Victoria, B.C.
McDougall, F.W.	Assistant Deputy Minister Alberta Forest Service Edmonton, Alberta
Wright, J.	Chief Forester North Western Pulp & Power Ltd. Hinton, Alberta
Young, W.	Assistant Chief Forester (Resource Management) B.C. Forest Service Victoria, B.C.

Active

Albricht, M.	B.C. Forest Service Tappen, B.C.
Ambrose, J.	University of Guelph Arboretum Guelph, Ontario
Beaudoin, R.	min. des Terres et Forêts Ste-Foy, Québec
Buchert, G.	Ontario Ministry of Natural Resources Maple, Ontario
Crown, M.	B.C. Forest Service Duncan, B.C.
Dhir, N.	Alberta Forest Service Edmonton, Alberta

Fogal, W.H.	Canadian Forestry Service Petawawa, Ontario
Hall, J.P.	Canadian Forestry Service St. John's, Newfoundland
Matthews, D.M.	Canadian International Paper Co. Dalhousie, New Brunswick
Mullin, T.J.	Nova Scotia Department of Lands and Forests Truro, Nova Scotia
Pharis, R.P.	University of Calgary Calgary, Alberta
Robert, D.	min. des Terres et Forêts Ste-Foy, Québec
Ronald, W.G.	Canada Department of Agriculture Morden, Manitoba
Segaran, S.	Department of Renewable Resources Winnipeg, Manitoba
Stipanicic, A.	min. des Terres et Forêts Ste-Foy, Québec
Sziklai, P.	North Western Pulp & Power Ltd. Hinton, Alberta
Vincent, B.	Proctor and Gamble Cellulose Ltd. Grande Prairie, Alberta
Ying, Cheng	Canadian Forestry Service Petawawa, Ontario

Corresponding

Bax, H.	K.B.M. Forestry Consultants Thunder Bay, Ontario
Beaven, A.B.	Manitoba Forestry Association Winnipeg, Manitoba
Benoit, P.A.	Canadian International Paper Co. Montreal, Quebec
Bradshaw, D.	Newfoundland Forest Protection Association St. John's, Newfoundland
Carpentier, J.P.	min. des Terres et Forêts Ste-Foy, Québec
Kin-Wah, Cheung	B.C. Forest Service Victoria, B.C.
Lizotte, H.	Quebec Forestry Association Quebec, P.Q.
Coats, J.D.	Ontario Forestry Association Willowdale, Ontario
Cuttell, R.J.	Parks and Recreation Department Dorval, P.Q.

Dojack, J.	Ottawa, Ontario
Dugas, P.	Protection de l'environnement Montréal, Québec
Flavelle, F.W.	Department of Tourism and Renewable Resources Prince Albert, Saskatchewan
Forward, R.	Newfoundland Forest Protection Association St. John's, Newfoundland
Garceau, P.	Canadian International Paper Co. Maniwaki, Quebec
Gilbert, R.	Cie. de papier Québec Baie Comeau, Québec
Hall, A.D.	Canadian Forestry Association Ottawa, Ontario
Howe, G.	Department Regional Economic Expansion Indian Head, Saskatchewan
Huntley, G.D.	Canadian Forestry Service Sault Ste. Marie, Ontario
Jorgensen, E.	Canadian Forestry Service Ottawa, Ontario
Kelly, J.B.	C.F.A. of New Brunswick Fredericton, New Brunswick
Kemperman, J.	Ontario Ministry of Natural Resources Thunder Bay, Ontario
Lapointe, P.	min. des Terres et Forêts Hull, Québec
Lathamm, J.A.	Reid Collins Associates Vancouver, B.C.
Levasseur, C.	University Laval Quebec, P.Q.
Lyster, R.H.	C.F.A. of British Columbia Vancouver, B.C.
Macdonald, J.I.	Atlantic Resource Consultants Ltd. Fredericton, New Brunswick
Marceau, J.P.	J.D. Irving Ltd. Grand Falls, New Brunswick
Mathieu, P.	Revue Forêt Conservation Québec, P.Q.
Menard, G.	Co. Internationale Pap. Can. Maniwaki, Québec
Milette, P.	College Algonquin Pembroke, Ontario
Miller, F.	Alberta Forestry Association Edmonton, Alberta
Mubareka, M.A.	Fraser Co. Ltd. Edmunston, New Brunswick
Neider, D.	Can. Parks & Recreation Association Vanier, Ontario

Paquette, E.	Papeterie Reed Ltee. Québec, P.Q.
Pinard, M.	Canadian International Paper Co. Montreal, Quebec
Pitel, J.A.	Canadian Forestry Service Petawawa, Ontario
Pollett, F.A.	Canadian Forestry Service St. John's, Newfoundland
Pickert, J.R.	Alberta Institute of Technology Edmonton, Alberta
Robinson, F.N.	Abitibi Paper Co. Ltd. Sault Ste. Marie, Ontario
Schiedel, I.H.	Maple Ridge, B.C.
Smith, S.M.	Prince Albert Pulp Ltd. Prince Albert, Saskatchewan
Speed, W.A.	Nova Scotia Forestry Association Halifax, Nova Scotia
Starr, Leonard	Great Lakes Paper Co. Ltd. Thunder Bay, Ontario
Tan, Geok-Yong	University of Alberta Edmonton, Alberta
Thomson, P.	Canadian International Paper Co. Maniwaki, Quebec
Vessie, B.A.	Department Natural Resources Bathurst, New Brunswick
Vogel, K.	Manitoba Renewable Resources and Transport Services
Voth, B.	Rayonier of Canada Vancouver, B.C.
Wentz, C.F.R.	Saskatchewan Forestry Association Saskatoon, Saskatchewan
Zajc, M.	Algonquin College Ottawa, Ontario

(b) Retiring Members

Dr. R.J. Hilton	University of Guelph
Mr. M.J. Holst	Canadian Forestry Service, Petawawa, Ontario
Mr. H.G. MacGillivray	Canadian Forestry Service, New Brunswick

(c) Change of Status

Dr. D.J. Durzan, now working at Appleton, Wisconsin, changes from "Active" to "Resident Abroad".

(d) Obituary

The early death of Dr. Bruce Dance was noted with regret.

Motion: That the individuals applying for Sponsoring, Active and Corresponding memberships as listed, be duly elected. Moved by R.M. Rauter, seconded by Y. Lamontagne. Carried.

(e) Honorary Members

Two retiring members, Mr. Holst and Mr. MacGillivray had been sponsored for honorary membership. Letters supporting their nomination were read from the sponsors and the careers of these two men were outlined, showing the important impact their work was having and would continue to have on tree improvement in Canada. Apart from their more routine functions, both these men had assembled material in field plantations which would be used for studies for many years to come. Both were elected to honorary membership by a unanimous vote.

181. BUSINESS ARISING FROM THE MINUTES OF THE 15TH MEETING

a) Working Party for the Conservation of Endangered Arboreal Germplasm

Motion: That the Canadian Tree Improvement Association supports the principles of need and method outlined in the paper "Gene Pool Conservation for Applied Breeding and Seed Production", presented by Dr. C.W. Yeatman (Tokyo, 1972), and recommends that the urgent need for action on this matter be brought to the attention of all Canadian Forest Services and other concerned public and private agencies.

Action: Dr. Yeatman, Chairman of the Working Party, reported that the publication referred to had received wide exposure in the past two years. It was displayed and distributed in association with the Canadian Forestry Service genetics exhibit that was shown before industrial, governmental and lay audiences at national and provincial forestry meetings, and workshops in Ontario, Quebec and Newfoundland. The exhibit, and the publication, were also on display at the current meeting.

b) University Education in Genetics - Policy, Planning and Support

Motion: That the Canadian Tree Improvement Association should make every effort to persuade the Universities, both in eastern and western Canada, to include in their programs more undergraduate training in tree improvement, including training in depth in quantitative genetics at the graduate level.

Action: Letters were sent out to the Deans at University of British Columbia, Lakehead University, University of New Brunswick, University of Toronto, Laval University, University of Alberta and to the Director General of the Canadian Forestry Service. Replies were received from most of the letters, but not from Laval or Lakehead. The replies were held on file and an information letter was sent to the members. The members were asked to direct any further action by the executive. Comments differed, some pointing to a lack of student interest, while others discussed the shortage of employment opportunities, and the possibility of promotion by C.T.I.A. and of financial incentives. For further action see New Business.

c) Address Labels

Motion: That a survey of members of C.T.I.A. be made as to their requirements for an address labels service, when the survey had been completed, that an estimate of costs involved be forwarded to the Canadian Forestry Service for their consideration.

Action: This survey was not carried out.

d) Letterhead

Members were invited to submit suggestions for a suitable logo. Interim stationery had been purchased. Dr. Yeatman had obtained quotes on a two coloured design but was in favour of listing sponsoring members. In an attempt to complete the list of sponsors a letter was sent to all active members. Some replies have been received and the other agencies will be checked once more. The proposed letterhead was shown to the meeting.

182. REPORT COMMITTEE ON THE CONSERVATION OF ENDANGERED ARBOREAL GERMPLASM

C.W. Yeatman (Chairman)

The committee has not been active in taking new initiatives but has kept a watching brief on implementation of gene conservation of forest tree species. Most provinces have initiated or expanded programs to establish seed production areas in regions of intensive utilization and need for seed. Such areas are effective gene pool resources.

Dr. Khalil reported by letter that he had collected red pine seed from the remnant stand at Pine Acres, Newfoundland (lat. 48°45'N, long. 54°15'W). In 1976 about 160 seedlings were planted in the arboretum in the North Pond Experimental Area (lat. 48°40'N, long. 54°30'W).

Dr. Yeatman reported he had been nominated National Coordinator of Information on Forest Genetic Resources for F.A.O. He is also in contact by correspondence with Dr. Roland Loiselle, Head, Central Office for the Plant Gene Resources of Canada and secretary of the Canada Committee on Plant Gene Resources. The latter committee reports to the Canadian Agricultural Services Coordinating Committee. The Committee and the Central Office are primarily concerned with agricultural crop germplasm.

183. a) LOCATION OF NEXT MEETING

Dr. Khalil's invitation to meet in Newfoundland was read.

Motion: That the 17th Meeting of the Canadian Tree Improvement Association be held in Newfoundland in 1979. Moved by M.A.K. Khalil, seconded by C.W. Yeatman. Carried.

b) THEME OF NEXT MEETING

C.W. Yeatman suggested "Current Strategies for Genetic Improvement of Canadian Forest Trees".

Discussion then took place concerning the need to include future strategies or to restrict the scope to those already being practiced in Canada with simplification to prevent confusion for the forest manager who was concerned with their application. An alternative theme, "How to obtain quick application to forest genetics" was suggested by Dr. Vallée.

The following version of the themes were then placed in front of the members and supporting votes recorded to be used as guidance for the incoming executive:

I	(a)	Current strategies for genetic improvement of Canadian Forest Trees	(7 votes)
	(b)	Future strategies for genetic improvement of Canadian Forest Trees	(2 votes)
	(c)	Strategies for advanced generation breeding	(1 vote)
	(d)	Strategies for genetic improvement applicable to Canada	(8 votes)
II		How to obtain quick application of forest genetics	(1 vote)

184. ELECTION OF OFFICERS

Dr. C.W. Yeatman acting as a one-man nominating committee presented his slate which had been drawn up on the assumption that the meeting would be in Newfoundland.

Motion: It was then moved that the order of business be changed to include an item to amend the bylaws before the election of officers. Moved by R.M. Rauter, seconded by G. Murray. The need was seen to expand the executive to handle the enlarged programs and to add an editor's position and the bylaws had to be changed before this was possible. Carried.

Motion: That Article X of the bylaws be amended to read:

Officers. The officers of the association shall consist of a chairman, a vice-chairman (Symposium), a vice-chairman (Local Arrangements), an executive secretary and an editor.

All officers shall be appointed for a period of two years by election at the meeting of the deliberative assembly. Moved by R.M. Rauter, seconded by G. Murray. Carried unanimously.

Dr. C.W. Yeatman agreed to let his name stand as Editor.

Motion: That the proposed slate of officers be elected. Moved by R.M. Rauter, seconded by R.F. Piesch. Carried.

The officers for 1978-79 are:

Chairman:	Mr. Malcolm Squires
Vice-chairman (Symposium):	Dr. M.A.K. Khalil
Vice-chairman (Local Arrangements):	Dr. J.P. Hall
Executive Secretary:	Dr. Narinder Dhir
Editor:	Dr. C.W. Yeatman

NEW BUSINESS

185. UNIVERSITY EDUCATION IN FOREST GENETICS

The Chairman asked if more action was desired by the members on this topic.

Motion: That the gist of both Dr. Morgenstern's letter concerning vacancies and that of Dr. Khalil's concerning a scholarship fund be transmitted by the 1976-77 Chairman to the heads of Canadian forestry faculties. Moved by C.W. Yeatman, seconded by J. Coles. Carried.

R.M. Rauter raised the points (a) that the universities active in the field should be commended and (b) that even if the universities felt that there were insufficient opportunities for employment in forest genetics, the principles should be taught as part of general forest management. G. Murray drew attention to the differences between schools offering post-graduate courses and those which only provided training to the Bachelor level, noting that a Master's program would be instituted at the Lakehead University in the fall 1977. Dr. Murray also recommended that concerned members should write directly to their appropriate deans outlining specific deficiencies found in recent graduates with whom they had contact.

186. LETTERHEAD

In discussing Dr. Yeatman's proposed two colour letterhead, R.M. Rauter voiced concern about using sponsors names on the letterhead. She felt that there could be a conflict of interest between the views of the association and those of one or more sponsoring agencies for example, and that problems could develop involving using paper with the sponsors name without specific permission being given on each occasion. The possibility of a changing list of sponsors was also raised.

Motion: That the plain letterhead, without the list of sponsoring members be accepted and obtained. Moved by C.W. Yeatman seconded by R.M. Rauter. Carried.

187. SURVEY FOR ADDRESS LABELS

It was noted that the previous meeting's motion still required action.

188. BYLAWS

The chairman stated he would entertain a motion to establish a committee to examine the bylaws and recommend any needed changes.

Motion: That a bylaws committee of three, consisting of Dr. J. Klein, Dr. N. Dhir and Dr. B. Dancik be appointed. Moved by R. Calvert, seconded by M.A.K. Khalil. Carried.

The three individuals expressed a willingness to serve and to prepare recommendations and resolutions for the 1979 meeting.

189. PLANNING FUTURE MEETINGS

A motion concerning the need for longer planning of future meeting sites was moved by C.W. Yeatman, seconded by M.A.K. Khalil.
WHEREAS ample and advance planning of biennial meetings are necessary to meet the objectives of the C.T.I.A. most effectively.
WHEREAS at any one meeting only a portion of the membership can attend to participate directly in the business meetings.
WHEREAS many factors of time, personnel, opportunity, sequence of meetings, geography and subject matter need to be considered in planning future meetings.

BE IT RESOLVED THAT

1) the sequence of biennial meetings of the Canadian Tree Improvement Association be planned three meetings in advance;

2) that at each biennial business meeting

   a) invitations and/or suggestions be requested for the locale of the third meeting to be held 6 years after the current meeting.

   b) the location of the second meeting after the current meeting be decided on a vote of the membership based on the proposals made at the previous meeting.

   c) the theme of the symposium at the meeting following the current meeting be decided on the basis of recommendations made by the executive in consultation with members representative of the institution or sponsor hosting the next meeting.

Moved by C.W. Yeatman, seconded by M.A.K. Khalil. The motion was read but before discussion took place a motion to adjourn to meet again at noon on June 28th was received, moved by B. Dancik, seconded by A. Gordon. Carried. 10:30 p.m.

The meeting was reconvened during the field trip to Morden Research Station on Tuesday, June 28th at 3:00 p.m. Twenty four members were present.

Discussion on the planning of future meetings continued and the motion presented above, by C.W. Yeatman, seconded by M.A.K. Khalil was carried.

190. LOCATION OF 1981 MEETING

The Chairman called for suggestions for the location for the 1981 meeting. An invitation had been extended by G.C. Warrack, Forester i/c Research Division, B.C. Forest Service.

Motion: That the 1981 meeting be held on the west coast, preferably on Vancouver Island. Moved by C.W. Yeatman, seconded by J.C. Heaman. Carried.

191. LOCATION OF 1983 MEETING

The chairman then called for suggestions for the location of the 1983 meeting. P. Sziklai requested that the possibility of a joint meeting with a U.S. tree improvement group be examined. R.M. Rauter suggested Maple or Rhinelander would be worth considering. Quebec was also suggested. It was recommended that these possibilities be explored so that a decision could be made at the 1979 meeting.

192. OTHER NEW BUSINESS

Motion: That the Executive of the C.T.I.A. 1978-79 approach the forest industry in an attempt to elicit scholarships in forest genetics for post graduate study. Moved by M.A.K. Khalil, seconded by S. Segaran. Discussion centred around the possible administration of such funds, either they might be paid to the students or to the Universities themselves. J.C. Heaman drew attention to the system used by the Western Forestry and Conservation Association scholarships. C.W. Yeatman suggested that the C.P.P.A. or the C.F.A. might be approached to administer or support such a fund. G. Vallée drew attention to the wording of the motion that left the initiative to the incoming executive. Carried.

193. APPRECIATION FOR LOCAL ARRANGEMENTS

R. Calvert drew attention to the fact that although he had been named as local organizer for the 16th meeting, he had immediately been moved to a position at Petawawa. He had called on Wilbert Ronald to take over the duties although he was not then a member of the association and he had stepped in and performed these admirably including providing us with the excellent meal at the Station. He also thanked the Station staff for their part in the program.

Motion: That the 16th Meeting of the C.T.I.A. express its appreciation to Dr. Wilbert Ronald for his efforts on our behalf. Moved by R. Calvert, seconded by B. Dancik. Carried.

194. C.I.F. WORKING GROUP ON FOREST GENETICS

G. Murray, chairman of the C.I.F. Working Group emphasized the need to maintain a high profile and requested more articles on forest genetics for the Forestry Chronicle. He felt there was a need for general articles, e.g. progeny testing, - aims, objectives, etc. seed orchards - management practices, design, etc. Industrial foresters must be kept informed of developments and thus provided a ready means of access to them. Articles and suggestions should be mailed directly to him at the Lakehead University.

195. VANCOUVER MEETINGS 1978

F. Yeh drew the attention of the members to a series of meetings planned for Vancouver in mid-August 1978.

a) I.U.F.R.O. Working Groups: Provenance Douglas fir
Lodgepole pine
Sitka Spruce
Abies species

b) I.U.F.R.O. Working Group - Genetics

c) North American Quantitative Forest Genetics Group

d) Tree Isozyme Workshop

Details would be available from Dr. Sziklai at U.B.C. or Dr. Yeh of the B.C. Forest Service, Research Division, Victoria, B.C.

196. APPRECIATION

On behalf of the members of the Association, G. Vallée proposed a vote of thanks to the outgoing executive.

197. ADJOURNMENT

Motion: There being no further business, that the 16th Business Meeting of the C.T.I.A. be adjourned. Moved by R. Calvert, seconded by B. Dancik. Carried.

J.C. Heaman
Executive Secretary
C.T.I.A./A.C.A.A.

ACKNOWLEDGEMENTS TO C.B.A. AND G.S.C.

The success of the Winnipeg conference was largely due to the joint nature of the meeting with the Canadian Botanical Association and the Genetics Society of Canada. Much of the essential organization with respect to arrangements for meeting rooms, on campus accommodation, social events, luncheons and banquets, registration and much more was willingly done on our behalf by members of the executive of these organizations. We are truly grateful for their efforts. Special appreciation is extended to Phyllis McAlpine (G.S.C.) and Jennifer Shay and David Punter (C.B.A.), who worked long hours to assure a smooth running meeting.

R.F. Calvert
Chairman, Local Arrangements
C.T.I.A./A.C.A.A.

MEMBERS' WORKSHOP

ATELIER DES MEMBRES

MEMBERS' WORKSHOP
Monday, June 27, and Wednesday, June 29

Chairman: Dr. J.I. Klein

INTRODUCTION

Discussions of Canadian tree improvement programs were organized by major topics, each with a moderator and rapporteur. The objective was to emphasize strategy and accomplishments to date through brief oral presentations and audience participation. The discussions and the condensed accounts of them reported here were necessarily limited. Identification of speakers, project leaders and sponsoring agencies has been omitted in some cases to improve readability. Further details are to be found in the progress reports published in these Proceedings.

VARIATION STUDIES AND SELECTION IN NATIVE SPECIES

Spruces

Moderator: C.W. Yeatman
Rapporteur: N.K. Dhir

Provenance experiments with white spruce from eastern and central portions of the species range have attained plantation ages approaching 20 years, from Ontario to Newfoundland. Throughout the area, populations from the Upper Ottawa Valley have consistently been among the best performers. In one plantation in New Brunswick, two populations from the northeastern portion of the same province were also above average in growth. For exploitation of these results, seedling seed orchards are being established in the Maritime Provinces, using open-pollinated progenies originating in the superior source areas. One thinning has been done in the oldest of these orchards. The area of seed orchard is to be increased as more material becomes available. At the Petawawa Forest Experiment Station, a project is underway to determine the geographic extent of the superior source in the Ottawa Valley by more intensive sampling.

Preparations for a new range-wide cooperative study on geographic variation of white spruce are being coordinated from Petawawa. The overall study will involve about 300 origins. Plantation establishment is scheduled for 1980. At Lakehead University, teaching and research functions are combined in experiments conducted by students on geographic variation in root regeneration potential of white spruce. A province-wide white spruce provenance experiment in Manitoba will be ready for planting in 1978. Similar trials are under development in Alberta.

Work on intra-population selection for white spruce is in progress across Canada. In Newfoundland, progeny of plus trees was not taller than progeny of check trees at the nursery stage. Establishment of clonal seed orchards using intensively selected plus trees is in progress in Nova Scotia, New Brunswick, and Ontario. The Province of Quebec has established a small area of seed orchard plantation using super-seedlings selected in nursery beds. The oldest trees have been planted for four years. In Ontario, ongoing attempts to collect seed from plus trees for operational use have met with difficulties. Controlled pollination using a type of bi-parental mating design is in progress for testing of seed orchard clones. There is an urgent need to increase white spruce seed production in Ontario, while reducing dependence on contract cone collections. A program based on open-pollinated progeny testing is underway in four areas of interior British Columbia. In one area, at six years of age, 45% of the variance among plot means in a progeny test was due to genetic effects. Expected genetic gain in seed orchards from the best 20 of 146 families in that test would be 23 to 26% by grafting of parental clones, or 11% by conversion of progeny test plantations.

Improvement of black spruce in Nova Scotia and New Brunswick is being planned with a strategy of open-pollinated progeny testing of several hundred selected parent trees. A program in progress in Ontario is similar to that province's white spruce program, employing grafted seed orchards of intensively selected plus trees and control-pollinated progeny tests. At Petawawa, past efforts with black spruce have concentrated on estimation of genetic parameters. Emphasis has recently shifted to large-scale testing of open-pollinated progenies. In each of three areas, tests including 100 to 130 progenies have been established on six or seven test sites. Field planting was done from 1974 to 1977, at a rate of about 5,000 trees per year. Small-scale provenance testing of black spruce is at an early stage in Manitoba.

A cooperative improvement program for red spruce in Nova Scotia will employ clonal seed orchards of intensively selected plus trees.

Pines

Moderator: R.M. Rauter
Rapporteur: B.P. Dancik

Early range-wide provenance experiments with jack pine, planted in Ontario and elsewhere, revealed major genetic variation in this species, with clines of growth related to latitude and a latitude-temperature index, particularly at southern sites. In the north, there was a strong provenance x environment interaction.

Regional improvement projects for jack pine are in progress from Nova Scotia and New Brunswick west to Saskatchewan. Programs in Nova Scotia, New Brunswick, Quebec, and Ontario are cooperative ventures, and have a common emphasis on large numbers of parent trees, open-pollinated progeny testing, and seedling seed orchards, although procedures vary. The New Brunswick and Quebec programs rely to some extent on selection, testing, and seed production from natural stands. All of these programs are in early stages of progress. Three areas in Manitoba and Saskatchewan have an improvement program underway. In each area, over 200 open-pollinated progenies from the area were planted from 1972 to 1976 in family tests with several sites for each test. As in the other jack pine programs, there was only moderate intensity of parent-tree selection. Seed orchards using parental or progeny genotypes will be established after successive evaluations of the tests.

Improvement of lodgepole pine is in initial stages in Alberta. Several hundred parent trees are being selected by ocular screening in two areas of the province. Open-pollinated progeny tests will be established. Some of the seed from the parent trees will be bulked for establishment of plantations in which mass selection will be carried out. A trial of more intensive plus-tree selection is planned for the coming year. The provincial government and forest industries are cooperating in this program. A separate industrial program is under development with lodgepole pine in part of the foothills area of west-central Alberta. Subject to approval of the parent firm, a seed source test will be initiated by 1980. It is hoped that an intra-population project can be started later, probably based on intensive plus-tree selection.

There are plans for an improvement program for red pine in Nova Scotia, partly to alleviate the seed shortage in that species. Results of a red pine provenance test in eastern Manitoba, to the 15th year, support continued use of local seed sources.

Efforts to improve blister-rust resistance, growth, and form of eastern white pine in Ontario have resulted in selection of a number of plus trees. Open-pollinated seed will be collected in a good seed year for establishment of progeny tests.

Other Conifers and Hardwoods

Moderator: R.M. Rauter
Rapporteur: A.G. Gordon

J.C. Heaman outlined the strategies for Douglas fir being carried out by the Forest Research Division of the B.C. Ministry of Forests. At this stage the program may be described as a logical bridge between a research project and a practical tree improvement program. Breeding production following up Alan Orr-Ewing's work has involved the following steps and accomplishments:

1. The establishment of an initial background breeding collection involving intensive plus tree selection with support from U.B.C. and the forest industries, racial selection, interracial crossing, and inbreeding.

2. Production of the first generation.

3. Conversion from selection breeding of individual clones to open pollination with seed orchards.

4. The 1966 IUFRO provenance collection under Ralph Schmidt now coming through under Keith Illingworth.

5. Seed orchards are now coming through with several companies. The Reforestation Division is presently responsible for co-ordinating the use of the orchards, cf. J. Konishi's contribution in "Members Reports".

Consultation was carried out with Gene Namkoong in 1972 and as a result a long term breeding program was developed with the following objectives:

Primary objectives -

1. Go for second generation selection. Current procedures are to leave out direct progeny testing and go directly to breeding production.

2. Obtain information on genetic components; variance, heritability, etc.

3. Obtain information on genotype x environment interaction because of the broad array of environments that must be dealt with.

4. Obtain information on general combining ability. This is being done by setting up mating designs employing modified 6 tree diallels. Each tree enters the program with 5 crosses and can therefore be ranked by general combining ability. The old progeny testing objectives for most purposes can be fulfilled with this procedure. A balanced design is desired but incomplete modified designs will be used. Seed will not be sown until all crosses are made. About 10 diallel crosses per year are currently being carried out.

5. Re-designing of the seed zones. Provenance studies in conjunction with this involve 350 plus tree populations.

Secondary objective -

To take advantage of Alan Orr-Ewing's promising interracial crossing research by generalizing and moving towards practical seed production. Capitalizing an interracial crossing will be attempted by initially using 5 tree factorial crosses.

Finally, Heaman commented on a new position in Western hemlock breeding being filled by Mike Meagher.

R.F. Calvert outlined the work on Larix being carried out by the Petawawa Forest Experiment Station of the Canadian Forestry Service, Environment Canada. Work will continue on studies established by Mark Holst. This initially involves a progeny experiment with 36 progenies on 3 sites. The trees are now 12 years old. It is intended to expand the studies to include an all-range provenance experiment. Initially the objectives involve stand tests but seed will be kept separate by parents in case any appear important.

R.M. Rauter reported upon the work of the Forest Research Branch, Maple, and the Forest Management Branch, Ontario Ministry of Natural Resources.

Tamarack and other larch species are being considered for the eastern region including the Domtar and Abitibi freehold lands. Collections have been made of 18 hectalitres (50 bushels). Students and district staff have been identifying candidate stands. Tests within areas, within stands and with individual trees are proposed. Seed production areas are planned and seedling seed production areas will be initiated. It is expected that the program will be expanded.

R.F. Calvert reported upon the hardwood improvement program other than poplars being initiated at Petawawa Forest Experiment Station. There are 64 species of hardwoods (including poplars) in southern Ontario, Quebec and the Maritimes. A number of these are high-value species. A "chance of success index" has been developed indicating current or potential value, ease of propagation, etc. For example, high value, low success species are yellow birch, sugar maple. Amenity aspects have been toned down. Red maple, therefore, has a diminished rating. Important species in the program will be black walnut, white and green ash, and red maple. Walnut and white ash are used for lumber and veneer. A limiting problem with ash is the widely experienced difficulty in getting seed to germinate.

A black walnut program will commence with a Canadian range-wide collection. Next year an intensive Southern Ontario survey and collection will be made. This will also include some specific U.S. sources. This will be established in Ontario, southern Quebec and (one) in Wisconsin. Since it is expected that there has been historical seed movement, it is presumed some of the populations will be mixed. Many populations, however, are presumed to be depleted, but with the seedling seed orchards the gene pool may be reconstructed. For ash, a stand test using Wright's design is proposed. Some information per tree is lost but it is good per stand. Test plantations of white ash were established in 1976 and 1977 in Ontario, Quebec and New Brunswick with provenance-progenies raised by Dr. Calvin Bey at the North Central Forest Experiment Station, Carbondale, Illinois.

Discussion

D.A. Fraser: Why is yellow birch not considered for an improvement program?

R.F. Calvert: Yellow birch is considered but it seems to have ecological limitations for planting programs (Rapporteur: At least one Ontario nursery is growing considerable numbers of yellow birch for current planting programs).

R.M. Rauter: In collecting desirable hardwoods, a close watch should be kept for any historical evidence of highgrading.

A.G. Gordon: With respect to ash collections, Kim Steiner at Pennsylvania State University has recently completed extensive provenance collections of green ash and is possibly also working with white ash. Regarding germination of ash seed, there is excellent work published in the mid 50's on this subject. Laslow Ferenczy studied seed coat inhibitors and Sumihiko Asakawa published a series of papers on *Fraxinus* germination.

Essentially the accepted technique to avoid the normal delayed germination in *Fraxinus* is not to let the seeds dry out. You can sow immediately following collection or stratify in damp granitic sand or in peat as the seeds are collected and sow altogether when the last collections are made. If the seed must be stored it will need to be dried. Normal germination time in this case will be about 18 months. However, prior to sowing, the seed should be stratified for at least 6 months to breakdown seed coat inhibitors. Germination time as a result may be considerably shortened. Soil pH should be held above pH 6. *Acer pseudoplatanus* would be handled in the same way as *Fraxinus*.

J. Klein to J.C. Heaman: If you find high specific combining ability, is there any way to take advantage of it?

J.C. Heaman: Using Orr-Ewing's known material we would repeat the crosses. There is a snag, however, having to put out 25 reciprocals each year. If there were 10 clones, a very large number of crosses and required areas are implied. If there are six clones, there are 5 crosses with every tree. There is a reciprocal male-female problem. We must put the progeny into eleven test sites and the maximum that we can use is only about 200 seedlings.

PROVENANCE TESTING OF EXOTICS

Moderator: R.F. Piesch
Rapporteur: J.F. Coles

A test of 30 red spruce provenances from the northeastern portion of the species range in Newfoundland revealed considerable height variation among sources. A few New Brunswick and Nova Scotia sources may be suitable for planting in Newfoundland. Sitka spruce has been tried in Ontario, Quebec, and Newfoundland. Data from recent measurements of provenance trials in Quebec are being evaluated to determine provenance variation in spruce budworm damage. Some populations may be useful in parts of Newfoundland, but this species, along with Engelmann spruce, has shown no promise in Ontario.

In the early days of Canadian forest genetics a Norway spruce plantation established at Petawawa (Hudson's Place) in 1922 suffered severe winter damage in the winter 1933-34. Dr. C. Heimburger selected eight winter hardy trees of the some 1500 originally planted. All but 22 of the remainder were cut. Progeny of the selected individuals have done well in provenance trials in various locations, in environments as severe as that of Riding Mountain National Park in Manitoba. At that location, only one population, from the southern Urals, survived and grew better than the Hudson's Place population.

Replicated plantations and observation plots of Scots pine, Norway spruce and exotic larches were established by Mr. M.J. Holst at Petawawa and elsewhere over a period of years. Scots pine provenances from the Baltic region and from southwestern Russia and northern Ukraine (Kiev, Woronesh, Smolensk) have proven best at the Station. Some clones of trees selected in southern Ontario were found that formed inherently good Christmas trees and were winter hardy at Petawawa F.E.S. Near the southern margin of the boreal region in Manitoba and Saskatchewan, the same Scots pine populations from southwestern U.S.S.R. survived and grew better to 10 years from planting than populations from the Urals, Siberia, or further north in European Russia, and outgrew local jack pine at one location.

HYBRIDIZATION AND SPECIES COMPARISONS

Moderator: R.F. Piesch
Rapporteur: J.F. Coles

Hybrids of Sitka spruce and Engelmann spruce with white spruce growing in Ontario, have been generally intermediate with respect to their parents, and show little evidence of heterosis or other advantage. Some offspring of a cross between Sitka spruce and Serbian spruce (*Picea omorika*) appear heterotic, but height growth is variable in this hybrid. Repeated attempts at *Picea omorika* x *chihuahuana* and *Picea rubens* x *chihuahuana* crosses have yielded a few seedlings. The interspecific hybridization program with spruces at the Forest Biology Lab of the Province of Ontario has had as its primary contribution the clarification of phylogenetic relationships in the genus.

Plantations of exotics at Petawawa, referred to earlier, provide a useful source of breeding materials even though the exotics program is now largely inactive. There are plans to establish a clonal seed orchard from selected trees of European and Japanese larch growing in these plantations. The Japanese larch have not yet flowered. Dunkeld larch has not been heterotic at the Station.

Lodgepole pine and its hybrids with jack pine have been found lethally susceptible to sweetfern blister rust, and should not be planted in central or eastern Canada. Some lodgepole pine and more lodgepole x jack pine hybrids persist long enough to produce pollen and are then potential sources of genetic contamination in native jack pine.

Severe frost caused 95% mortality in a 1973 trial of 32 poplar species and clones in Newfoundland. A clone bank has been established from 10 survivors for production of further cuttings for new trials, scheduled to be planted in 1978. In Manitoba, hybrid poplar clone 44-52 planted in 1972 has grown better on loamy soils with a pH of 7 than on a sandy loam with a pH of 5.7. No disease has been found to date. Hybridization of aspen with balsam poplar and eastern cottonwood is being pursued by the Canada Department of Agriculture in Morden, Manitoba, to combine the hardiness of aspen with the rooting ease of the other species. The objective of this work is to produce cultivars for use in shelterbelts, cities, and parks on the prairies. Some past attempts have been unsuccessful because the cross was performed in only one direction, for combinations that work only in the other direction. Softwood cuttings from one aspen hybrid have rooted well and hardwood cuttings are scheduled for trial in fall 1977.

Seedlots of Norway maple and sycamore maple have been acquired from Kiev and Moscow, in the hope that these sources will prove suitable for amenity planting in hardiness zones 3 and 4. Unfortunately, germination is not good. Samples of these lots are being sent to the Lakehead and Morden.

SEED PRODUCTION, PROPAGATION, OTHER PROJECTS

Moderator: J.C. Heaman
Rapporteur: G. Murray

Vegetative Propagation and Seed Production

The objective of work described by the speakers was the reduction in the amount of time required before selected parent trees could be tested. Miss M. Rauter, of the Ontario Ministry of Natural Resources outlined one approach which involved outplanting rooted cuttings taken from selected spruce. (*Picea glauca* (Moench) Voss) and *Picea mariana* (Mill.) B.S.P.).

Progress in this work has reached a stage at which the collection and rooting of cuttings during 1976 was on a semi-operational basis involving the participation of field staff under instruction. Considerable success in rooting both greenwood and dormant cuttings has been achieved although the program has relied mainly on the latter since they are easier to transport without damage. Experience has shown that rooted cuttings are best lifted once the roots have become dormant, as active roots are brittle and easily broken during transplanting. The use of cuttings was also discussed by Dr. R. Piesch from the Canadian Forestry Service, Pacific Forest Research Centre. In this case the objective was early seed production on rooted and unrooted cuttings of western hemlock (*Tsuga heterophylla* (Raf.) Sarg.). Viable seed have been collected and grown following controlled pollination of flowers produced in the first year after the cuttings were rooted. The number of cones produced increased rapidly following outplanting of the rooted cuttings. Greatly enhanced female flower production by these rooted cuttings occurred in response to treatment with gibberellins. Early cone production has also been obtained on unrooted cuttings planted in soil or with their bases in water and receiving various fertilizer, gibberellin, and auxin treatments. Although needle losses did occur, the cuttings in some treatments held most of their needles, from the time they were cut in spring until the fall, and produced cones containing viable seed. These seed produced seedlings that were, initially, smaller than those grown from seed collected from the parent trees, but these size differences became less obvious with time.

Technology Transfer

Miss M. Rauter, Dr. M.A.K. Khalil, from the Newfoundland Forest Research Centre, and Dr. J.F. Coles, from the Maritimes Forest Research Centre discussed different programs with what seemed to be very similar basic objectives. In all programs the primary concern seemed to be to get tree improvement into the field on an operational basis.

In Ontario the active involvement of field foresters is seen as one of the keys to the success of the tree improvement program. One of the approaches being taken to get field foresters informed and interested in tree improvement activities is the preparation of a series of six manuals dealing with different aspects of tree improvement work. An attempt has also been made to predict what the regional seed requirements will be by the year 2000. This information will provide a basis on which to plan for such needs as greenhouse or nursery space, and number and area of seed production areas and seed orchards.

In Newfoundland there is a need for an active program of tree improvement as part of a program of intensive forest management. Following recommendations made during a "Forest Improvement Workshop" in 1976, the Provincial Cabinet approved in principle the concept that the successful implementation of such a program of tree improvement in Newfoundland requires the cooperative participation of those in the wood-using industries and in the federal and provincial governments. As in Ontario, the transfer of the results of tree improvement research to foresters in the field is considered essential for the success of the program.

The cooperative approach to tree improvement has also been taken in New Brunswick and Nova Scotia, where the substantial reforestation programs provide an excellent opportunity for the use of superior stock. Although there are differences in the organization of the cooperatives, both involve the province, industry, and the Maritimes Forest Research Centre (M.F.R.C.). In New Brunswick there is an informal arrangement that also involves the University of New Brunswick. Facilities and expertise will, on the whole, be provided by the province and by the M.F.R.C., while the industrial cooperators will undertake the selection work on their own land and on Crown leases. These cooperators will also provide and prepare sites, and assist in planting on their own land. In contrast, the arrangement in Nova Scotia is that payments made by industrial cooperators will be used by the province to do the necessary work.

The discussion that followed these presentations emphasized the interest of members in the operation of cooperatives. The experience of a number of members has been that companies were often reluctant to make the commitment of money or other resources required for the successful implementation of a cooperative agreement. It appears that a major challenge facing those already involved in tree improvement is to convince senior company executives that there are real benefits to be derived from participation in such cooperative agreements.

MEMBERS' REPORTS
RAPPORTS DES MEMBRES

TREE IMPROVEMENT IN NEWFOUNDLAND, 1975-1977

J. Peter Hall

Canadian Forestry Service
Newfoundland Forest Research Centre
St. John's, Newfoundland

TRIALS OF EXOTIC SPECIES

No results are available on the plantations of exotic *Picea*, *Pinus* species or on the species trials in the Arboreta. Work has continued on the plantation of exotic *Abies* species and on establishment of plantations of *Larix*.

(a) *Establishment of a Larix species trial.* In April 1976 a plantation was established on a clearcut site in western Newfoundland to test the suitability of 3 species of *Larix* for planting (Rowe 1976). The following seedlots were planted:

Species	Nfld. seedlot no.	Age class	Provenance
L. kaempferi	645	2+1	England - High Meadow Forest
L. eurolepis	647	2+1	Scotland - Newton Nursery
L. eurolepis	438	2+1	Scotland - Mabie Seed Orchard
L. sibirica	648	2+1	U.S.S.R. - Krasnojarsk
L. sibirica	633	2+2	U.S.S.R. - Krasnojarsk
L. laricina	565	2+2	Ontario, Petawawa

The experiment was a randomized complete block with 10 replicates of each species. Ninety trees of each species were planted - a total of 540 trees.

The NFRC is also developing a program for the introduction of larch as a major plantation species. Research will be centered around the selection of superior individuals for the establishment of a seed orchard and on the introduction of suitable exotics for the Island. In addition, work will be started on the production of fast-growing hybrids.

(b) *Plantation trial of exotic Abies species*

Veitch's Silver Fir (*A. veitchii* Lindl.) which is reportedly resistant to attack by the balsam woolly aphid (*Adelges piceae* Ratz.) is currently being tested in plantations to determine its suitability for replacing aphid-susceptible balsam fir. The total height growth is about the same for both species, however, there are differences in the timing and rate of growth (Schooley 1977). Balsam fir flushed earlier by one to two weeks. The rate of growth of the shoots was faster on balsam fir for the first half of the growing season and the maximum rate of growth was reached two to three weeks earlier than Veitch's fir. This late flushing may be an advantage to Veitch's fir because late spring frosts often damage balsam fir.

A further remeasurement of height development will be made in 1977.

REFERENCES

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GENETIC IMPROVEMENT OF NATIVE SPECIES BY RANGE-WIDE SELECTION AND BREEDING

M.A.K. Khalil

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Key words: Black spruce; White spruce; Provenance tests; Progeny tests; Predictions of growth.

INTRODUCTION

Three studies were in progress during the period under report and they are summarized below.

STUDY NO. NFC. 21-1. GENETIC IMPROVEMENT OF BLACK SPRUCE IN NEWFOUNDLAND

The following three approaches were adopted for the genetic improvement of black spruce.

Regional Black Spruce Provenance Experiments

The seven field experiments planted in 1972 and 1974 were maintained. The data from the nursery phase were analyzed. Multiple regression analysis of the mean length of the terminal shoot of the 29 local provenances in 1970 was conducted. The mean length of the shoot was taken as the dependent variable and three geographic factors influencing the micro-evolution of the species and seven genetic characters of the provenances were used as independent variables in an attempt to establish criteria for prediction of the annual height growth in the species. The following 10 independent variables were selected:

X_1 - Latitude of the provenance (°N).

X_2 - Longitude of the provenance (°W).

X_3 - Altitude of the provenance (m).

X_4 - Mean cone length of the provenance (cm).

X_5 - Mean cone diameter of the provenance (cm).

X_6 - Mean weight of 1,000 oven-dried seeds of the provenance (g).

X_7 - Mean number of days from January 1 to opening of apical bud of the terminal shoot of seedlings at Pasadena, averaged over all replications.

X_8 - Mean number of degree-days above 5.6°C from January 1 to the date of opening of the apical bud of the terminal shoot of the seedlings at Pasadena for each provenance averaged over all replications.

X_9 - Mean length of the growth period of the terminal shoot of the seedlings of the provenance at Pasadena averaged over all replications.

X_{10} - Mean number of degree-days above 5.6°C during the growth period of the seedlings at Pasadena for each provenance averaged over all replications.

Only two independent variables (X_1 and X_{10}) are significantly correlated with the annual height growth of the terminal shoot. This indicates that the inter-provenance differences in the annual height growth are caused by the differential energy available during the growth period. A paper on this study is under submission to the Silvae Genetica.

All-Range Black Spruce Provenance Experiments

Two of the three field experiments planted in June 1975 were tallied for survival in September 1976. These were Millertown Junction Road and Serpentine Lake areas where the survival was 90 and 93 percent respectively.

Black Spruce Progeny Experiments

Single-tree open-pollinated seed for progeny tests and wood specimens for examination of wood quality were collected from a location in the Burin Peninsula in Rowe's Forest Section B.30. The seed was extracted, dewinged and cleaned in the usual way. Single-tree open-pollinated seed from 20 locations and control-pollinated seed from one location is now available. A set of progeny experiments are now being planned.

STUDY NO. NFC. 21-2. GENETIC IMPROVEMENT OF WHITE SPRUCE IN NEWFOUNDLAND

This study is comprised of the following two parts.

Great Lakes-St. Lawrence Region White Spruce Provenance Experiment

This experiment in the North Pond Experimental Area in east-central Newfoundland is one of a series of cooperative experiments. The year 1976 was a good seed year for white spruce. Seed was collected from six best provenances, extracted, dewinged and cleaned. This seed will be sown in the nursery at Pasadena for raising planting stock.

Genetic Variation in White Spruce in the Exploits River Valley in Central Newfoundland

The nursery phase of this study, started in 1971, to verify the genetic superiority of phenotypically superior trees of white spruce from two locations in the Exploits River Valley in Central Newfoundland, was completed in 1975. The data for height in the falls of 1974 and 1975 and root-collar diameter in the fall of 1975 were analyzed by analysis of variance and Scheffe's S-tests. These tests show that although significant differences in four-year growth between the two locations existed no such differences could be detected between the progenies of the phenotypically superior and average trees at either location. The superiority of "plus" trees over "ordinary" trees is attributed to more outbreeding in the former than in the latter class of trees. Heritability studies show the possibility of more genetic gains by selection from "plus" trees than that from "ordinary" trees in the Frenchman's Pond area. Establishment of a seed orchard of "plus" trees from each location is now possible and recommended. A paper is under submission to the Silvae Genetica.

Two progeny field experiments have been laid out in the Rattling Brook area about 11 km from Grand Falls. Spare seedlings from the Frenchman's Pond area have been outplanted near these experiments.

The stand in the Frenchman's Pond area was sampled for biochemical analysis of the foliage to verify genetic differences between the phenotypically good and average trees. Trees were classified into three classes, viz. "plus" ($\bar{X} + 1\sigma$ and over)*, "ordinary" ($\bar{X} \pm 1\sigma$)* "minus" ($\bar{X} - 1\sigma$ and under)* trees. Random samples of 1976 foliage were obtained from five trees in each class and kept separate by trees. They were analyzed at the Prairie Regional Laboratory of the National Research Council of Canada at Saskatoon, Saskatchewan and contents of 22 terpenes were estimated. The results are being analyzed.

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* $\bar{X}$ = Mean

σ = Standard deviation

GENETIC IMPROVEMENT OF POPLARS BY SELECTION AND BREEDING

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Keywords: Poplars; Hybrids; Exotics; Hybrid poplars; Exotic poplars.

INTRODUCTION

The forest genetics program at the Newfoundland Forest Research Centre currently consists of three research projects and a project of technology transfer. The research projects are poplars, provenances of native species and those of exotic species. This report deals with Project No. 2-302-014 (Genetic improvement of poplars by selection and breeding). This is an on-going project, which was started in 1972 to identify clones of hybrid and exotic poplars likely to be suitable for commercial propagation in Newfoundland. Results of the nursery phase were reported in 1975 and have since been published (Khalil 1976). The present report describes the work done since the previous report in 1975.

Adequate nursery stock was available in the Canadian Forestry Service Research Nursery at Pasadena in western Newfoundland in the spring of 1976 to start phase 2 (the outplanting phase) scheduled for that year, to study and demonstrate the performance of these clones under various field conditions. The outplantings consisted of an archive, a demonstration plot and four replicated clonal experiments.

THE ARCHIVE

The archive was established in two parts, one in the Red Cliff area about three miles west of Grand Falls on the Trans-Canada Highway and the other near the guest house of the Price (Nfld.) Pulp and Paper Limited at Grand Falls. Both areas were cultivated in the spring of 1976 to reduce root competition from grass. One-year old rooted cuttings of 20 clones were planted on May 19-21 in the Red Cliff area and on July 21 eight selected clones near the guest house. These clones were <u>AK.30</u>, AS.34, <u>AT.42</u>, <u>GA.87</u>, <u>GA.88</u>, CAG.77, CAG.118, D.38, D.89, DN.2, DN.5, DN.7, DN.16, DN.17, DN.28, DN.30, DN.42, I.45/51, I.78B, <u>Jac.4*</u>, Jac.6, <u>Jac.15*</u>, <u>Jac.16*</u>, <u>Jac.17*</u>. (The clones underlined have been planted in the archive near the guest house, the rest in the Red Cliff area and those marked with an asterisk are common to both. See Appendix I for identity of the clones). Ten plants of each clone were planted with a spacing of 4.6 x 4.6 m. The survival in September was 87 and 46 percent in the Red Cliff and the guest house areas respectively. Though survival in the Red Cliff area was excellent the plants hardly grew during the summer. This appears to be due to competition from grass and impoverished and compacted soil due to grazing by cattle and horses over a long period of years. The low survival in the archive near the guest house is attributed to damage of the plantation caused by persons digging worms and obtaining sods. Many cuttings were uprooted. The surviving plants have grown better in this area than at Red Cliff.

THE DEMONSTRATION PLOT

The demonstration area was established to demonstrate the performance of the fast growing clones in large blocks under forest conditions. The plot was located in the Rattling Brook area about 10 km south of Grand Falls on an area that had been burnt accidentally in July 1975. Eight square blocks 18 x 18 m in size were laid out in the spring of 1976. Cuttings were rooted in Spencer-Lemaire root trainers (size 20 x 4.5 x 4.5 cm). Each block was planted with 36 rooted cuttings of one clone, spaced 3 x 3 m. The eight clones planted were DN.2, DN.5, DN.30, I.45/51, Jac.4, Jac.15, Jac.16 and Jac.17. A survival count in September showed a survival of 68 percent. The low survival appears to be due to the following reasons:

1. Rooting in containers was not good. The cuttings were planted deep in containers leaving one or two buds above the planting medium. This left only a small space for roots to grow. Although containers are very convenient for transportation and handling of the material they did not prove satisfactory for rooting cuttings.

2. Competition from hardwood undergrowth increased in the year following the accidental fire.

3. Presence of humus in lightly burnt patches.

4. High soil acidity in some patches.

THE CLONAL EXPERIMENTS

The four clonal experiments were located as follows and were planted on the dates noted against each.

Forest Section B.28a - Millertown Junction Road area; lat. 48°27'N, long. 56°14'W - June 22-24.
New Bay Pond area; lat. 49°05'N, long. 55°36'W - June 28-30.

Forest Section B.28b - South Brook Valley; lat. 48°55'N, long. 57°38'W - June 9-10.
Robinson River area; lat. 48°14'N, long. 58°36'W - June 14-16.

The cuttings had been prepared in the first week of April and stored in cold storage at -2°C till the planting dates.

The sites selected had a substantial proportion of trembling aspen (Populus tremuloides Michx.) which was a good indication of their suitability for poplars. The areas were recently cutover and were cleared of the slash. The site in the Robinson River area was sprayed with an aqueous solution of 2,4-D (0.9 ℓ of 2,4-D/80 ℓ solution) at the rate of 1.1 kg/ha in the summer of 1975 to control competing vegetation. The four experiments were laid out in the summer of 1975 in six-replicated randomized complete block design with four-tree square plots planted randomly with unrooted cuttings 20-25 cm long and spaced 3 x 3 m, except the New Bay Pond area where the spacing had been reduced to 2.5 x 2.5 m.

The experiments were tallied for survival in September. The survival was very low, the best at Millertown Junction (48%). The main reasons for low survival are excessive humus, high soil acidity and competition from natural vegetation. Frost in June, August and September aggravated the damage to tender sprouts.

The potential of poplars for fast growth and their success under varied site conditions in Canada, U.S.A. and other countries justifies planting four new experiments in 1978. Soil preparation, mainly scarification and liming, will be done and rooted cuttings will be used. A complete archive will also be established at a more suitable site than was done in 1976

APPENDIX I - The clones

Clonal No.	Origin
A.546; A.547	Populus alba. Grand Falls, Newfoundland, lat. 48°55'N., long 55°40'W.
AK.28, AK.30	P. alba Brampton (A.69) x davidiana v. glandulosa (gl. 1). Korea (gl. 1) selected from population 363 produced at Maple.
AS.34	P. alba (A.69) x sieboldii (S2). Japan (S2). Selected from population 431 produced at Maple.
AT.42*	P. alba Brampton (A.69) x tremuloides (T.18) Port Bolstern. Selected from population 274 produced at Maple.
TAC.23*	P. balsamifera L. Deer Lake, Newfoundland, lat. 49°07'N., long. 57°25'W.
C.147	P. canescens Ingolstadt. Munden, West Germany.
CAG.23, CAG.25, CAG.26, CAG.77	P. canescens Czechoslovakia (C.18) x (alba x grandidentata AG.7. Toronto, Ontario (AG.7). Selected from population 406 produced at Maple.
CAG.118	P. canescens Czechoslovakia (C.18) x (alba x grandidentata) AG.7. Toronto, Ontario (AG.7). Selected from population 355 produced at Maple.
D.38	P. deltoides Bartr. Belleville, Ontario, lat. 44°06'N., long. 77°20'W.
D.89*	P. deltoides Bartr. Norris Arm, Newfoundland, lat. 49°05'N., long. 55°12'W.
DN.2	P. euramericana Cv. Baden 437. Munden, West Germany.
DN.5	P. euramericana Cv. Gelrica. Munden, West Germany.
DN.7	P. euramericana Cv. Heidemij. Munden, West Germany.
DN.16*	P. euramericana Cv. Regenerata Batard d'Hauterive France.

DN.17	P. euramericana Cv. Robusta, France.
DN.28	P. euramericana Cv. Ostia. Munden, West Germany via Novi Sad, Yugoslavia.
DN.30	P. euramericana Cv. Canada Blanc. Novi Sad, Yugoslavia.
DN.41, DN.42	P. euramericana. Grand Falls, Newfoundland, lat. 48°55'N., long. 55°40'W.
I.45/51	P. euramericana Cv. I.45/51. Casale. Monferrato, Italy.
I.78B	P. euramericana. Cv. "Jacometti 78B" Italy via Oxford, England No. 46/1015 of T.R. Peace.
GA.87, GA.88	P. grandidentata (Maple) x alba (A.321). Selected from population 436 produced at Maple.
Jac.4	P. balsamifera x deltoides. Gore Bay, Manitoulin Island, Ontario, lat. 45°55'N., long. 82°30'W.
Jac.6	P. balsamifera x deltoides. 1.6 km (1 m.) north of Walkerton, Ontario.
Jac.14*, Jac.15* Jac.16*, Jac.17*	P. balsamifera x deltoides. Grand Falls, Newfoundland, lat. 48°55'N., long. 55°40'W.

* Rooted cuttings included.

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RESEARCH ON EXOTIC SPRUCE AND FIR PROVENANCES

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Key words: Sitka spruce; Red spruce; Provenance experiments.

INTRODUCTION

This report summarizes the progress of Project No. 2-302-16 (Research on exotic spruce and fir provenances). The status of the studies in progress is reported below.

STUDY NO. NFC. 20-2. PROVENANCE EXPERIMENTS WITH SITKA SPRUCE

This study consists of nine replicated experiments with 12 provenances of Sitka spruce (Picea sitchensis (Bong.) Carr.) assembled from the area between latitudes 44°-57°N and longitudes 124°-136°W on the west coast of Canada and U.S.A. Eight provenances of Sitka spruce and one of native black spruce from Badger, Newfoundland were common to all experiments. The remaining four Sitka spruce provenances and one provenance of white spruce (Picea glauca (Moench) Voss) from the Acadia Forestry Station, New Brunswick, were distributed among the experiments according to availability of seedlings. The experiments were planted with 2-2 seedlings in the spring of 1969 (7 locations) and 1970 (2 locations). They were measured in the fall of 1974 at the ages of 9 and 10 years from seed. Five characters were studied, viz. initial survival, mortality due to Armillaria mellea (Vahl. ex Fr.) Kummer root rot, winter desiccation, height and root-collar diameter.

Height and the degree of winter desiccation were considered to be the best criteria for evaluating provenances for the various sites. Provenances suitable for each location have been identified on the basis of above the average height growth and 20 percent or less winter damage. No provenances appear suitable for afforestation in Mobile which represents Rowe's Forest Section B.30, North Pond (Rowe's Forest Section B.28a but poor soil), Roddickton (Rowe's Forest Section B.29) and Sandy Brook (Rowe's Forest Section B.28b but poor soil and wind-swept site). Similarly, four provenances, viz. 3, 18, 32 and 54 were unsuitable for all locations. Three of these, viz. 3, 18 and 54 originated from the region south of latitude 48°N and provenance 32 was obtained from the southern part of Queen Charlotte Island where it has acclimatized to mild maritime climate. The provenances which appear suitable at present for other areas are listed below:

Big Falls	Provenance 33
Crabbe's River	Provenances 2, 30, 31, 33, 38
Little George's Lake	Provenances 4, 31, 37, 38
New Bay Pond	Provenances 4, 29, 31
Sheffield Lake	Provenances 2, 29, 33

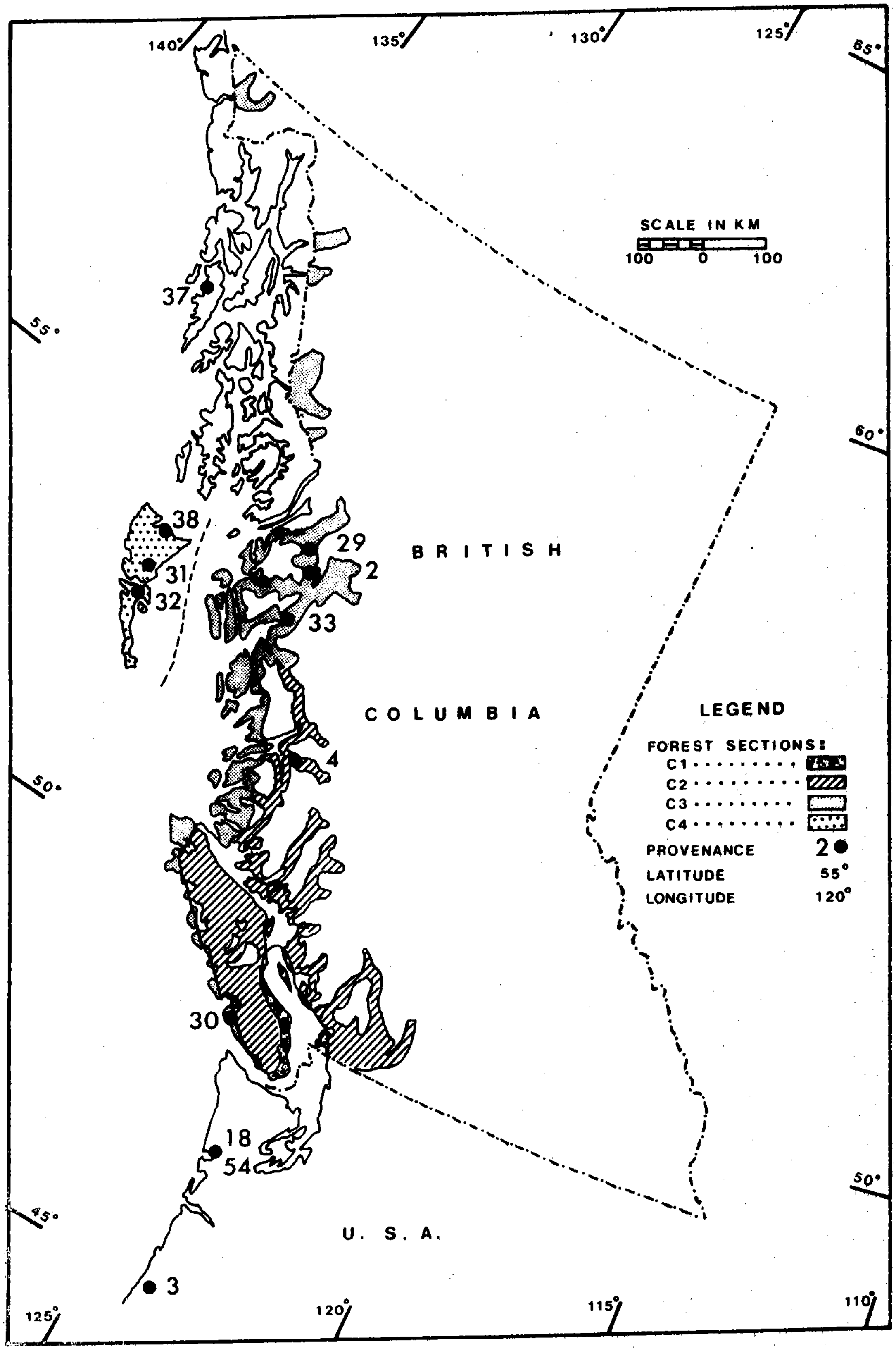

FIG. 1 LOCATION OF PROVENANCES

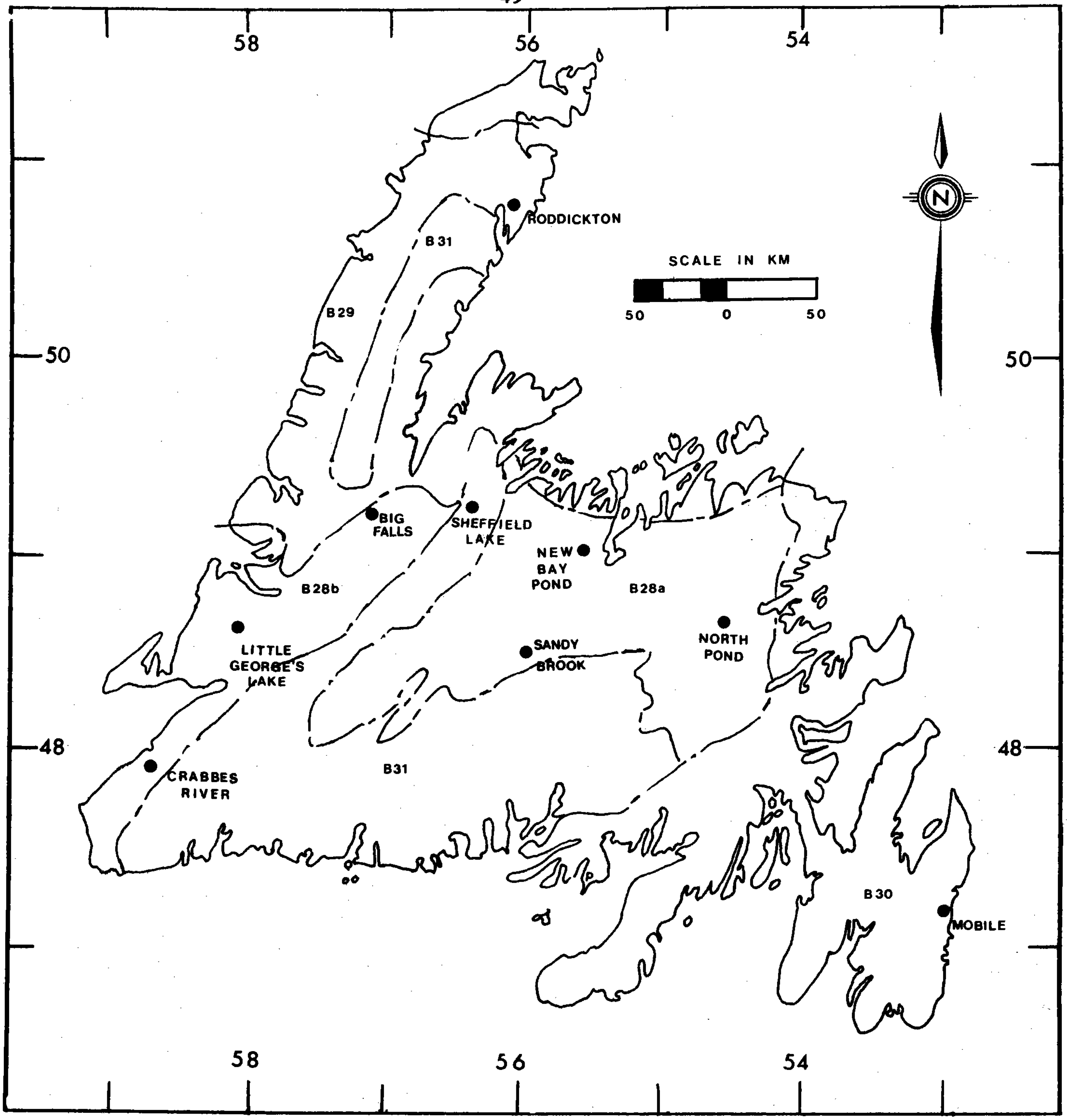

FIG. 2 LOCATION OF EXPERIMENTS

TABLE 1. Geographical and meteorological data on provenances

Forest section or state	Provenance	Lat. °N	Long. °W	Alt. m	Representative station	1	2	3	4	5	6	7	8	9	10	11
						Representative Meteorological Data***										
C.2*	30. Klanawa R., Van. Is., B.C.	48°50'	125°15'		Port Alberni	-1.1	May 1	Oct 1	153	Mar 21	Nov 12	236	15.6	25.4	25.0	1,667
C.3*	2. Skeena Val., B.C.	54°45'	128°45'		Ethelda Bay	2.2	May 1	Nov 1	184	Mar 28	Nov 19	236	12.2	81.3	17.8	1,389
	4. Bella Coola B.C.	52°22'	126°45'													
	29. Nass Riv. Valley, B.C.	55°00'	129°00'													
	33. Kitimat, B.C.	54°03'	128°31'	61												
C.4*	31. Yakoun Riv. Val. B.C.	53°30'	132°15'	152	Sandspit	0	May 1	Nov 1	184	Apr 10	Nov 18	222	12.8	27.9	16.7	1,263
	32. Pallant Creek, Q.C. Is., B.C.	53°05'	132°05'	76												
	35. Masset, Q.C. Is., B.C.	54°00'	132°20'													
Alaska**	37. Sitka, Alas.	57°05'	135°20'	0-152	Juneau	7.9	May 13	Sep 25	135	Apr 20	Oct 22	184	11.0	58.0	16.3	1,049
Oregon**	3. Cascade Hd Ore.	44°46'	124°00'	61	Portland	0.3	Feb 22	Dec 3	284	Feb 1	Dec 7	299	17.2	16.7		2,256
Wash.**	18. Aberdeen, Wash.	47°00'	124°00'	0-152	Seattle	0.6	Feb 23	Nov 30	280	Feb 4	Dec 16	314	15.8	17.8	20.8	2,202
	54. Aberdeen, Wash.	47°06'	124°00'	0-152												
B.28a*	59. Badger, Nfld. (Black sp.)	48°58'	56°04'	106	Badger	-12.2	Jun 10	Sep 15	90	May 10	Oct 14	157	12.8	40.6	21.1	972
A.2*	439. Acadia Forestry Station, N.B.	45°59'	66°22'	61	Fredericton	-14.4	May 6	Sep 20	117	Apr 20	Oct 25	188	60	46.7	25.5	1,550

*Rowe, 1972; Chapman and Brown 1966

**Anon. 1965; Anon. 1973 Anon. 1975

***Meteorological factors

1. Mean January minimum temperature
2. Mean date of last spring frost
3. Mean date of first fall frost
4. Mean number of frost-free days
5. Mean date of commencement of growing season (mean temperature above 5.6°C)
6. Mean date of end of growing season (mean temperature below 5.6°C)
7. Mean number of growing days
8. Mean temperature during May-September (°C)
9. Mean rainfall during May-September (cm)
10. Mean daily maximum temperature in July (°C)
11. Mean degree-days above 5.6°C

Figs. 1 and 2 show the locations of the provenances on the west coast of Canada and U.S.A. and the location of experiments in Newfoundland respectively. Table 1 provides a list of the provenances with pertinent geographic and meteorological data. A paper is under submission to the Forestry Chronicle for publication.

PROVENANCE EXPERIMENTS WITH VEITCHII FIR

Results reported in previous meetings and those reported elsewhere in this meeting on Veitchii fir (*Abies veitchii* (Lindl.)) are encouraging. Consequently, a study is planned for testing several provenances of this species. Seed of nine provenances has been procured from Japan and a provenance study is being planned.

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THE TREE IMPROVEMENT COOPERATIVE PROGRAM IN NEWFOUNDLAND

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Key words: Technology transfer; Extension

INTRODUCTION

The need to increase forest production in Newfoundland to meet the current and future demands for wood and fibre had been felt for some time and was highlighted by the Report of the Newfoundland Federal-Provincial Task Force on Forestry (Anon. 1973). The need has been felt for intensive forest management and improvement necessary to increase production, to reduce unemployment and to ameliorate the environment. The 1975 meetings of the Canadian Tree Improvement Association, the CIF Working Group 7 and the Canadian Pulp and Paper Association, attended by forest manages from Newfoundland, increased their interest in intensive forest management and improvement in the Province. The Newfoundland Forest Research Centre played an important role during the last two years in technology transfer needed to achieve this.

A broad based "Forest Improvement Workshop", sponsored jointly by the Newfoundland Department of Forestry and Agriculture and the Newfoundland Forest Research Centre, was held at Gander on February 18 and 19, 1976. Senior executives from the federal and provincial governments and wood-using industries participated. This report summarizes the relevant decisions of the workshop and subsequent developments.

THE WORKSHOP

Statement of the Problem

Three speakers, representing the federal and provincial governments and the industry stated the problem, which can be summarized as follows:

1. In spite of a large forest resource, marginal growth rates and small scattered stands result in low productivity and increased costs, which threaten the future of the forest industry in the Province.

2. Sufficient general and local information is available for initiating an effective cooperative program of intensive forest management and improvement.

Subject Matter Presentations

Progress to date and future plans in tree improvement, regeneration, stand manipulation and nursery management were presented.

The presentation on tree improvement was made by the writer. The vital role of tree improvement in a forest improvement program was explained. It was emphasized that though the general principles of tree improvement are known much concerted effort is needed in research on the basic genetics of local species to constitute a sound basis for their improvement. Interim programs of applied research were outlined, comprising selection of seed production areas, plus trees and stands and establishment of progeny tests and seed orchards. Dr. C.W. Yeatman of the Canadian Forestry Service described such a cooperative program which has been in progress for several years in Quebec.

Recommendations

After consideration of the four presentations referred to above it was agreed that a program of forest improvement needs a four-way approach with the components of tree improvement, regeneration, stand manipulation and nursery management. The recommendations are listed below:

1. That a five-person "Action Committee" be constituted representing the federal and provincial governments and industry, to meet by mid-March 1976 for preparing an action plan for forest improvement acceptable to all concerned with its implementation.

2. That a summary of the Gander meeting be prepared for the "Action Committee" prior to their first meeting.

3. That the complete proceedings of the Gander meeting be published.

4. That immediate action be taken to get some aspects of a forest improvement program started, e.g. a genetics program.

5. That the Canadian Forestry Service undertake training sessions in silviculture for provincial and industry field staff using materials and format similar to that used at the Gander meeting.

6. That the headquarters of the Newfoundland Forest Service should have silviculture staff to provide overall planning, guidance and coordination for regional staff.

7. That pre-commercial thinning receive high priority as a forest improvement treatment.

8. That a forest genetics program be started immediately since it will be several decades before the full results are obtained and the initial costs are low.

9. That reforestation be an integral part of the forest improvement program.

10. That an inventory of problem areas arranged in order of priority for treatment receive high priority.

SUBSEQUENT DEVELOPMENTS

Shortly after the meeting at Gander a brief for the Provincial Cabinet was prepared seeking approval in principle to the concept of a cooperative program. This approval has been received and agreements with the two major pulp and paper companies have been reached.

A permanent "Forest Improvement Steering Committee" was formed on July 7, 1976. The chairman of this committee is the Assistant Deputy Minister for Forestry in Newfoundland and the membership consists of: Director of Forest Management for the Province, the Director and the Program Manager, Forest Resources Research of the Newfoundland Forest Research Centre of the Canadian Forestry Service, the Woodlands Managers and Chief Foresters of Bowaters and Price (Nfld.) Pulp and Paper Co. and the Chief Forester of Labrador Linerboard Limited. The following terms of reference have been established for the committee.

1. To act as a liaison and policy advisory committee between industry and the federal and provincial governments.

2. To define objectives, develop programs and strategy, and to implement and coordinate efforts.

3. To have authority to appoint working sub-committees and draw on staffs of represented organizations to man committees and perform the necessary planning and development work.

The Steering Committee has appointed two technical sub-committees, viz. the Stand Improvement Sub-Committee and the Regeneration and Tree Improvement Sub-Committee. The sub-committees have reviewed past work in the Province in their respective fields. They have prepared a short term program for 1976 and are preparing a long term five-year program to be initiated in 1978.

REFERENCE

Anon. 1973. Report of the Newfoundland Federal-Provincial Task Force on Forestry, St. John's, Newfoundland, 137 pp.

TREE BREEDING AT THE MARITIMES FOREST RESEARCH CENTRE, 1975 AND 1976

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INTRODUCTION

Twenty million tree seedlings are planted annually in the Maritime Region and it is projected that this number will reach 60 to 70 million by 1985. The opportunity exists to increase forest growth by utilizing genetically superior seeds and seedlings in these reforestation programs. The objective of the tree breeding work at the Maritimes Forest Research Centre is to determine the amount of genetic improvement attainable within promising tree genera and to provide resource managers of the region with the information and breeding materials required to obtain realistic genetic improvement of trees used in reforestation.

J.F. Coles joined the staff of the Canadian Forestry Service, Maritimes Forest Research Centre, in April 1975. D.P. Fowler returned to the M.F.R.C. in July 1975 on completion of a Professional Development Assignment at the University of California, Berkeley. In December 1976, H.G. MacGillivray retired after more than 20 years service in tree improvement research at the M.F.R.C. These personnel changes have had, and will continue to have, an influence on tree improvement activities in the Maritime Region.

HYBRIDIZATION IN *PICEA* AND *LARIX*

The objectives of this work are to produce and test inter- and intraspecific hybrids that may be of value in the Region, to develop methods of mass producing promising hybrids, and to provide information and breeding materials for the production of genetically improved trees to forest managers. Because of the present importance of *Picea* species and the potential importance of *Larix* species and hybrids to reforestation, work has been concentrated on these genera.

A limited number of exploratory crosses involving white spruce (*Picea glauca* (Moench) Voss) and black spruce (*P. mariana* (Mill.) B.S.P.) as female parents and *P. chihuahuana* Martinez and *P. bicolor* Mayr. as male parents was attempted in 1975. Flowering of spruces in central New Brunswick was generally good in 1976. White spruce flowered abundantly in all areas where spruce budworm damage had not been extreme in 1975. Black spruce flowering was generally good throughout the area while flowering of red spruce (*P. rubens* Sarg.) was generally poor (presumably because of 1975 budworm damage). *Picea abies* (L.), *P. obovata* Ledebour, and *P. engelmannii* Parry also produced some flowers.

The following non-native pollens were available for interspecific crossing work:

(1) Picea chihuahuana, Mexico, 1975 natural stand
(2) P. breweriana S. Wats., Denmark, 1975 Hørsholm Arboretum
(3) P. orientalis (L.) Link., Denmark, 1975 Hørsholm Arboretum
(4) P. wilsonii Masters, Denmark, 1975 Hørsholm Arboretum

These four pollens were tested on 11 white spruce, 11 black spruce, 2 red spruce, 2 Norway spruce, 3 Siberian spruce (P. obovata), and 1 Engelmann spruce (P. engelmannii). No Larix pollinations were attempted in 1975 and 1976.

SPECIES AND PROVENANCE TRIALS

H.G. MacGillivray retired in December 1976. Mr. MacGillivray has been responsible for studies on species and provenance testing in the Maritime Region since the initiation of the work in 1953. During this period many species and provenance trials were established throughout the Region. These include:

Species trials: five of Abies (including all species native to temperate North America and Europe and several of the more coastal species of eastern Asia); seven of Larix, five of Pinus (including one consisting of 40 species), and one each of Picea and Chamaecyparis.

Provenance trials: three of Abies balsamea (L.) Mill., one Larix leptolepis (Sieb. & Zucc.) Gord., eleven Picea abies (L.) Karst., two P. glauca, P. sitchensis (Bong.) Carr., one P. mariana, one Pinus banksiana Lamb., two P. resinosa Ait., three Pseudotsuga menziesii (Mirb.) Franco, and one Betula alleghaniensis Britton. In addition, nursery provenance trials were carried out with Pinus banksiana and Picea mariana.

Because of the impending retirement of the research officer, much of the work on this study during 1975 and 1976 was directed toward remeasuring plantations and up-dating and summarizing records and data so that the study can be continued with a minimum of disruption. Only one new experiment (Expt. 60) was field planted during this period. Six provenance trials were remeasured and data compiled for several other trials, including those of Pinus banksiana, P. resinosa, Picea glauca, P. mariana, and Larix leptolepis.

All tests established in Nova Scotia were summarized by location, species, type of test, date planted, and date measured, and were cross referenced to existing reports. Work is continuing on the compilation of data for New Brunswick and Prince Edward Island tests.

<u>Experiment 60</u>: All-range black spruce, <u>P</u>. <u>mariana</u>, seed source study (1971 germination).

In the spring of 1975 nine replicated provenance trials were field planted with the cooperation and assistance of industrial and provincial organizations. Eight of the tests compare selected fast-growing provenances. All 102 provenances are included in the other test at the Acadia Forest Experiment Station. Several slow growing northern and western provenances were also included in the test planting on the Cape Breton Highlands. Survival counts carried out in 1975 and 1976 indicated that 7 of the 9 plantings were highly successful, one moderately successful, and one poor. This last test which had been established on an old field in Prince Edward Island was replanted in 1976 but, again, survival was disappointing.

POPULATION STUDIES

Family relationships within stands are increasingly being mentioned in the literature but as yet few authors have quantified these relationships. Information on the existence and extent of family structures is necessary to correctly estimate potential genetic gain and to determine the most effective selection practices for improving a species.

White Spruce (<u>Picea glauca</u>)

Previous work (Coles and Fowler, 1976) indicated that family structures exist in both natural and old-field stands of white spruce. The amount of natural inbreeding is being determined from seed set and seedling growth data from extensive controlled pollinations (self, unrelated, and wind) in three stands. Cluster analysis applied to cone, seed, foliage, and phenology measurements from each of about 100 trees in two mapped old-field stands may show reduced variation among near neighbours, some of which may be attributable to genotype. Electrophoresis techniques using acrylamide slab gel are being developed. Unfortunately, individual white spruce seeds contain insufficient protein to produce clear banding patterns by our methods. Several enzyme systems have been tried using needle material but only esterase, peroxidase, and glutamic-oxalacetic transaminase provide reproducible results to date. Preliminary runs show that banding patterns of an individual tree do vary throughout the growing season.

Black Spruce (<u>Picea mariana</u>)

As with white spruce, the amount of natural inbreeding is being determined from seed set and seedling growth data from controlled pollinations (self, unrelated, and wind). Data will be available from 16 trees in 3 stands.

Larch (Larix laricina Koch.)

A major population structure experiment of Larix laricina was started in the greenhouse and transplanted to the nursery in 1976. This experiment involves over 250 families obtained from controlled pollinations in 1974. Five trees in each of four stands were pollinated with 13 pollens including self, near neighbour, moderately near neighbour, distant neighbours, and long-distance pollinations as well as appropriate wind-pollinated controls. Information from this experiment is expected to provide information on natural inbreeding, population structure, heritability, and genetic gain and will be important in determining optimum breeding strategies.

A second Larix experiment, a "spin-off" from the preceding, involves the genetic control of flower colour. A knowledge of the inheritance of this marker will be useful for future population studies.

TECHNICAL ASSISTANCE PROGRAM

Substantial reforestation programs are underway or being developed in both New Brunswick and Nova Scotia. These programs provide an excellent opportunity for the use of superior stock with consequent increased yields. It is the objective of the M.F.R.C. work in this field to assist provincial and industrial agencies in developing operational tree improvement programs through advice and consultation, and special research investigations.

In 1976, the Maritimes Forest Research Centre was instrumental in initiating the formation of a tree improvement cooperative (to be known as the New Brunswick Tree Improvement Council) involving the Province of New Brunswick, nine New Brunswick industries and the Maritimes Forest Research Centre. Plans are being formulated now for the improvement of black spruce, jack pine (Pinus banksiana), white spruce, and larch and to expand and complement the work already undertaken by the Province. The establishment of a cooperative involving the Province of Nova Scotia, three Nova Scotia industries and the Maritimes Forest Research Centre is being discussed.

A small progeny test, seedling seed orchard of Ottawa Valley white spruce sources, was established at Abercrombie Point, N.S. in cooperation with Scott Paper Co. Ltd. and the Province. Additional Ottawa Valley material to enlarge this orchard is presently in our greenhouses and will be outplanted in the spring. Seeds and technical assistance were provided to the Province of New Brunswick for the initiation of a production seedling seed orchard of Ottawa Valley source white spruce.

TISSUE AND ORGAN CULTURE

Tissue Culture

The production of homozygous lines and the subsequent crossing of these lines to produce heterotic hybrids has been successfully used as a breeding technique with several agricultural crops (i.e. hybrid corn).

The development of near homozygous lines requires several generations of inbreeding (usually self-fertilization). Because of the long period between generations, this technique has been avoided by tree breeders. If haploid plants could be located or produced, their chromosome complement could be doubled to produce homozygous diploids and the long period required to produce such trees by inbreeding could be avoided.

The gametophyte stage (haploid) in gymnosperms, although greatly reduced in comparison to the sporophyte, undergoes several cell divisions. If the gametophyte could be induced to undergo further divisions and subsequently to differentiate into a functional plant, the production of haploids and homozygous diploids would be feasible.

Recent developments in the field of tissue culture (i.e. culture of the gametophyte of ginkgo) indicate that this approach is plausible. Male and female gametophytes and gametophyte pieces have been cultured in vitro and the effects of various nutrients, growth regulators, etc., on cell division and differentiation have been studied. The studies have been mainly with red pine gametophytes. This species has been selected because of its genetic uniformity and low frequency of deleterious genes. Once techniques have been successfully developed for red pine they will be used with other coniferous species.

To grow conifer tissues in tissue culture requires about 20 different nutrient chemicals, each of which has to be present in specific amounts to assure growth. Similarly, the requirements for such physical factors as pH, light and temperature cycles, ion exchange capacity of the nutrient medium, gas exchange, etc., have to be correctly determined. Furthermore, once growth has been satisfactorily obtained, the chemical-physical environment has to be manipulated in such a manner that the growth pattern changes from an unorganized to an organized pattern. Each stage of organization generally requires adjustments in the environment (Bonga, 1977).

By manipulating the growth hormones in the media, embryo-like structures were induced in the initially unorganized callus tissue (Bonga 1974a, 1977). The tissues derived from the male gametophyte grow faster, and generally form embryo like structures more easily than the tissue derived from female gametophytes. However, in the tissues derived from the male gametophyte, there often is a high ratio of diploid over haploid cells. There are strong indications that these diploid cells have arisen from fusion of haploid cells within single pollen grains (Bonga, 1974a, b), and thus would be homozygous diploid, i.e. the desired condition, and did not originate from the heterozygous diploid cells of the anther walls or from fusion of different pollen grains. However, it is still preferable to work with tissue in which the haploid-diploid ratio is as high as possible. It was found that specific, short duration centrifugation treatments (Bonga and McInnis, 1975), and cold treatments (Bonga, 1974a, b) increased the ratio considerably.

It is important to have good cytological techniques to determine: (1) if cells are haploid or diploid; (2) if diploid cells arise from fusion of haploid pollen cells or from the diploid anther wall cells. The techniques commonly used in conifer cytology were tested but none of them were satisfactory. Therefore, efforts were made to develop new techniques to (1) intensely stain chromosomes in callus and pollen tissues; (2) properly separate cells, so that large numbers of cells can be studied; (3) accumulate metaphases in the highest possible numbers; (4) shorten and separate chromosomes as much as possible for easier counting. With regard to callus tissues, the first three of these objectives have now been achieved (Bonga and Venketeswaran, 1976); the new stains for pollen are much better than the original ones, but the possibility of further improvements is still being investigated. Better chromosome shortening and separation is still a problem requiring a solution.

Another major problem during the early years of the study was that suitable material was available for only a few weeks each year, which severely restricted the number of experiments that could be carried out. Microsporophylls can be collected for only a few days every spring, and they remain viable in normal storage for only about 3-5 weeks. Storage in a nitrogen-air 1:1 mixture was found to double the storage life of the material (Bonga 1974b) presumably by reducing respiration.

It is intended to continue the study along much the same lines followed over the last 2-3 years. To obtain haploid, and eventually homozygous plantlets, the interactions of the various physical-chemical factors that will induce haploid tissue proliferation and differentiation will have to be more precisely defined.

Organ Culture

Conifers are mainly propagated sexually because vegetative propagation of trees old enough to have demonstrated their superior characteristics is often difficult. However, where vegetative clonal propagation is economically feasible, it is often preferred to sexual propagation because it allows fixing of selected genetic characteristics. Consequently, it is important to develop methods to vegetatively propagate older trees.

To date, the most common method of vegetative propagation of conifers has been rooting of cuttings. However, cuttings often fail to root properly and in these cases tissue and organ culture could be a more promising approach (Bonga, 1974, 1977). Complete or partial vegetative regeneration of conifers from tissue or organ cultures has been achieved by other researchers for several species from explants taken from either embryos or young seedlings, but not from explants from older trees.

In our attempts to obtain vegetative propagation from tissues of older trees of Abies balsamea L. (balsam fir), dormant buds minus bud scales were used as explants. The literature reports several hardwood species that have been propagated by in vitro vegetative propagation because they or their callus often form adventitious embryos or organs more easily than explants from other parts of the plant. In spite of extensive efforts, the balsam fir buds have, so far, failed to root. However, specific short term hormone treatments were developed which induced the formation of adventitious embryos from tissues of the needles of the buds. Some of these embryos germinated and formed small seedlings. However, germination was precocious and, consequently, the developing seedlings were severely stunted. Methods to obtain normal germination of the adventitious embryos, therefore, remain to be developed.

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AMÉLIORATION DES ARBRES FORESTIERS AU SERVICE DE LA RECHERCHE DU MINISTÈRE DES TERRES ET FORÊTS DU QUÉBEC

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PROJET G 68-1. SÉLECTION DE CLONES ET AMÉLIORATION DU PEUPLIER (POPULUS L.), PAR G. VALLÉE

Les travaux se sont poursuivis en 1975 et 1976, surtout par la réalisation de plantations comparatives dans le sud du Québec, par des observations sur 35 dispositifs et par l'acquisition de nouveaux clones et de lots de graines des *Populus trichocarpa* Torr. et Gray et *P. nigra* L.

Plantations comparatives

En 1975, trois tests de descendances ont été établis. Un test a été installé au populetum de Matane avec 45 descendances d'hybrides et deux au populetum de Villeroy, dont l'un avec 131 descendances d'hybrides obtenues de croisements contrôlés en 1971 et l'autre avec 34 descendances principalement de *P. deltoides* Marsh. provenant de la vallée du Saint-Laurent. Au total, 18 621 plants ont été plantés en dispositif et en plantation conservatoire.

En 1976, trois plantations conservatoies ont été réalisées au populetum de Villeroy avec (a) 57 provenances de *P. trichocarpa* représentées par 9 549 plants, (b) 27 descendances de *P. deltoides* provenant de Belgique et de l'Illinois représentées par 1 113 plants et enfin (c) 37 descendances d'hybrides obtenus de croisements contrôlés réalisés en 1973 et ayant produit 653 plants.

Acquisitions

Par l'intermédiaire du *Working Party On Provenance of Poplars* de l'IUFRO, 8 lots de graines de *P. trichocarpa* ont été obtenus afin de compléter la collection de provenances ainsi que 43 lots de graines de *P. nigra* provenant de Belgique, Hollande, Hongrie, Bulgarie et Yougoslavie. Ces graines ont été semées dès leur réception.

Notre collection de clones s'est enrichie de 50 clones de *P. nigra* provenant des Pays-Bas expédiés par le Dr. Koster de l'Institut de Dorschkamp et de 16 clones d'hybrides provenant de France expédiés par M. Franclet de l'AFOCEL. A la mi-octobre 1976, nous avons sélectionné 22 *Populus* x *jackii* Sarg. en forêt naturelle le long de la route Trans-Canada entre Québec et Montréal. Tous ces arbres adultes montraient une très bonne résistance aux maladies foliaires qui ont été particulièrement sévères en 1976 à cause d'un été très pluvieux.

Avec ces dernières acquisitions, notre collection de clones représente 740 sujets et les plantations de provenances et de descendances d'hybrides ou d'espèces comprennent 38 330 plants occupant une superficie de 36 hectares. L'objectif, au départ du projet en 1968, de constituer une banque de génotypes apte à la sélection et à la réalisation de croisements, est atteint en partie. Cette phase de collection qui se poursuivra nous semble nécessaire pour assurer l'amélioration du peuplier dans l'avenir.

PROJET G 70-3. AMÉLIORATION DU MÉLÈZE (LARIX, MILL.), PAR ANTE STIPANICIC

Le projet d'amélioration du genre mélèze, qui a débuté au Service de la recherche du ministère des Terres et Forêts en 1970, se développe selon les étapes prévues et selon les moyens disponibles. Comme précisé au moment de la mise en marche du programme, l'objectif principal de ces travaux est de trouver les espèces, les hybrides, les provenances et les clones les mieux adaptés aux conditions des régions à reboiser au Québec.

Plantations expérimentales

Au printemps 1976, deux vergers à graines, un test de descendances et une plantation conservatoire de semis sélectionnés ont été installés dans 3 arboretums. Il s'agit de 40 descendances d'arbres de belle venue, surtout de *Larix decidua* Mill., provenant de la vallée du Saint-Laurent.

Présentement, nous possédons dans la pépinière 22 provenances de *Larix* x *eurolepis*, 13 provenances de *L. decidua*, 10 provenances de *L. leptolepis* Gord. et 12 provenances de *L. sibirica* Lebed. et des hybrides *L. sibirica* x *L. leptolepis* et x *L. decidua*. Ce matériel fait partie des expériences No 377 et No 378 du *Petawawa Forest Experiment Station*. Au printemps 1977, toutes ces provenances seront plantées sous forme de plantations comparatives ou de futurs vergers à graines dans différents arboretums. Les observations et les mesures faites après la deuxième et la quatrième année dans la pépinière nous permettent de tirer quelques conclusions sur le comportement juvénile de ces provenances. Nous avons remarqué une faible résistance au froid chez les *L. leptolepis* et chez plusieurs *L.* x *eurolepis*, mais par contre l'accroissement de ces deux espèces est supérieur par rapport à *L. decidua* et surtout à *L. sibirica*. Certains lots de *L. sibirica* où il y avait possibilité d'hybridation avec les autres espèces du genre *Larix* montre une très forte hétérogénéité au point de vue de l'accroissement en hauteur, ce qui confirme l'hypothèse que certains hybrides de *L. sibirica* pourraient être très intéressants pour les forêts boréales.

Récolte des graines

A) Profitant d'une fructification assez bonne en 1976, l'accent a été mis sur la récolte de graines de *L. laricina* (Du Roi) K. Koch dans le sud du Québec plus particulièrement. Ainsi, 25 provenances comprenant 200 descendances ont été échantillonnées. Cet échantillonnage, ainsi que les autres lots de graines récoltés en 1976 ou reçus de PFES et de quelques organismes aux USA, nous a permis de mettre en marche durant l'hiver 1976-77 un test sur 87 provenances recouvrant assez bien la partie sud-est de l'aire de distribution du mélèze laricin.

Le Service de la recherche possède présentement dans sa banque de semences une collection de 40 lots de graines (soit descendances, soit provenances) de Larix dahurica (Rupt.) Kuseneva, L. decidua, L. leptolepis, L. occidentalis Nutt., L. olgensis Ostenf. et Syrach et L. sibirica. Nous avons reçu ces lots du Service de la restauration et de PFES. Au printemps 1977, nous allons semer une partie des graines de L. occidentalis, L. olgensis et L. dahurica pour obtenir quelques informations sur le comportement de ces espèces au Québec.

Propagation végétative: greffage et bouturage

En vue de former des vergers à graines clonaux, nous avons continué de greffer les arbres de belle venue et aussi des sujets d'autres arbres pour lesquels nous avons déjà la preuve qu'ils peuvent produire des hybrides de qualité supérieure. Au printemps 1976, nous avons réalisé 449 greffes, mais le résultat était très faible.

PROJET G 74-1. AMÉLIORATION DU PIN GRIS (PINUS BANKSIANA LAMB.), PAR R. BEAUDOIN

Le Service de la recherche poursuit sa politique d'amélioration des espèces à croissance rapide telles que le pin gris. Cette espèce est par nature très hétérogène, ce qui laisse supposer qu'on peut obtenir des gains appréciables sur plusieurs caractères par la sélection. C'est aussi une espèce rustique, d'amplitude écologique importante, qui couvre 12 à 15 pour cent de la surface de nos forêts productives et accessibles au Québec et dont la demande pour le reboisement ne cesse de croître.

La plupart des travaux entrepris par le Service sur le pin gris sont fait en coopération avec différents organismes, tels le Service de la restauration du ministère des Terres et Forêts, la Compagnie Internationale de Papier, la Station forestière Expérimentale de Petawawa, le Centre de Recherche Forestière des Laurentides et la Consolidated Bathurst Ltée.

Echantillonnage dans le Nord-Ouest du Québec

Jusqu'à présent, nous avons sélectionné 139 arbres, dont la plupart proviennent des comtés d'Abitibi Est et Ouest. Une description complète des arbres est effectuée et les cônes sont récoltés pour l'extraction de la graine. En utilisant les cartes forestières qui montrent la nature et l'étendue des peuplements dans la zone échantillonnée, on s'aperçoit que l'intensité d'échantillonnage a été constante et proportionnelle à la superficie des peuplements. Les arbres sélectionnés sont très éloignés les uns des autres (minimum 3 km) ce qui rend tout lien de parenté (demi-frères) pratiquement impossible.

Les critères que nous avons retenus dans nos travaux de sélection portent sur la rectitude du fût, les caractères dendrométriques, la finesse des branches, l'angle d'insertion des branches et l'état de santé de l'arbre.

Cette sélection va se poursuivre dans cette région au cours de l'automne 1978. Notre but est d'obtenir un échantillonnage représentatif de cette région avec un nombre suffisamment élevé d'arbres sélectionnés pour établir un test de descendances et un verger à graines de descendances.

Amélioration de la provenance Baskatong

Un peuplement semencier de 120 hectares a été délimité au sein d'une population naturelle de pin gris de bonne qualité dans le secteur de la Côte jaune à l'ouest du lac Baskatong par la compagnie "Canadian International Paper" (CIP).

Dans ce peuplement, des étudiants participant à des travaux d'été subventionnés par le Ministère ont sélectionné et identifié en 1974 et 1975 un total de 325 arbres plus. Une équipe formée à partir d'effectifs du Service de la recherche et de la C.I.P. a procédé à l'échantillonnage complet de ces arbres plus au cours de l'hiver 1976. Une partie des greffons prélevés a été expédiée à Petawawa et l'autre partie a fait l'objet d'une campagne de greffage de février à avril 1976 au Service de la recherche. Cependant, le taux de survie des plants greffés lors de cette campagne n'a été que de 12%, en grande partie à cause de la pauvre qualité des greffons (longueur moyenne 6 cm, diamètre 2-3 mm). Ainsi, des 304 arbres greffés, seulement 200 demeurent représentés.

Les arbres plus ont été abattus lors de l'échantillonnage, ce qui a permis de faire une description détaillée de chaque arbre et de réaliser une étude dendrométrique en laboratoire. A partir des données recueillies sur le terrain et qui concernent l'arbre et son habitat immédiat, on peut reproduire graphiquement celui-ci tel qu'il se présente dans la nature. Toutes les données sont quantitatives, donc facilement comparables d'un individu à l'autre.

Des études de densité du bois faites sur chaque arbre indiquent des différences appréciables pour ce caractère, ce qui permet d'entrevoir une amélioration notable de la qualité du peuplement par cette voie. Ainsi, la densité basale enregistrée au d.h.p. sur du bois de 25 à 35 ans varie de 0.50 à 0.30 pour des échantillons dont le rythme de croissance est très peu variable.

Succédant à un feu datant de 1923, le peuplement a un densité de 1 300 tiges à l'hectare. Les arbres sélectionnés ont une hauteur moyenne de 18,3 m et un diamètre de 192,9 mm. La croissance en diamètre ralentit aux environs de 15 à 20 ans tandis que la croissance en hauteur fait de même aux alentours de 20 à 25 ans. Tous les arbres du peuplement sont affectés d'une ou plusieurs courbures qui sont en général peu prononcées (flèche moyenne 26 mm).

Le caractère non-sérotineux des cônes apparaît sur 2 à 3 pour cent des arbres du peuplement. Sur ceux-ci, 75 pour cent des cônes sont ouverts sans distinction d'âge. La germination des graines se situe entre 75 et 85 pour cent pour la majorité des arbres échantillonnés. Cependant, pour des cônes de même âge, 8 pour cent des lots de graines ont une germination aussi faible que 32 pour cent.

La figure 1 illustre les différentes étapes à suivre ainsi que la répartition des tâches entre les divers organismes concernés par ce projet d'amélioration.

Test de provenances

Pour une espèce hétérogène comme le pin gris dont l'aire de distribution est fragmentée, on peut diviser l'étendue de son aire naturelle en un nombre défini de superficies très variables et dont l'évolution s'est faite au cours des temps depuis la dernière glaciation. On sait d'ores et déjà que cette espèce montre des différences de vigueur positive suivant un axe est-ouest et que les résultats obtenus à ce jour suggèrent l'utilisation des provenances locales pour les reboisements et l'amélioration du pin gris sur une base régionale.

En 1965, un test comprenant 88 provenances dont 28 du Québec a été installé dans 4 régions de la province sous la responsabilité du Dr Yeatman du Service canadien des forêts. Malgré les résultats intéressants obtenus, l'étendue de l'aire du pin gris au Québec et le morcellement des peuplements suggèrent la réalisation d'un test plus complet avec un échantillonnage intensif. Ce test permettra de choisir pour une zone donnée les meilleures sources de graines et de fixer les limites du transfert de semences tout en complétant nos connaissances sur la variabilité du pin gris.

Actuellement le Service possède des lots de graines représentant 73 provenances de pin gris du Québec. On prévoit d'ici un an ou deux compléter l'échantillonnage de l'aire du pin gris avec l'objectif d'accumuler 150 provenances.

PROJET G 75-1. SÉLECTION D'ESPÈCES POUR L'ORNEMENTATION ET LA RÉALISATION DE BRISE-VENT SUR LES ABORDS DES ROUTES ET AUTOROUTES, PAR G. VALLÉE

A la demande du ministère des Transports du Québec, un arboretum pour la sélection d'espèces aptes à l'ornementation et à la réalisation des brise-vent sur les abords des routes et autoroutes a été établi en 1975. Il se situe à l'intersection de la route pour Sainte-Brigitte-des-Saults et de l'autoroute Trans-Canada, à mi-chemin entre Québec et Montréal.

Objectifs

L'objectif principal est d'identifier les espèces d'arbres, arbrisseaux et arbustes résistant au sel, tant au niveau des racines qu'au niveau de la cime, et ayant des caractéristiques d'arbres ornementaux ou d'alignement pour la constitution de brise-vent.

En second lieu, par le principe de base du dispositif mis en place, il sera possible d'évaluer le comportement des espèces en bouquet d'arbres et comme arbre isolé.

Méthode

Le dispositif est installé sur deux terrains situés de chaque côté de l'autoroute et entrecoupés par les voies de sortie et d'entrée. Il comprend généralement, pour chaque espèce, 4 répétitions de 15 arbres dont deux sur les abords de l'autoroute et deux sur les voies de service. L'espacement adopté est de 3 m x 3 m et les parcelles sont constituées par 3 lignes de 5 plants.

En ornementation, les résineux sont utilisés pour leur effet esthétique qui est apprécié à cause de leur feuillage persistant durant l'hiver ce qui enjolive le paysage. Dans cette optique, le dispositif a été conçu en situant deux rangées de parcelles près des voies de l'autoroute et de service. Les espèces résineuses occupent la première rangée par rapport aux voies, en avant des espèces feuillues qui occupent la deuxième rangée ainsi que toute la surface intérieure des terrains.

Le terrain entre les voies de l'autoroute sera occupé par des plantations d'alignement, en alternant des parcelles linéaires d'espèces résineuses et d'espèces feuillues arbustives.

Toutes les parcelles n'ont pas été plantées car les plantations de différentes espèces et provenances se poursuivront selon leur disponibilité. Les provenances d'espèces croissant en bordure de l'océan seront recherchées.

En 1975 et 1976, quelque 54 espèces comprenant 78 provenances ont été plantées.

PROJET G 76-1. GÉNÉTIQUE DU SAPIN BAUMIER (ABIES BALSAMEA (L.) MILL.) EN RELATION AVEC LA TORDEUSE DES BOURGEONS DE L'ÉPINETTE, PAR D. ROBERT

Introduction

Cette étude a été entreprise afin de vérifier si les sapins baumiers à débourrement tardif sont moins affectés par la tordeuse des bourgeons de l'épinette que peuvent l'être ceux dont le débourrement hâtif, ou même normal pour une région donnée, évolue simultanément avec le développement larvaire de la tordeuse.

Les données ont été prélevées à l'arboretum de Parke, comté de Kamouraska, au Québec. Cette station est située dans la région forestière L-6 de Rowe; elle est caractérisée par la sapinière à bouleau jaune sise sur un till schisteux limoneux.

Matériel

C'est le dispositif D-85-72 du Service de la recherche du ministère des Terres et Forêts qui a servi pour les besoins de l'expérience; il s'agit d'un test de descendances sur le sapin baumier comportant 47 descendances distribuées en 6 blocs dont deux sont complets. Les blocs sont formés de parcelles linéaires de 10 plants dont les écartements sont de 2,5 mètres de part et d'autre. Pour les besoins de l'étude, seules deux répétitions complètes furent retenues.

Données

Les observations sur le débourrement furent prises au printemps de 1976, le 28 mai et les 3, 8, 12 et 21 juin, selon une échelle de valeur composée de 6 classes, allant du stade sans aucun développement (stade 1) au stade totalement débourré (stade 6).

Par la suite, des observations ont été faites sur les dégâts causés par les gelées tardives ainsi que sur la défoliation subies par le vieux feuillage et les pousses de 1976. Les hauteurs et longueurs de pousse des plants furent relevées à la fin de la saison de croissance.

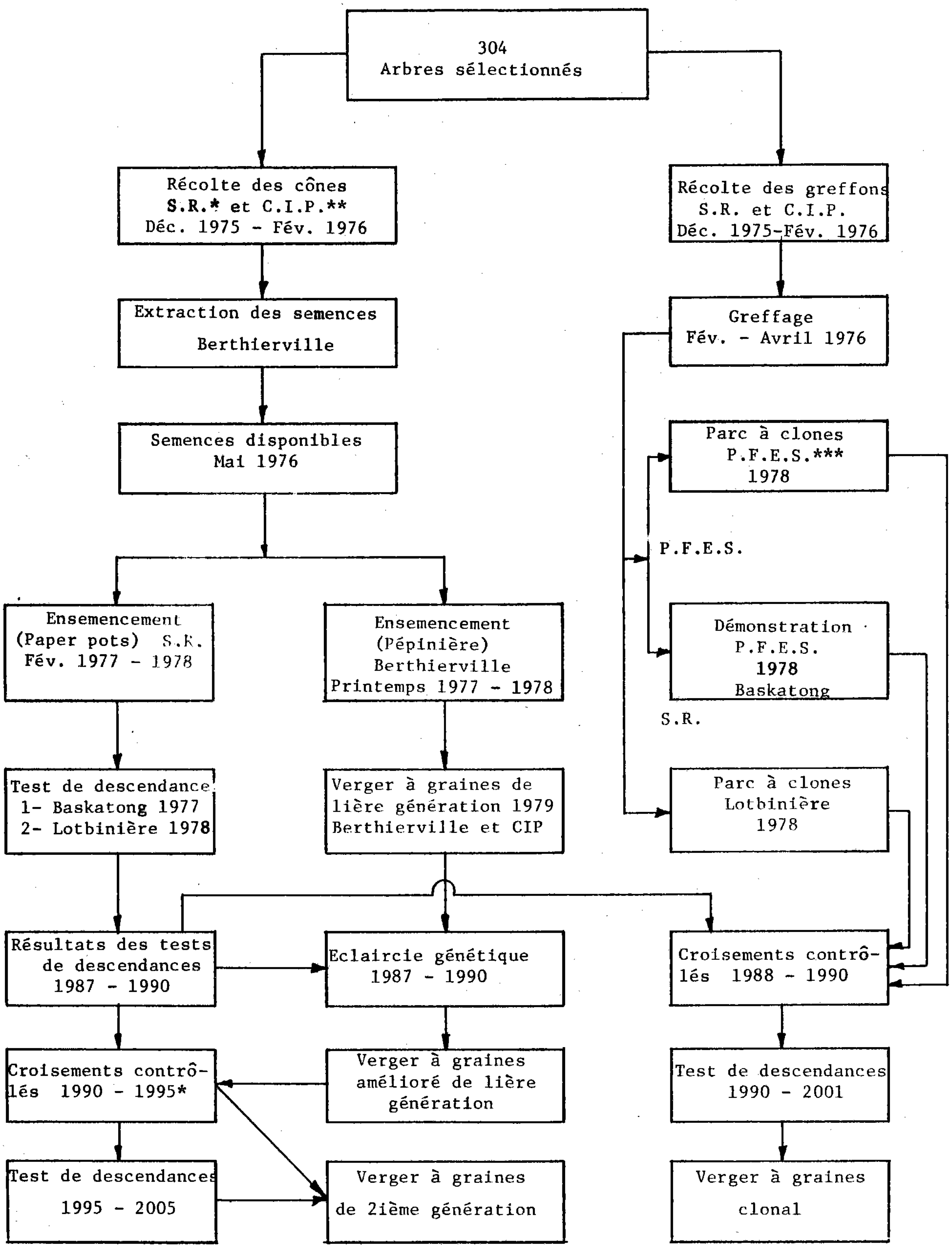
Résultats

L'analyse des données est présentement en cours. Toutefois, l'analyse initiale des composantes principales a permis de diviser l'ensemble des descendances en deux sections distinctes: d'une part, les descendances à débourrement hâtif, soit la majorité et d'autre part, les descendances à débourrement tardif.

Parmi ces dernières se retrouvent toutes les descendances composant la provenance du mont Gosford, Québec, la plus méridionale de cette étude, dont la latitude nord est de 45°10', la longitude de 70°31' et l'altitude de 1 040 mètres. Egalement, trois des quatre descendances de la provenance de Drummondville, de 45°33' de latitude nord, de 72°17' de longitude ouest et de 61 mètres d'altitude, se retrouvent parmi le regroupement des descendances à débourrement tardif.

Ces deux provenances se détachent donc des autres, qui présentent dans l'ensemble un débourrement relativement hâtif et homogène. L'influence du débourrement tardif ou hâtif quant au degré de défoliation causé par la tordeuse est toujours à l'étude.

Figure 1. ETAPES ET REPARTITION DES TACHES ENTRE LES DIFFERENTS ORGANISMES CONCERNES PAR L'AMELIORATION DU PIN GRIS DE BASKATONG



* S.R.: Service de la recherche

** CIP : Canadian International Paper

*** Petawawa Forest Experiment Station

AMÉLIORATION DES ARBRES À LA PÉPINIÈRE FORESTIÈRE DE BERTHIERVILLE, P.Q.

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Mots-clés: semences forestières, peuplement semencier, test de provenances, verger à graines, sélection.

L'usine d'extraction des semences de la pépinière forestière de Berthierville a pour tâche, l'extraction, la vérification, l'entreposage, le traitement et la distribution de toutes les semences forestières récoltées au Québec. Le généticien, localisé à la pépinière, est le responsable régional pour les travaux d'amélioration des arbres. Il est également chargé de l'établissement des vergers à graines de production dans toute la province. Il est à noter que les travaux de recherches en génétique forestière sont effectués par le Service de la Recherche du ministère des Terres et Forêts.

Un bref aperçus des activités à l'usine d'extraction des semences ainsi que des travaux en amélioration des arbres, est présenté dans les lignes qui suivent.

RÉCOLTE DE CÔNES ET EXTRACTION

Le tableau 1 présente les différents volumes de cônes récoltés au cours de 1975 et 1976 dans les 13 zones de récolte des semences dans la province.

Tableau 1. Quantité de cônes récoltés, par espèce, en 1975 et 1976 au Québec.

Espèce	Cônes récoltés en 1975	1976
	.... x 40 litres	....
Larix decidua	--	139.7
Larix laricina	--	2.6
Larix leptolepis	--	105.8
Pinus banksiana	10379.3	--
Pinus nigra	13.0	--
Pinus resinosa	298.2	--
Pinus strobus	3.0	532.4

Environ 35 x 40 litres de semences de diverses espèces furent aussi cueillies durant les deux dernières années: Acer, Fraxinus, Juglans, Quercus et Tilia.

Les quelques 1733 kgs des semences extraites de ces cônes en plus semences déjà en entrepôt seront suffisantes pour satisfaire la production régulière en pépinière ainsi que l'ensemencement aérien dans la plupart des espèces sauf pour Picea abies, Pinus resinosa et P. strobus. Il est à remarquer que les objectifs de récolte pour 1976 furent réduits de beaucoup dû à des coupures importantes dans le budget.

Cent quartre-vingt-deux (182) échantillons furent prélevés de ces semences afin d'y effectuer des tests d'humidité, de germination et de pureté et de déterminer le nombre de semences viables par kilogramme.

La plupart de ces cônes sont récoltés dans des peuplements de belle venue soit sur des arbres debouts ou abattus. Préalablement à la récolte, la qualité du peuplement est vérifiée par un forestier.

L'identité de la provenance des semences est maintenue durant toutes les phases de l'extraction, de l'entreposage et de la production en pépinière afin de pouvoir reboiser les plants à un endroit le plus près possible du lieu d'origine des semences.

AMÉLIORATION DES ARBRES

Durant 1975 et 1976, la majorité des travaux en amélioration des arbres furent ralentis ou même suspendus à cause des restrictions budgétaires.

Peuplements semenciers

Des travaux d'éclaircie sont toujours prévus dans le peuplement semencier de 40.5 hectares de Pinus banksiana Lamb. localisé dans les cantons Houde-Provost. L'éclaircie aura pour but de dégager la cime des meilleurs phénotypes afin d'accroître leur production en semences. La récolte de cônes sera effectuée par la coupe d'une partie du peuplement. La superficie coupée sera reboisée avec les plants issus de ce peuplement.

La superficie du peuplement semencier de P. resinosa situé dans la canton Chertsey sera portée de 16 à 42 hectares en 1977. L'éclaircie et la fertilisation seront pratiquées afin de faciliter la cueillette des cônes au moyen d'équipement mécanisé et d'augmenter la production de semences. L'établissement d'un nouveau peuplement semencier dans les environs immédiats est prévu avec des semis originaires de ce peuplement.

Tests de provenances

Un dispositif comprenant 8 provenances de Picea abies de la Nouvelle-Angleterre et 2 provenances locales fut mis en terre dans 5 régions géographiques différentes au Québec. Ces plantations seront transformées en vergers à graines de production après élémination des piètres provenances alors que les meilleures seront reproduites végétativement dans un verger clonal.

Des semences de *Larix eurolepis* en provenance du Danemark ont été mises en terre à la pépinière de Berthierville au printemps 1976. La plantation est prévue pour le printemps 1978. Les meilleurs phénotypes seront dégagés et conservés dans un verger à graines de semis pour la production commerciale.

Vergers à graines

La sélection de semis-plus s'est poursuivie dans les différentes pépinières de la Province. En 1975 et 1976, 3000 semis-plus ont été sélectionnés selon des normes très rigides et ont été plantés dans les différents vergers déjà établis. Des observations oculaires sur les semis-plus plantés il y a déjà 4 ans démontrent une supériorité évidente de la croissance des semis sélectionnés sur celle des témoins. Des graines récoltées sur ces mêmes semis présentent un bon pourcentage de semences viables particulièrement sur *Pinus banksiana* et *Larix laricina* et *Picea glauca*.

La prochaine étape de ce programme sera de sélectionner les plants à floraison précoce et à les propager végétativement. Il en sera de même pour les plants qui conserveront une croissance exceptionnelle mais qui fleuriront plus tard.

Un programme d'amélioration du *Pinus banksiana* avec la provenance Côte Jaune située dans la région du Lac Baskatong, dans l'ouest du Québec, a été mis sur pied avec la collaboration du service canadien des forêts, de la Compagnie Internationale de Papier du Canada et du Ministère des Terres et Forêts du Québec. L'établissement d'un verger à graines de semis avec les semences prélevées sur environ 300 arbres sélectionnés, nous incombe. A cet effet, la production de semis pour la plantation d'une première tranche de 25 acres en verger, fut entreprise à l'automne 1976. La plantation sur le terrain est prévue pour le printemps 1979.

Sélection d'arbres

Pour les fins du programme d'amélioration du *Pinus banksiana* de Côte Jaune, environ 300 arbres furent sélectionnés par des étuidants sous la direction des officiers de la Compagnie Internationale de Papier du Canada. Tous le cônes sur les arbres sélectionnés furent cueillis. Sur réception à Berthierville, ils furent classifiés en deux catégories: les cônes jaunes ou ceux produits durant l'année et les cônes gris ou ceux âgés de plus d'un an. Les résultats de quelques observations sont présentés dans le tableau suivant. Ils représentent une moyenne de tous les arbres sélectionnés.

Observations	Cônes jaunes	Cônes gris	Total
Nombre de cônes/arbre	64	191	255
Nombre moyen de graines pleines par cône	20.7	18.4	19.4
Poids moyen de 1000 graines	3.56 grs	3.34 grs	3.45 grs
Nombre de graines pleines par kilogramme	281,000	301,000	291,000

Les semences extraites des cônes jaunes sont en général plus grosses que celles extraites des cônes âgés comme on peut le voir par un poids plus élevé de 1000 semences et un nombre moindre de semences au kilogramme.

Un programme de sélection d'arbres-plus a été entrepris à l'automne 1976. La sélection se fera d'abord dans les peuplements semenciers déjà établis dans la région administrative de Montréal pour s'étendre par la suite aux autres régions. A date, 19 arbres ont été sélectionnés à la Pépinière forestière de Berthierville et les travaux se poursuivront au cours de l'été 1977.

GÉNÉTIQUE ET AMÉLIORATION DES ARBRES AU CENTRE DE RECHERCHES FORESTIÈRES DES LAURENTIDES, 1975-77

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Les essais de provenances et les études génécologiques mises sur pied au cours des dernières années apportent des résultats d'intérêt grandissant avec l'augmentation en âge du matériel expérimental. L'information obtenue de cette étape préliminaire a contribué à stimuler la poursuite des études existantes et l'initiation de nouvelles études, et a facilité leur orientation. La demande toujours grandissante, en quantité, qualité et diversité, pour le bois et ses dérivés justifie non seulement le maintien mais aussi l'accentuation des programmes de recherche et d'amélioration génétique de nos espèces forestières d'importance économique.

GÉNÉCOLOGIE ET RECHERCHE SUR LES PROVENANCES

Des progrès sensibles ont été réalisés dans le cadre du programme d'amélioration génétique au CRFL. Au début, l'accent a été placé sur les essais de provenances, les études génécologiques des espèces forestières indigènes de valeur commerciale et sur l'introduction d'espèces exotiques. Nous avons sur peid un cinquantaine de tests de provenances et de descendances représentant quelque 460 populations et plus de 340 arbres individuels des genres Betula, Larix, Picea, Pinus et Pseudotsuga, dans différents secteurs forestiers du Québec (Tableau 1). Ces études nous ont permis de démontrer que l'épinette rouge (Picea rubens Sarg.) ne devrait être utilisée que pour le reboisement sous futaie et non en terrain découvert dû à sa faible résistance au froid et au dessèchement hivernal. De plus, cinq provenances supérieures d'épinette blanche (Picea glauca (Moench) Voss) ont pu être recommandées pour le reboisement dans le Québec méridional. Ce sont les provenances 2438 (Peterborough, Ont.), 2445 (Cushing, Qué.), 2446 (Beloeil, Qué.), 2484 (Lac Mitchinamecus, Qué.), 2485 (Lac Simard, Qué.). L'hybride entre l'étaux élevé de mortalité causée par le froid et les arbres survivants développent une forme arbustive à cause de gel des bourgeons.

Les meilleures provenances d'épinette de Norvège (Picea abies (L.) Karst.) ont une croissance supérieure aux épinettes indigènes lorsqu'elles sont plantées dans le sud du Québec. Les provenances qui ont démontré le plus fort taux de survie et la meilleure croissance sont: QS-8 (Smith Pl., Qué.), 1720 (Istebna, Pologne), 2365 (Hudson's Place), 2314 (Maltesholm), 2313 (Borestad) et 2312 Össojö (Suède via Allemagne). L'hybride Picea abies x Picea asperata a une croissance inférieure à l'épinette de Norvège et a une plus grande variabilité.

Des très faibles différences sont observées entre les provenances de pin rouge (Pinus resinosa Ait.) plantées à Valcartier et à Drummondville. Les variations dans la croissance en hauteur sont également faibles à l'intérieur des populations.

Dans les plantations nordiques de pin gris (Pinus banksiana Lamb.), les provenances locales ont généralement la meilleure croissance et sont affectées à un degré moindre par le chancre scléroderrien (Gremmeniella abientina (Lagerb.)) reflétant bien leur adaptation au milieu environnant.

Des pertes considérables causées en majeure partie par le chancre godronien (Godronia spp.) dans les tests génécologiques de bouleau jaune (Betula alleghaniensis Britt.) diminuent grandement l'ampleur des résultats escomptés. Quelque 400 arbres-mères de 48 populations y étaient représentés et les tests devaient être transformés en aires de production de semences par la sélection inter- et intrafamiliale.

GÉNÉTIQUE ET AMÉLIORATION DE L'ÉPINETTE BLANCHE

Dans le cadre de notre étude génétique et d'amélioration de l'épinette blanche, 250 familles uniparentales représentant 50 populations ont été semées selon un dispositif expérimental en contenant de papier (Japanese paper pot) au mois de janvier 1976. Quelque quatre mois après la germination, les semis avaient atteint en moyenne 5 pouces de hauteur. Des différences génétiques importantes entre les familles étaient facilement discernables. Avant de repiquer les jeunes semis en pépinière où l'étude se poursuit, ils ont été forcés à entrer en dormance par l'abaissement graduel de la température nocturne, la diminution de la période journalière de lumière, l'arrêt de la fertilisation azotée et l'application d'une fertilisation sur une base hebdomadaire de phosphore et de potassium. Quatre semaines après le début du traitement, tous les semis étaient en dormance et suffisamment lignifiés pour être repiqués à l'extérieur sans danger de perte.

Une étude génétique, à l'échelle nationale, de l'épinette blanche a été élaborée en collaboration avec la Station forestière expérimentale de Petawawa. Selon le plan établi, 100 provenances dont 80 du Québec et de l'Ontario, seront testées dans quatre sections forestières du Québec. Les semences obtenues des populations québecoises et ontariennes seront maintenues par arbre-mère de façon à permettre le choix ultérieur des meilleures descendances et fournir une évaluation de l'importance de la variance génétique de type additif.

GÉNÉTIQUE ET AMÉLIORATION DU PIN BLANC

Au début du vingtième siècle, le pin blanc occupait quelque 37,000 milles carrés du territoire québecois. Aujourd'hui, on ne le retrouve en peuplements, d'une étendue respectable, que dans la Vallée de L'Outaouais et de ses affluents. Malgré son importance économique, le pin blanc n'a pas occupé la place qui lui revient dans le reboisement,

Tableau I. Tests de provenances et de descendances établis au Québec par le SCF de 1955 à 1976

Expérience	Espèce	Année de plantation	Nombre de provenances ou de descendances	Localité	Lat-N	Long-O	Elevation m
			Espèces Indigènes				
93-E	*Picea glauca*	1958	25	Drummondville	45°57'	72°30'	76
93-F	" "	"	25	Harrington	45°51'	74°38'	183
96-C	*Pinus resinosa*	"	12	Valcartier	46°56'	71°30'	183
95-D	*Picea rubens*	1959	14	Valcartier	46°56'	71°30'	183
95-E	" "	"	15	Drummondville	45°57'	72°30'	76
95-F	" "	"	16	Lac Mégantic	45°34'	70°47'	457
194-G	*Picea glauca*	1964	25	Harrington	45°51'	74°38'	183
194-H	" "	"	25	Baskatong	46°58'	76°08'	244
194-I-1	" "	"	25	St-Jacques des Piles	46°44'	72°45'	152
194-I-2	" "	1965	28	Grandes Piles	46°42'	72°41'	183
194-I-3	" "	"	28	Casey	47°44'	74°06'	427
255-E-9	*Pinus banksiana*	1966	64	Baskatong	46°58'	75°42'	244
255-E-10	" "	"	64	Clova	47°52'	75°38'	457
268-E-5	" "	"	25	Clova	47°53'	75°38'	457
292	*Picea glauca*	1969	40 des.	Valcartier	46°56'	71°30'	183
520	*Abies balsamea*	1972	23 des.	Valcartier (Donnacona bloc)	46°57'	71°31'	274
500-A	*Betula alleghaniensis*	1972	265 des. (39 pro.)	Arboretum de Lotbinière	46°30'	71°55'	80
500-B	" " "	"	203 des. (42 pro.)	Arboretum de Matapédia	48°30'	67°25'	185
500-C	" " "	"	145 des. (39 pro.)	Arboretum de Fort Coulonge	45°51'	76°34'	275
353-B-1	*Picea mariana*	1974	86	Arboretum de Mont-Laurier	46°47'	75°51'	244
353-B-2	" "	"	86	Arboretum de Lac St-Ignace	49°00'	66°20'	460
353-B-3	" "	"	90	Arboretum de Chibougamau	49°58'	74°15'	366
353-B-4	" "	1975	100	Valcartier (Donnacona bloc)	46°51'	71°32'	152

Tableau I. (Suite)

353-B-5	*Picea mariana*	1975	90	Arboretum de Labrieville	49°12'	69°36'	488
353-B-6	" "	"	85	Arboretum d'Amos	48°27'	78°14'	305
		Espèces Exotiques					
57-A	*Picea abies*	1955	6	Drummondville	45°56'	72°30'	61
57-B	" "	1956	5	St-Henri de Taillon	48°43'	71°55'	122
57-D	" "	"	6	Ste-Anne de la Pocatière	47°21'	70°01'	183
57-E	" "	"	6	Valcartier	46°56'	71°31'	183
57-C	" "	1957	7	St-Roch de Mékinac	46°47'	72°45'	183
57-G	" "	"	8	Valcartier	46°54'	71°27'	335
57-H	" "	"	7	Causapscal	48°31'	67°12'	366
200-M	" "	1961	3	St-Magloire	46°35'	70°19'	640
277-D-1	" "	1969	22	Valcartier	46°56'	71°30'	183
310-E-1	" "	1969	22	Valcartier	46°57'	71°31'	274
320-C	" "	1971	11	Valcartier	46°56'	71°30'	183
349-C-1	" "	1976	28	Valcartier (Donnacona bloc)	46°51'	71°32'	152
349-C-2	" "	"	28	Arboretum de Bonaventure	48°10'	65°20'	215
349-C-3	" "	"	28	Arboretum de Mont-Laurier	46°37'	75°51'	244
350-D	" "	1971	31 des. (12 pro.)	Arboretum de Matapédia	48°30'	67°25'	185
328-C	*Abies* sp.	"	8	Valcartier	46°57'	71°31'	274
510-A	*Pseudotsuga menziesii*	"	10	Valcartier	46°57'	71°31'	274
510-B	" " "	"	9	Arboretum de Matapédia	48°30'	67°25'	185
530-A	*Picea glauca var. albertiana*	1972	28	Valcartier (Donnacona bloc)	46°51'	71°32'	152
		Hybrides					
135-A	*P. sitchensis* x *glauca*	1959	5 des.	Valcartier	46°56'	71°30'	183
135-B	" " "	"	5 des.	Drummondville	45°57'	72°30'	76
253-F	*P. abies* x *asperata*	1961	2	St-Magloire	46°35'	70°19'	640
348-C	*P. glauca* x *glauca*	1971	37 des.	Valcartier	46°56'	71°30'	183
540	*P. mariana* x *rubens*	1972	3	Valcartier (Donnacona bloc)	46°51'	71°32'	152

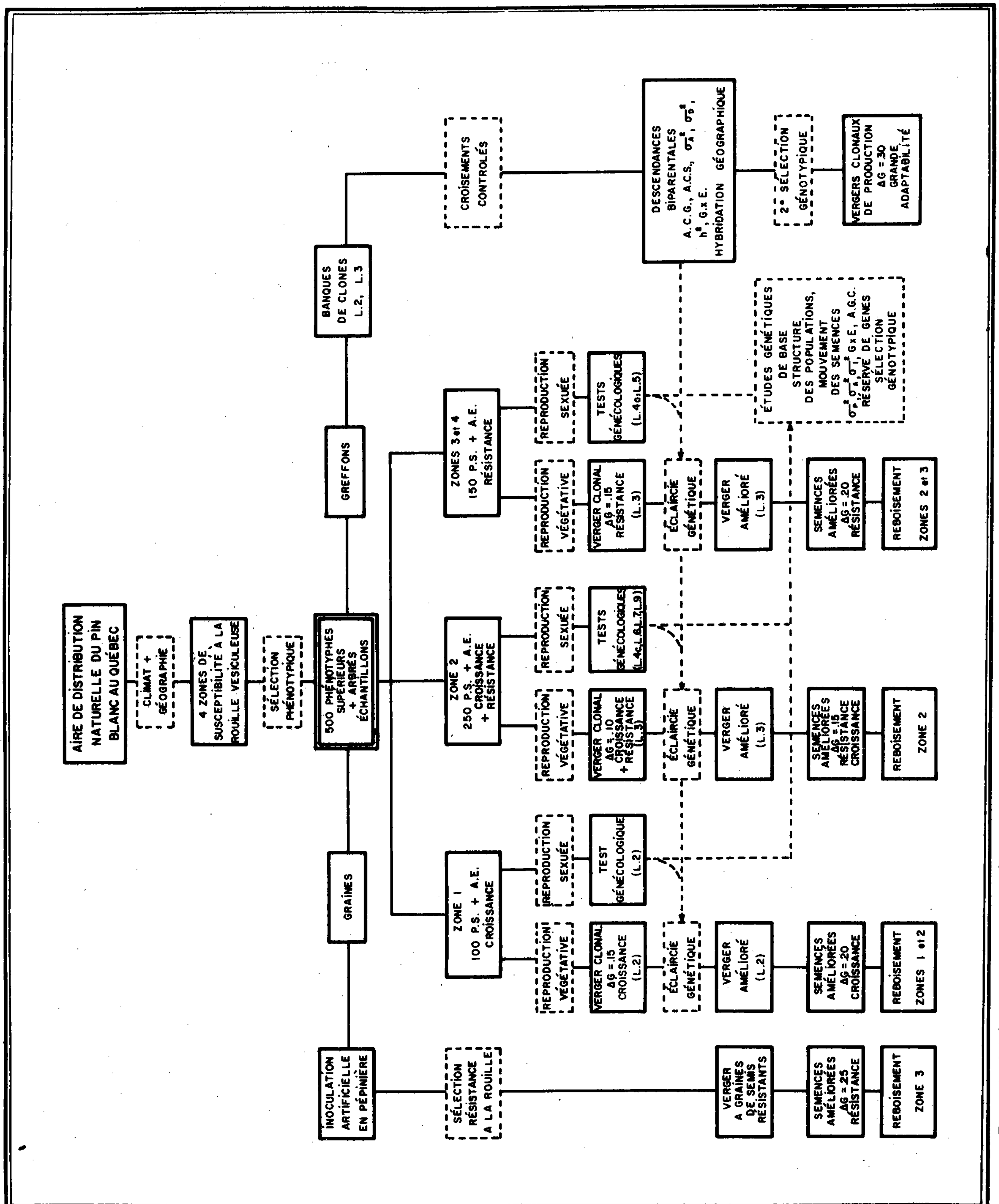

Figure I. Schéma du Programme D'Amélioration Génétique du Pin Blanc principalement à cause de la peur suscitée par la rouille vésiculeuse (Cronartium ribicola J.C. Fisch.). Une réévaluation de la situation de la rouille a permis de subdiviser l'aire de distribution du pin blanc au Québec en quatre zones de susceptibilité (Lavallée 1974). Les deux zones de plus faible occurrence de la rouille occupent les trois quarts de l'aire climatique et déaphique favorable aux plantations de pin blanc au Québec. L'importance du pin blanc dans le reboisement ira sans doute en s'accentuant au cours des prochaines années.

Un programme de recherche et d'amélioration visant la création de variétés de pin blanc de résistance accrue à la rouille vésiculeuse, de croissance rapide et de forme améliorée a été initié. Les principales étapes de ce programme sont indiquées à la Figure 1. En août et septembre 1976, cinquante phénotypes supérieurs et porteurs de cônes ont été sélectionnés dans la région de L'Outaouais. Un échantillon de bois a été prélevé sur chacun des arbres sélectionnés afin d'étudier leur densité.

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ECOLOGY OF JACK PINE, BLACK SPRUCE AND TAMARACK IN THE LA GRANDE RIVIÈRE - LAC SACKAMI AREA OF NORTHERN QUEBEC

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Specimens of these three tree species growing on various sites were collected in 1976 for total growth analysis. Observations were made of their distribution and a possible effect of environmental changes on their growth patterns because of future changes in water table levels because of construction of dykes and dams were contemplated. Sample areas included: the south bank of the La Grande Riviere near LG 2, the townsite of Radisson, along the Duncan Lake road west of Camp des Pins, the Camp des Pins - Duncan Dam road, Camp Environment - Lac Helene road and along the Yasinski Lake - LG 3 road (Fig. 1).

Although Jack Pine (*Pinus banksiana* Lamb.) followed the typical distribution of dominance on the dry outwash sands and Black Spruce (*Picea mariana* (Mill.) B.S.P.) and Tamarack (*Larix laricina* (Du Roi) K. Koch) on the poorly drained boggy areas, the three species occurred in equal distribution on certain sandy till sites. One hundred year old, seven meter high Jack Pines on a site without evidence of a fire history, had little Jack Pine reproduction and were being replaced by Black Spruce. Pendulous Black Spruce forms found in open stands had the appearance of Norway Spruce (*Picea abies* (L.) Karsh.).

Observations were made on revegetation of bare soil along road allowances as carried out with seeds of grasses and legumes protected by a green-dyed cellulose mulch. An experimental tree nursery established on the Lac Helene road was studied. Work continues on the analysis of the tree growth data.

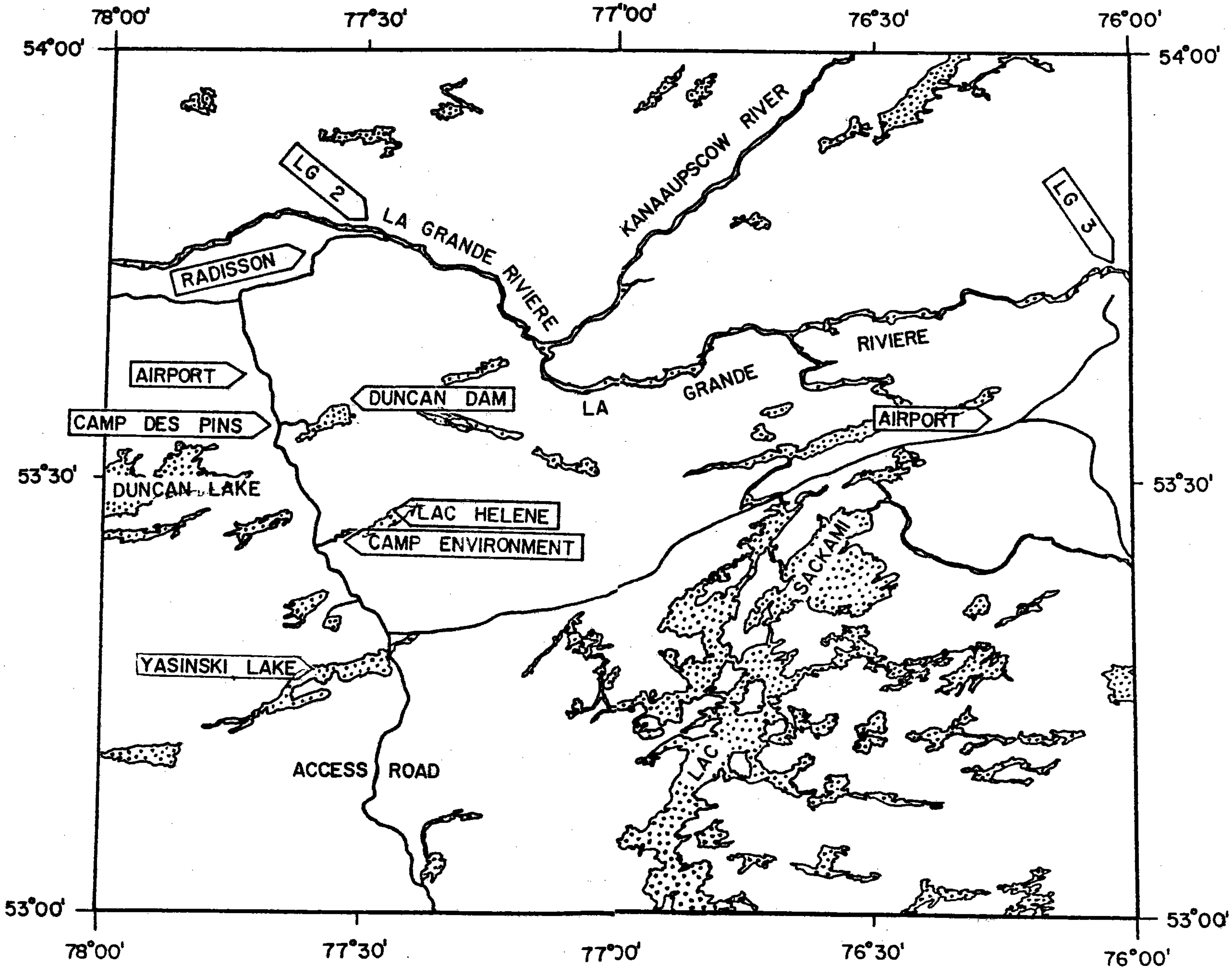

Figure 1. Sample areas in the vicinity of La Grande Riviere - Lac Sackami, northern Quebec.

HARD PINE IMPROVEMENT IN ONTARIO*

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The hard pine improvement program in Ontario presently has two main objectives: (1) jack pine (Pinus banksiana Lamb.) improvement in northern Ontario through stand selection and progeny testing, and (2) production and evaluation of exotic hard pine species and their hybrids for use in southern Ontario.

The need for large quantities of jack pine seed for Ontario's direct-seeding reforestation effort necessitates stand testing to develop seed production areas in which large quantities of seed would be easily collected as needed. The first step in the stand testing program is to identify important jack pine forest areas to be sampled. Climatic information and provenance test results will be used as a basis for classifying the province into several jack pine improvement regions. Materials from selected stands will be tested on a regional level, including those stands already designated as seed collection reserves.

A tree selection and breeding program is aimed at developing improved jack pine for seedling stock production. Trees selected in seed production areas are supplying breeding material. A study of selected phenotypes has indicated significant variation between parent trees in seed weight and in one- and two-year height growth of progeny. Early height growth of seedlings was correlated not to the phenotype of parent trees, but to the seed weight. Establishment of a clonal seed orchard of selected "plus" clones from the Swastika area is scheduled for spring, 1977. These clones were grafted and grown at Petawawa Forest Experiment Station, and will be returned to the Swastika area for evaluation.

The exotic hard pine material collected and established in arboreta continue to be the basis for breeding work in southern Ontario. A number of individuals from provenance and breeding experiments show good performance at Turkey Point on Lake Erie, thus indicating potential in southern Ontario. Six family trials will be established in spring, 1977 to evaluate performance over a range of southern Ontario site conditions.

Included are Pinus rigida Mill x taeda L., P. rigida x elliottii Engelm., P. rigida x radiata D. Don, and P. densiflora Sieb. and Zucc. x nigra Arnold hybrids, along with P. rigida, P. nigra and P. sylvestris L. provenance selections. Half-sib family tests of P. densiflora and P.

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thunbergiana Franco sown in December, 1976 will be transplanted to the nursery this spring and outplanted in experimental plantings in spring, 1978. A bulk planting of F_2 *P. nigra* x *densiflora* is also being raised in the greenhouse and nursery for eventual outplanting and performance assessment. A series of controlled crosses will be carried out on selected material of flowering age to combine characteristics of the best individuals.

TREE IMPROVEMENT AT THE ONTARIO TREE SEED PLANT

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Keywords: Vegetative propagation, seed orchards, progeny testing.

The tree improvement staff at the Ontario Tree Seed Plant is responsible for grafting scions from selected plus trees throughout the Province, nursing grafted stocks in the nursery, establishing seed orchards, and providing supporting services to the Forest Genetics Group, Research Branch, which is currently carrying out progeny testing work in our seed orchards.

Following is a summary of the work done in the last 2 years.

GRAFTING

Until 1977, most of the plus trees were grafted at Angus. These included many trees from the north west part of the Province. Experience showed that it was expensive and risky to ship grafted stock of considerable size through such a long distance back to that region to be planted into the seed orchard. In the summer of 1976 grafting facilities in the Thunder Bay nursery were expanded and modernized. As a result most of the plus trees in the northwestern site regions were handled at that centre. Therefore the grafting target for the 1976-77 season at Angus was correspondingly lowered:

Table 1. Grafting program at Angus

Species	Total grafts	Total clones	% Survival in greenhouse
		1975-1976	
White spruce	2596	106	63
Black spruce	1784	71	87
White pine	1598	64	99
		1976-1977	
White spruce	2425	90	*
Black spruce	1096	43	
White pine	1800	64	

* Figures unavailable because grafting is still in progress.

The persistent lower percentage of survival after grafting in white spruce (Picea glauca (Moench) Voss) seems to reflect the effect of budworm infestation through these years. The difference in graftability among species and the beneficial combination of nursing conditions in our greenhouses were borne out in the survival percentage of white pine (Pinus strobus L.). For, starting 1975, in addition to keeping the humidity high and the temperature between 65-75°F, a photoperiod of 17 hours was maintained.

SEED ORCHARDS

Due to specific requirements by the present block system and the quantity of grafted stock available no new blocks of 3E white spruce and 3E black spruce (Picea mariana (Mill.) B.S.P.) were planted in the seed orchard. However, five blocks of Norway spruce (Picea abies (L.) Karst) were out planted in the Glencairn seed orchard. Also a white ash (Fraxinus americana L.) progeny/provenance test planting was carried out in the north east corner of the same orchard. Trees were supplied from Illinois and were planted at 12 x 12 spacing. The area was surrounded by rows of poplar (Populus L.), European alder (Alnus glutinosa (L.) Gaerth), red oak (Quercus rubra L.), and black locust (Robinia pseudoacacia L.). The whole plantation occupies about 5 acres.

Four blocks of 5E white spruce were planted in the Gurd Township seed orchard, North Bay District. The plus trees were selected around the Pembroke area and represent the Douglas-Beachburg source.

PROGENY TESTING

Whenever requested, supporting services were rendered to the Forest Genetics Group, Forest Research Branch, in their progeny testing work. Local staff assisted in collecting pollen, isolating flowers, control pollination, picking cones, and extracting seeds. In the two year period a total of 269 lots of white spruce and 117 lots of black spruce control-pollinated cones were picked and processed. In addition, 108 lots of cones from black spruce and 20 lots of cones from tamarack (Larix laricina (Du Roi) K. Koch) plus trees were processed for one-parent progeny testing purpose.

FLOWER INDUCTION TRIAL

In the spring of 1976 flowers were counted on the branches of all the 83 trees treated with GA 4/7 in the previous year. The records according to treatment and dosage were sent to the Forest Genetics Group for detailed reporting. At the time of assessment it seemed to indicate that while there was no definite correlation between treatment and flower production on the treated branches there was an increase of flowers on the tree as a whole. In the spring of 1976, 27 white spruce grafts were selected in the same area. The apical terminals of each tree were sprayed with GA 4/7 alone or GA 4/7 plus NAA solution. The treatments were completed in 8 weekly intervals, from the end of May to the end of July.

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

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The objectives of genecological studies in the spruce genus (Picea) are:

(1) To elucidate the contribution of species, forms, provenances and hybrids in productivity systems;

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

(3) To evaluate the effect of provenances, seed zones (site regions) in productivity systems; and confirm the validity of the limits of movement of spruce stock between regions.

TAXONOMY AND GENETICS OF PICEA RUBENS AND P. MARIANA

A range-wide sampling of Picea rubens Sarg. populations with a representative sampling of Picea mariana (Mill.) B.S.P. was made to investigate the variation within P. rubens and the nature and extent of hybridization between the two species. Factor analysis using 14, 21, and 24 characters, successively, indicated that the clusters of the parent species were quite discrete. Variation was found to be continuous within but not between the species, and gene flow was not more in one direction than the other. Species were found to maintain their centroides with a very low level of hybridization, and introgressive hybridization was found to be of a very limited nature.

Controlled crosses indicated that the crossability of the parent species with the distantly allopatric Picea omorika ranged from 36 to 71%, while the crossability of the sympatric P. rubens x P. mariana and the reciprocal was from 1 to 3%. Other interspecific crosses were considered. Variation in the P. rubens x P. mariana F_1 was substantial and sufficient to explain most of the variation observed in the occasional hybrid swarm found in nature. Backcrossing data indicate that it was not more successful than parent species crosses. Regeneration data from a soil site moisture catena for both species were evaluated to estimate the number of hybrids moving into the population relative to the parent species. These were found to be very low. A homeostatic process involving an array of both genetic and ecological barriers was proposed to explain the persistence of P. rubens in the presence of P. mariana and other selection pressures. A comparison was made of the relationships between P. glauca and P. englemanii and that of P. rubens and P. mariana. It was concluded that the latter are not a species pair in the same sense as the former (Gordon 1976). These findings are much in accord with those of Manley (1976).

HYBRIDIZATION

In 1975 flowering was light. Two P. omorika clones were crossed with P. omorika, P. rubens, and P. chihuahuana. Two Ontario P. rubens clones were crossed with southern Appalachian P. rubens, P. mariana, P. omorika and P. chihuahuana; and P. mariana with Ontario P. rubens and P. chihuahuana. All of these crosses were successful except P. rubens x P. mariana and x P. chihuahuana, and P. mariana x P. chihuahuana. The germination was very low in the P. omorkia x P. chihuahuana cross (0.16%). There were 2 clones, 63 cones, 3788 seeds of which only 6 were viable.

1976 was a heavy flowering year but very severe drought conditions in late summer may have negatively affected seed set. Eleven intraspecific crosses involving 3 species were attempted successfully, and 19 interspecific crosses involving 13 species, of which 9 were successful.

Seven clones of P. omorika were crossed with P. chihuahuana, P. sitchensis, P. glauca, P. engelmannii and P. breweriana. Only the latter two were unsuccessful. Germination was low, ranging from 0.21% for P. chihuahuana with 3 seedlings; 0.51% for P. sitchensis with 52 seedlings; 0.88% for P. glauca with 29 seedlings; to 1.17% for P. engelmannii with 9 seedlings. There were a few reverse embryos in these lots but all these hybrids have been confirmed.

The repeatability of the P. omorika x P. chihuahuana cross and the consistent crossability level has now been demonstrated 4 years in succession since the cross was first made in 1973. However, the hybrid seedlings from 1976 are for the first time demonstrating heterosis over the P. omorika parent. The P. omorika x sitchensis seedlings are also clearly heterotic over the P. omorika parent. This cross is not new however. We first made it in 1971 and it has been extensively demonstrated at least 4 times previously in Europe (Eklundh 1943, Langner 1959, Vidakovic 1963, Rouland 1971).

P. mariana was crossed with 2 Ontario, 1 Nova Scotia and 1 North Carolina provenances of P. rubens. Germination varied from 2 to 5 percent.

Nineteen clones of P. rubens representing Ontario, Nova Scotia, New York, North Carolina and Tennessee provenances were crossed with P. mariana, P. chihuahuana, P. sitchensis, P. glauca, P. engelmannii, P. pungens, P. abies, P. asperata, P. schrenkiana, P. breweriana, P. jezoensis and P. maximowiczii. Only the first four were successful and on a very few clones. Germination for the cross with P. mariana was 3% but for the others was very low: P. chihuahuana 0.27% with 3 seedlings; x P. sitchensis 0.11% with 11 seedlings: x P. glauca 0.20% with 7 seedlings. This is only the second time in 4 years that seedlings have been obtained with P. rubens x P. chihuahuana the first time in 6 years for both P. rubens x P. sitchensis and x P. glauca. The resultant seedlings are still unconfirmed.

PICETA

The relationship of genetic variation on the nutrition, growth and efficiency in spruce are being investigated on a large number of spruce species and provenances on the same and different sites. An array of Ontario P. mariana and P. glauca provenances are included. The experimental plantations, called "Piceta", cover a complete range of plant hardiness zones and site regions in Ontario.

Most of the planting is complete but some replacement lots are still being inserted. Initial measurements have been completed in some of the Piceta. One Picetum established in 1961 is now advanced enough, and is being currently used for breeding work. A number of experiments involving hybrid seedlings are also being outplanted.

The work of this Unit is otherwise largely occupied with productivity and nutrient cycling studies in spruce forest ecosystem research (Gordon 1975).

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HARDWOOD TREE IMPROVEMENT PROGRAM OF THE SOUTHERN SILVICULTURAL RESEARCH UNIT

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OBJECTIVES

The objectives of the tree improvement program being conducted in southern Ontario by the Southern Silvicultural Research Unit, Forest Research Branch of the Ontario Ministry of Natural Resources are to develop practical techniques for the selection, mass production, establishment and management of superior trees and shrubs on lowland and upland sites to help meet the forestry, agricultural, wildlife and environmental needs of the Ministry.

INTRODUCTION

It has been the policy of the Southern Silvicultural Research Unit to establish a tree improvement program as the first silvicultural step in the reforestation of lowlands, in the establishment of nectar plantations and nut groves and in the hardiness evaluation of several strains of tulip poplar. This basic approach consists of locating, selecting, propagating and establishing superior timber, nectar and nut tree selections on a variety of sites in southern Ontario.

SWAMP TREE IMPROVEMENT RESEARCH

Up until a few years ago, no serious effort had been made to develop a tree improvement program for those species which grow in the swamps of southern Ontario. Since 1959, an intensive program was formulated to locate, select, propagate and establish timber phenotypes and provenances of silver maple (*Acer saccharinum*) eastern cottonwood (*Populus deltoides*), Jackii poplar (*Populus jackii*), red ash (*Fraxinus pennsylvanica*), European alder (*Alnus glutinosa*) and European willow (*Salix alba*) (Table 1). Since 1971, three silver maple seed orchards of six timber selections from three Ontario populations have been established as well as two silver maple provenance trials from 18 locations in southern and northern Ontario. Preparatory work is well advanced on planting of two red ash seed orchards consisting of 14 selections from three populations. Most of the plus trees are from 80 to 100 ft. (24 to 30 m) in height with diameters ranging from 12" to 23" (30 to 58 cm). Plans have also been made to establish a Jackii poplar clonal orchard in 1977 in the Forest Tree Seed Orchard at Glen Cairn.

Table 1. Number of phenotypes, parents, progenies, clones, provenances of nine native and exotic species being tested in the swamps of southern Ontario since 1965.

Species	Phenotypes	Parents	Progenies	Clones	Provenances
Acer saccharinum	21	9	21	14	18
Populus deltoides	11	5	21 (1/2 sibs)	11	3
Populus Jackii	8	3	7	8	4
Populus balsamifera	6	2		6	1
Populus sargentii	2			2	1
Populus trichocarpa	1				1
Fraxinus pennsylvanica	14			10	3
Alnus glutinosa	3		5	3	5
Salix alba				16	

NECTAR TREE IMPROVEMENT RESEARCH

This program was started in 1970 by developing techniques to root European black locust cultivars which had been brought to this country by Prof. Gordon Townsend, Apiculture Section of the Ontario Agricultural College, University of Guelph.

The next three years were devoted to locating, selecting and propagating black locust of local origin which were considered to be above average nectar producers as it was felt that such trees should be adapted to local conditions. Observations indicated that the flowering period for all selections of black locust growing in several locations in Ontario only encompassed a three week period from the last week of May to the end of the first two weeks of June. It was then decided that for a practical approach to this problem it would be essential to establish a multi species nectar plantation of melliferous tree, shrub and herb selections which would be capable of producing a continous and dependable annual supply of nectar throughout the entire growing season, i.e. from April to October. Furthermore, it was decided that in order to get maximum production of nectar per unit area, it would be necessary to establish three floral layers of trees, shrubs and herbs. This approach would allow for an immediate supply of nectar within one year of establishment of the herb layer and as the shrubs and trees come into flower in succeeding years, the yield of nectar would undoubtedly increase until all space both in area and in depth would be in full production.

Table 2. Common and scientific names and approximate flowering dates in 1976, arranged in chronological order of potential nectar producing selections of trees, which are being established in a nectar plantation in southern Ontario.

Common name	Trees Scientific name	Number of progeny and Selections	Flowering Date
Silver maple	Acer saccharinum	14	April 1 - 15
Norway maple	Acer platanoides	1	April 15 - 30
Hedge maple	Acer campestre	1	April 15 - 30
Siberian crab	Malus baccata	3	May 1 - 10
Ohio buckeye	Aesculus glabra	2	May 15 - 26
Horse chestnut	Aesculus hippocastanum	2	May 26 - June 8
Red horse chestnut	Aesculus carnea (hybrid)	3	May 26 - June 8
Hawthorn	Crataegus spp	1	June 1 - 21
Black locust	Robinia pseudoacacia	33	June 1 - 21
Tulip poplar	Liriodendron tulipifera	2	June 8 - 24
Yellow wood	Caladrastis lutea	2	June 12 - 30
Clammy locust	Robinia viscosa	3	June 18 - 30
Honey locust	Gleditsia triacanthos	2	June 20 - 30
Japanese lilac	Syringa reticulata	1	June 22 - 30
Little leaf linden	Tilia cordata	1	June 22 - July 4
Large leaf linden	Tilia platyphyllos	1	June 22 - July 4
Indian catalpa	Catalpa bignoides	4	June 22 - 30
American catalpa	Catalpa speciosa		June 22 - 30
Chinese catalpa	Catalpa ovata	2	July 1 - 28
American basswood	Tilia americana	14	July 4 - 18
Korean evodia	Evodia daniellii	2	Aug. 21 - Sept. 10

EDIBLE NUT TREE IMPROVEMENT RESEARCH

The edible nut tree research program is still relatively undeveloped. To-date most of the effort is devoted to locating and establishing in the nursery selections of various nut species and progenies from recognized cultivars (Table 3). However, a limited cooperative breeding program is underway in the Niagara peninsula with Mr. H. Troup. Here pecan is being crossed with two shagbark hickory cultivars to produce a Hican with the thin shell of the pecan but with a hickory flavour. Two nuts were produced out of 109 crosses in 1976. The poor results may be attributed to technique and to pollen incompatability.

Table 3. Species, selections, progeny and clones established in the nursery at Maple, Ontario.

Common name	Scientific name	Selections	Progeny	Clones
Black walnut	Juglans nigra	2	4	4
Carpathian walnut	Juglans regia		3	1
Butternut	Juglans cinerea	1		1
Heartnut	Juglans sieboldiana cordiformis		1	
Sweet chestnut	Castanea mollissima		4	
Shagbark hickory	Carya ovata		4	
Filberts	Corylus hybrida	10	2	10
Korean pine	Pinus koraiensis		1	

TULIP POPLAR HARDINESS TRIALS

INTRODUCTION

The objectives of this study are to not only evaluate the hardiness of three strains of tulip poplar (Liriodendron tulipifera) in southern Ontario but also to ultimately expand the range of this valuable species north of its present limit by introducing hardier strains into this province.

The study was initiated in 1967 by a remark of Dr. Heimburger who stated that the tulip poplar from the mounts of West Virigina were hardier than the tulip now growing in Ohio and Ontario; as their ancestors had survived the last ice age by growing in the mountains above the ice-filled valleys. When the ice melted, the southern strains moved northward following the retreating ice into Ohio and Ontario.

In 1969, Prof. Franklin C. Cech sent seed for this project from both the mountain and the valley strains. These were stratified in the winter of 1969-70 and sown in the spring of 1970. A total of 39 trees germinated in 1970, 332 in 1971, 24 in 1972 and 3 in 1973. Seedlings of these two strains and seedlings of the Ontario strain from the Ontario forestry nursery at St. Williams were outplanted in the spring of 1973 in 0.5 acre (0.25 ha) openings in 12 hard maple and two conifer stands. The planting areas were spaced at about 50 mile (80 km) intervals from Cambridge to North Bay. The three strains were randomized and replicated three times. Since then, the trees have been tallied for height and survival at the end of each growing season over the past four years. Results to-date indicate that tulip poplar can not only be grown successfully in hard maple stands as far north as Orillia but the measurements indicate that on good sites, they will grow as well as they do in their natural range. In fact, several trees in the Sunnidale planting have outgrown in four years what the average tulip grew in an experiment in Alabama in five years. There is also a strong indication that the mountain strain is hardier and will grow faster than the Ohio and the Ontario strains. It was also observed that north of Orillia in Bracebridge, Powassan and North Bay the growing season was too short as all trees in all three strains over the past four years had not hardened sufficiently to prevent them from being either partially or completely top-killed following the first fall frost.

Table 4. Number of trees and the mean and maximum height of three strains of tulip poplar measured in the fall of 1976 after four growing seasons in 10 planted areas from Cambridge to Bracebridge.

Location		V_1-West Virginia			V_2-Ohio Valley			O-Ontario		
District	Property	No.	Ht.	Max Ht.	No.	Ht.	Max Ht.	No.	Ht.	Max Ht.
Cambridge	Sudden	7	5.8	7.7	8	7.0	8.0	9	5.1	11.5
"	McKendrick	6	3.2	5.7	6	2.3	2.8	7	2.4	4.2
"	Valens	5	5.2	9.6	4	6.0	8.1	4	3.4	4.8
Owen Sound	Aberdeen	7	2.9	6.7	11	3.2	5.2	7	1.4	3.1
" "	Chatsworth	6	2.8	3.8	10	2.3	3.8	5	3.3	4.6
Huronia	Primrose	1	1.1	1.1	1	1.6	1.6	1	0.8	0.8
"	Cripps (Wasaga)	8	8.1	12.0	12	6.3	8.8	11	6.4	10.5
"	Coldwater	7	6.1	9.7	12	5.8	8.4	9	5.8	8.2
Lindsay	Havelock	8	1.6	3.4	7	1.9	2.9	9	2.0	3.0
Bracebridge	Bracebridge	8	1.9	2.8	10	2.3	3.9	4	1.2	1.7

No. of trees in each planting of V_1 - 8

No. of trees in each planting of V_2 - 12

No. of trees in each planting of 0 - 12

THE GENETIC IMPROVEMENT PROGRAM OF SPRUCE AND LARCH FOR ONTARIO, 1975-76*

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The previous report (Rauter 1976) submitted to this Association presented Ontario's spruce artificial regeneration targets for the next 30 years, thus illustrating the need for a comprehensive genetic improvement program. Presently, the emphasis is on white spruce (Picea glauca (Moench) Voss) and black spruce (P. mariana (Mill.) B.S.P.) progeny tests to determine the genetic value of seed production areas and plus tree selections. The vegetative propagation program of rooting cuttings from nursery and plantation selections is well-established. Recently, there has been only a little work done on inter-specific hybridization and evaluation of other spruce species. Aspects related to breeding, such as induction of flowering, are being examined on a small scale.

The potential of larch has been recognized and we have started several studies with tamarack (Larix laricina (Du Roi) K. Koch.) and with exotic larch species.

SELECTION AND IMPROVEMENT OF BLACK AND WHITE SPRUCE

Progeny tests

One-parent progeny tests of selected phenotypes within seed production areas (SPA) have been started. Cone and seed data as well as germination capacity and growth performance are evaluated. Parent-progeny correlations will also be established. An early evaluation of one of the tests (Table 1) showed highly significant variation between progenies. The average one-year height growth ranged from 41 to 71 mm (1.6 - 2.8 in.) with the tallest individual being 146 mm (5.7 in.). The variation demonstrates the difference in combining ability of individual trees in a SPA. This emphasizes the need to do selective rather than mechanical thinning when managing these areas.

Table 1. ANOVA, One-year seedling height, half-sib progenies from a white spruce seed production area.

	SS	dF	MS	F	F.05	F.01
Progenies	1804.7049	38	47.49	3.95**	1.48	1.74
Reps	34.5892	4	8.65	0.72ns	2.43	3.44
P x R	1827.9845	152	12.03			

*Contribution No. 1027 of the Forest Research Centre, Ontario Ministry of Natural Resources, Maple, Ontario, L0J 1E0.

The combining ability of plus trees established in clonal seed orchards is also being studied. Open-pollinated cones of black spruce were collected and cone and seed measurements will be correlated to parent and progeny growth. The seed from each ramet was germinated and grown separately so that the effect of different pollinators on the combining ability of a clone could be determined. The range of one-year seedling heights of the half-sib progenies collected and grown from different ramets of the same clone (Table 2) illustrate the effect of clonal position in the orchard.

Table 2. One-year seedling height, half-sib progenies from a black spruce clonal seed orchard.

Clone	No. of half-sibs	Weighted average of one-year height growth (mm)	Range in heights for half-sibs within a clone (mm)
354	2	9.2	8.9 - 9.5
291	8	8.9	7.2 - 9.8
385	5	8.8	8.6 - 9.2
358	2	8.6	8.3 - 8.8
304	8	8.1	7.5 - 9.0
Control population	1	8.0	
290	8	7.9	7.4 - 8.4
288	8	7.6	7.2 - 8.4

Controlled pollinations in the orchards continue through our use of a bi-parental mating design (Rauter 1975a).

Initiation of flower primordia

In 1975, a cooperative research project with Dr. Richard Pharis of the University of Calgary* was undertaken to stimulate flowering of white spruce through gibberellin application. Counts of male and female flowers taken in the spring of 1976 indicated that gibberellins were effective in promoting flowering. These data will be published with Dr. Pharis at a later date.

Vegetative propagation by rooting of cuttings

Clones of white and black spruce super seedlings selected in nurseries are being propagated by rooting cuttings (Rauter 1975b). Young trees in plantations throughout the province also provide material for vegetative propagation.

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The technique for rooting is constantly improving. Initially, environmental problems in the mist house hindered rooting success. The conditions have been modified and rooting percentages have been increasing yearly. White spruce has consistently rooted better than black, but rooting of the latter has improved considerably. Originally, the rooting medium was coarse sand. The resultant roots were very thick and brittle, and were extensively de-aged when handled. Testing soil mixes showed that a finer, more supple root system develops when peat is added to the sand. Currently a 1:1 mix is used.

However, transplant stock is still a major problem, often resulting in high mortality. In order to overcome this problem, a rooting bed was established in the nursery so that cuttings could be rooted and grown undisturbed until they were of field planting size. The rooting bed consisted of a fine sandy-loam soil. A wood frame was built around the bed and then covered with aluminum-painted plastic fixed on lath. The cuttings were placed directly into the soil and watered manually. When sampled in the fall, some cuttings had roots and most were still green and healthy. In the spring, the plastic will be removed and the cuttings grown until they are of outplanting size.

LARCH IMPROVEMENT

A larch-breeding program has recently been initiated as the importance of this fast-growing conifer for intensive management has been recognized. Initial efforts are on stand selection and testing of tamarack which exhibits large variation in form and growth, thus promising considerable and rapid genetic gains. Work has started in eastern Ontario where seed from several areas was collected in the fall of 1976 and is being prepared for testing in 1977.

In addition to the tamarack work, species trials of other larches will be established. In 1976, we obtained seedlings of several larch species and hybrids from Mark Holst, Petawawa Forest Experiment Station* and seed from Dr. Barner in Denmark**. This material will be tested throughout the Province.

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POPLAR AND WHITE PINE BREEDING AT MAPLE IN 1975 AND 1976*

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An earlier report to this Association (Zsuffa 1976a) summarized the objectives and acheivement of poplar and white pine breeding. Here, the progress since 1974 is discussed in view of recent observations.

POPLAR

The present breeding program concentrates on P. deltoides Marsh x balsamifera L., P. deltoides x trichocarpa Hook, P. deltoides x Maximowiczii Henry, P. deltoides x nigra L. and P. tremuloides Michx x tremula L. crosses. The lack of information on genetic variation and racial development in native species has been a hindrance in selecting parent trees. Work in this area should start in the near future. The pollen source for the exotics has either been imported from other countries or collected from arboreta already established in Ontario. To enrich the gene pool of exotics for future selection and breeding many plantations are currently being established.

Most of the information gathered to date is for P. euramericana (Dode) Guinier clones from Europe, P. deltoides and P. x Jackii Sar. selections from Ontario, cottonwood (Aigeiros Duby) and balsam poplar (Tacamahaca Spach) hybrids from U.S. (Northeastern Forest Experiment Station, Durham, New Hampshire) and Leuce Duby interspecific hybrids from Ontario and Europe. Presently, information for new P. deltoides, P. balsamifera and P. trichocarpa interspecific hybrids as well as P. tremuloides and its hybrid varieties is limited, but will accumulate rapidly from numerous clonal trials.

The breeding program is oriented to provide suitable material for (a) pulpwood production in intensively managed plantations, on marginal or submarginal farmlands ("short-rotation poplar"), (b) woodfibre and food production on densely grown, intensively-managed, frequently-harvested coppices on farmlands ("poplar farming"), (c) veneer and pulpwood production in forest type plantations on cut-over woodlands. The main requirements for all types of poplar culture are (1) good rooting ability, (2) resistance to frost, (3) resistance to diseases and insects, (4) fast growth, (5) desired site adaptability, and (6) desired biomass characteristics (Zsuffa 1976b).

*Contribution No. 1025 of the Forest Research Branch, Ontario Ministry of Natural Resources, Maple, Ontario L0J 1E0.

(1) Good rooting ability. Our experience shows that clones of Aigeiros and Tacamahaca hybrid origin have good results in rooting, while clones developed from P. deltoides species selections and Leuce interspecific crosses are poor and unpredictable, especially under field conditions (Zsuffa and Saul 1976). Presently, we are exploring ways to stabilize the rooting ability of vigorously growing Leuce hybrid clones. As for P. deltoides, improved rooting ability is sought in its hybrids with P. nigra and Tacamahaca poplars.

(2) Resistance to frost. In southern Ontario large clonal variation was observed and resistant clones were examined and selected within all hybrid groups. In central and northern Ontario the examined clones of P. alba L. hybrid parentage and of P. deltoides x nigra origin were frost susceptible. However, resistant clones of P. deltoides var. occidentalis Rydb., clonal selections is in progress. Also, numerous new crosses of P. deltoides and P. balsamifera are being made, to develop good rooting clones which will inherit the frost hardiness of northern balsam poplar and the good wood quality of cottonwood. Such clones would play a significant role in intensively managed short-rotation or mini-rotation coppice plantations on marginal farmlands in northern Ontario. Also, they would replace some of the low quality aspen in forest stands.

(3) Resistance to diseases and insects. Clonal selection for resistance to many diseases is promising, whereas clonal selection for xylophages and defoliating insects appears difficult. The selection of resistant clones to aphids and leaf curling insects, which set back the growth in stool areas, appears realistic.

(4) Fast Growth. Fast initial growth is of most importance when planning short rotations. In general, the initial growth of newly planted Aigeiros and Tacamahaca hybrid stock is more vigorous than of Leuce hybrids, and the latter hybrids seem to be less suited for intensively-managed short-rotation plantations.

In test plantations, the growth rate of clones within each hybrid group varied widely and changed ranking with age. In a test plantation of 24 P. x euramericana clones the ranking changed considerably during the first 6 years of plantation age (Zsuffa 1975). Clearly, for a 1- to 3-year coppice rotation the "fast-starter" clones are well suited, whereas the longer rotations may require different clones.

(5) Site adaptability. Large variation for the different poplar species was observed. In general, P. deltoides x nigra hybrids are more site demanding and intolerant than Tacamahaca and Leuce hybrids. However, considerable clonal variation exists even within groups of clones of similar species origin. In test plantations of 24 P. x euramericana clones established on a number of different sites (Zsuffa 1975) the growth rate of individual clones varied by more than 50% and some clones grew well on a number of sites, whereas others were highly selective. The early growth of several new clones of P. deltoides x balsamifera, P. deltoides x trichocarpa, P. x Jackii x nigra and P. deltoides x nigra, which show broad site adaptability, is very promising.

(6) Desired biomass characteristics. Studies of pulp yield and quality showed large clonal variation and demonstrated the possibility of selecting fast growing clones producing juvenile wood with qualities similar to the wood of slower growing mature poplar trees (Anderson and Zsuffa 1975, Zsuffa 1976). Other characteristics of poplar biomass could be of interest when used as a source of silvi-chemicals, forage and protein. Preliminary studies show large clonal variation in important biomass characteristics for such end uses (Zsuffa 1976a, Anderson and Zsuffa 1977).

WHITE PINE

Activities were concentrated on (1) *P. strobus* L. plus tree selection and progeny testing, (2) field testing of *P. griffithii* McClelland x *strobus* F_1 and advanced hybrids, (3) field testing of blister rust resistant *P. strobus* progenies, (4) clonal propagation and testing of superior and blister rust resistant types, and (5) introduction of exotics.

Progeny trials of selected blister rust resistant *P. strobus* trees showed very significant (up to 100%) variation in the height growth of progenies at the end of the 5th year. Observations made on the open-pollinated seeds and progenies showed large variation in seed-weight and one-year seedling height. The above information indicated the importance of progeny testing for determining the combining ability of *P. strobus* plus trees. The significant correlation (r = 0.789**) between seed weight and seedling height indicated the influence of seed-weight on the nursery performance of the seedlings.

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RESEARCH ON TREE GENETICS, BREEDING, PHYSIOLOGY AND SEED AT PETAWAWA FOREST EXPERIMENT STATION 1975-76

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This paper outlines activities in the field of tree improvement, tree seed, and tree physiology at Petawawa Forest Experiment Station, Chalk River, Ontario, and deals with general staff changes, program strategy and trends; the details are given in the individual reports of E.K. Morgenstern, C.W. Yeatman, C.C. Ying, R.F. Calvert, B.S.P. Wang, B.D. Haddon, J. Pitel, D.F.W. Pollard and K.T. Logan.

STAFF DEVELOPMENT

In common with most research establishments, Petawawa Forest Experiment Station has been affected by the continuing climate of austerity. No major increases in operating funds have been provided to meet rising operating costs. Paradoxically there have been welcome increases in both professional and support staff engaged in tree improvement and tree seed activities.

Dr. C.C. Ying joined the staff early in 1976 and took over the white spruce (Picea glauca (Moench) Voss) improvement program, previously the responsibility of Dr. A.H. Teich, who is now with the Canadian Department of Agriculture at Harrow, near Windsor, Ontario. Dr. Ying's wide experience of quantitative genetics and biometrics will be of great value in the complex white spruce program with its numerous experiments.

Mr. R.F. Calvert came to Petawawa late in 1975 and initiated a program on the selection and improvement of hardwoods, a topic that has been of interest to him for many years. He is also responsible for the development of a larch program.

In the fall of 1976, some of the staff of the Forest Ecology Research Institute (F.E.R.I.), formerly working with Dr. Durzan in Ottawa, moved to Petawawa, bringing with them considerable expertise in biochemistry and tissue culture. Of these, Mr. Jack Pitel, a biologist, supported by Mr. Gary Scheer, is now assisting Mr. Wang of the Forest Tree Seed Centre with investigations of seed biology, particularly problems of seed storage and dormancy. Miss Francine Sheridan, also from the F.E.R.I., joined Mr. Wang to assist him in problems of seed testing.

This year Dr. Willard Fogal came to Petawawa from the Great Lakes Forest Research Centre at Sault Ste. Marie, Ontario. Dr. Fogal has experience of research in insect physiology, and is bringing this expertise to bear on problems of host-pathogen relationships. This will help us to understand the physiological basis of differences in resistance of tree genotypes. He is supported by Mr. Stan Lopushanski, who previously worked with Dr. Durzan at the F.E.R.I.

During this review period Mr. Mark Holst, the doyen of tree breeders in Canada, and one of the pioneers of tree improvement in North America, retired. He leaves behind him, at Petawawa and in many other places, many experiments, demonstrations, and gene plasm collections that have been, and will remain for many years to come, of immense value to tree geneticists and breeders in North America. His vast fund of knowledge always provides a stimulus to the scientists he meets. We are all sorry to see him go, and wish him an enjoyable retirement in Deep River, Ontario.

In the same period, Mr. John Santon, the Nursery Supervisor at Petawawa, also retired. Tree breeders and geneticists owe John Santon a great deal for his many years of dedicated cooperation. He used to the full his considerable technical ability and his "green thumb" to develop new propagation techniques and produce large quantities of first class transplants and grafts for use in tree improvement programs. We wish both John and his wife Audrey a happy retirement in the new house they are building on their farm beside Lake Dore, near Eganville, Ontario. The nursery program has been taken over by Mr. Zdenek Zdrazil, who worked with John Santon for some time before the latter's retirement; before that, Mr. Zdrazil provided technical assistance for tree physiology programs.

For part of the review period, Dr. Narinder Dhir, a National Research Council Post Doctoral Fellow, worked on white spruce with Station geneticists. He was able to make a significant contribution to the program before he left to join the Alberta Department of Energy and Natural Resources at Edmonton and lead their tree improvement program.

During the last two years, therefore, there have been considerable changes in staff in spite of the constraints of limited funds.

PROGRAM DEVELOPMENT

Genetics and Tree Improvement

The program has undergone a change in emphasis. The investigations of the genetic basis of the improvement of jack pine (*Pinus banksiana* Lamb.), white spruce, and black spruce (*Picea mariana* (Mill.) B.S.P.) still form the long-term core of the program. All these species are of great economic importance and are sufficiently well distributed and variable to respond well to genetic selection and improvement. There is now much more emphasis on the selection and improvement of hardwoods, with the effort divided between improvement of hardwoods for aesthetic and urban purposes and hardwoods for operational forestry, most effort being on the latter at the moment. The resurgence of interest in larch (Larix spp.) has also caused us to put more effort into the selection and improvement of this genus.

The old programs on Scots pine (Pinus sylvestris L.), Norway spruce (Picea abies Karst) and red pine (Pinus resinosa Ait.) are, for the moment, being held in abeyance. No new experiments have been planned for these species and we intend to take a close look at the numerous existing trials, measure them and publish the results, before deciding on future strategy.

So far the tree improvement program at Petawawa has placed emphasis upon provenance experiments, in order to provide a sound base of population genetics for future selection and breeding programs as well as providing guidelines on seed movement. Some of these programs (for example those concerned with white spruce, jack pine and black spruce) have begun to bear fruit, demonstrating the existence of genetically superior populations, and differences in resistance to at least one disease (Scleroderris).

These older programs are being consolidated by more detailed range-wide trials (e.g. white spruce and black spruce), and in most cases there is an increasing emphasis on tests of progenies from individual trees. Considerable effort has been made to convey the results to the forester, and carry the work into the development stage in cooperation with provincial governments and the forest industry. Cooperative work in establishing jack pine seed production areas is in progress in the provinces of Ontario and Quebec.

In some cases, for example white spruce, superior populations have been identified, but we do not know their extent. This has limited the immediate value of results as there are relatively few trees left on the original collecting sites. Investigations have begun on defining the geographical limits of superior populations (e.g. Beachburg, Ont. white spruce) so that, if the superior stands prove to be extensive, we can collect seed from larger areas before clonal seed orchards begin to yield seed.

Physiology

The physiology research has reached a stage where we must pause and reflect on future objectives and strategies. Many of the original goals have been reached; a successful tree growth acceleration system has been designed and put into operation, and we know much more about the physiological basis of gene effect on growth; we now understand at least in part why some genotypes grow faster than others. In addition the physiologists have worked in close cooperation with the geneticists concerned with jack pine and white spruce improvement, and have provided environmental prescriptions for plastic greenhouses used in the production of container plants by the government of Ontario. Recently there has been increasing interest by physiologists in problems arising from raising material for genetics experiments in containers, particularly the problem of root distortion and its effects on growth.

Tree Seed

Demands on the Tree Seed Centre for testing services and information greatly increased over the past two years, a reflection of the fact that the Centre is now the accredited Canadian member for testing of the International Seed Testing Association; over the 2 years 1257 tests were made, some for seed for export. It was found that some of the standard methods for testing seed were not suitable for Canadian tree species, and it has been necessary to devise new methods. Research continued on better ways of testing, collecting and storage of seed, and the results are of value to both scientists and operational foresters. A great deal of seed was provided to many agencies, and the Seed Bank now has 2000 seedlots of 100 tree species in storage. The Centre's recent increase in staff will enable seed testing, storage and collection problems to be examined in greater depth.

RESEARCH FACILITIES

Although there have been no major changes in research facilities during the review period, the Station was able to improve its in-house computer capability. The old, relatively slow, PDP-8 was retired after many years good service, and replaced by a faster, more flexible PDP-11E10, with a 28K core memory, a Decpack disc drive and discs with 1.2 million word capacity, a dual cassette tape drive, and a Calcomp plotter. The older, slower ASR 33 teletypes were replaced by two faster Decwriter II's. This, together with access to more powerful off-Station computing facilities, has greatly increased data output from all Station program, including tree genetics and improvement. Mr. Tom Pickett is now able to spend all his time on computer programming and operation.

THE FUTURE

Although it is clear that we shall have to contend with serious shortages of money and manpower for some years to come, the program is moving out of a holding position to one of cautious development with close scrutiny of costs, and taking advantage of every opportunity to increase efficiency and get more value for each dollar invested in research.

The main goals are to:

1. Carry the results of long term trials to the forester, and move into the development phase in close cooperation with many forestry organizations.

2. Complete the establishment of the all-range tests of black and white spruce.
3. Examine more closely the within-provenance variations of jack pine, white and black spruce, and establish single tree progeny tests with cooperators, particularly from populations known to be genetically superior.
4. Increase effort on the selection and breeding of hardwoods for operational and urban forestry.
5. Capitalize on existing knowledge of performance of introduced larches and their hybrids, increase effort on the selection and breeding of native larches, and carry results into the development stage as soon as possible.
6. Report on results from all the older trials, including those concerned with Scots pine, Norway spruce and red pine.
7. Examine the geographical extent of designated superior tree populations.
8. Examine the white spruce program as a whole, prepare a position paper, and develop a research strategy.
9. Increase the Tree Seed Centre's research effort on problems of seed testing, storage and dormancy.
10. Consolidate the current physiology program on growth acceleration and early screening and develop a new research strategy.
11. Initiate a research program on the genetic/physiological basis of variation in resistance of trees to pests and diseases.

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HARDWOOD GENETICS AND BREEDING
PETAWAWA FOREST EXPERIMENT STATION 1975-76

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INTRODUCTION

The hardwood genetics and breeding program at the Petawawa Forest Experiment Station began in the early winter of 1975. Studies are to be initially directed at species (excluding Populus L. sp.) growing in the Great Lakes-St. Lawrence, Acadian and Deciduous Forest Regions concentrating on areas with high hardwood production and where planting programs are being carried out. The main objectives of the program are to:

1. Investigate the variation and patterns of inheritance of desirable hardwood attributes;
2. Select, breed and propagate hardwoods for use in forestry and amenity plantings;
3. Increase the northern range of hardwoods used in amenity plantings;
4. Survey hardwood gene resources and recommend conservation measures;
5. Examine problems of hardwood propagation and seed storage;
6. Communicate and demonstrate results to the scientific community, foresters and town planners and to carry research results into the development phase by liaison with provincial and other forestry organizations.

PROGRAM DEVELOPMENT

Considerable activity has occurred in this program over its first year and a half of operation. First steps were to carry out an analysis of the potential of different species for improvement. Many features were considered and it was decided to begin major efforts on four species, black walnut (Juglans nigra L.), white ash (Fraxinus americana L.), green ash (F. pennsylvanica Marsh.) and red maple (Acer rubrum L.). These species not only have significant potential for forest production but also have high amenity values. Improvement in black walnut and white ash will be directed at improving log quality for the lumber and veneer industry. Although green ash and red maple can also be sawn to produce lumber products, efforts here will be directed mainly at fibre production on the poorer quality sites.

The development of cultivars for amenity plantings will not be a priority at this time. The main reason for this is that the types of effort required to develop cultivars is different from the traditional forestry approach. As a result, by-products of forest tree improvement programs rarely have an ornamental value (Santamour 1969). Because of limited staff, it was decided to concentrate on forestry problems. Trees with amenity value located in plantations or discovered growing naturally will, however, be reserved, propagated and tested.

Major experiments are underway in black walnut and white ash. A minor experiment with Norway maple (A. platanoides L.) and sycamore maple (A. pseudoplatanus L.) from Russia for amenity planting above 49° north latitude has also been established.

BLACK WALNUT

Black walnut is our most valuable hardwood species. Although its range in Canada is relatively small, it is considered a commercial species throughout this area (Funk 1970). Because of its high value the species has been severely overcut and in many areas specimens around farm buildings, in fence rows and within urban boundaries are all that can be found. Even within towns and cities walnut buyers are purchasing and logging trees. The value of this species adds a new dimension to the size of a commercial forest, which could be one tree in your back-yard. Gene pool conservation measures are urgently needed in black walnut and an improvement program is warranted.

Progress

During the fall of 1976 a Canadian-range seed collection was carried out. Nuts were collected from an area south and west of a line running from Lake Huron across the south end of Georgian Bay to the Lindsay-Peterborough area then south to Lake Ontario. Collections were also made between Brockville and Gananoque, from a planting in Ottawa and from what appears to be a natural population near Pembroke. A total of 80 seedlots of from 200 to 500 nuts each were collected mostly from single trees.

The seed was pit stratified in our nursery over winter and sown in randomized block design this spring. Plans are to lift the seedlings in the fall, overwinter them in a cooler and establish field experiments with 1-0 stock at several locations in the spring of 1978.

Gene pool conservation measures in walnut are difficult to implement because most trees occur on private land. For this reason some of the progeny produced in this experiment and some of those grown for future testing will be planted on crown land and maintained as a gene pool.

Cooperators

The walnut improvement program is being initiated in cooperation with P. Jaciw, Research Branch, Ontario Ministry of Natural Resources and Prof. L. Parrot, Faculté de Foresterie et de Geodesie, Université Laval, Quebec. Other cooperators may be included as the program develops.

WHITE ASH

White ash has a fairly wide range in Canada (Hosie 1969). It is a common tree especially in the southern part of its range where it is actively harvested for a wide range of uses. Gene pool conservation measures are not urgent in this species except perhaps in some northern areas.

Progress

The Petawawa Forest Experiment Station is cooperating in an all-range white ash progeny test initiated by Dr. C.F. Bey, North Central Forest Experiment Station, U.S. Forest Service, Carbondale, Illinois. For our part we have established one of five outplantings in Canada. Four of the plantings are with different cooperators; one is in New Brunswick, one in Quebec and two in Ontario. The Petawawa outplanting contains open pollinated progeny from 36 parents which were distributed throughout the species range.

The only Ontario seedlots contained in Bey's tests are from the Upper Ottawa Valley. No seedlots were included from site regions 7E or 6E. It is in these areas where white ash reaches its optimum development in Canada. As soon as there is a white ash seed crop, single tree collections will be made from as many areas as possible in its Canadian range to fill in the missing link in Bey's study and to provide detailed information about our native populations.

NORWAY AND SYCAMORE MAPLE

Within their respective ranges Norway maple (*Acer platanoides* L.) and sycamore maple (*A. pseudoplatanus* L.) have been widely cultivated as shade trees for long periods of time (Olson and Gabriel 1974). The wood of both species is hard and attractive and is used for furniture manufacture in Europe (Dengler 1935) but no reports of industrial use in North America have been found. The seed sources of these species used on this continent are undoubtedly from western Europe. The cultivars of both are not recommended for planting in hardiness zones colder than 5b, with the exception of Norway maple 'Crimson King' which is recommended for planting in 4b (Sherk 1971, Ouellet and Sherk 1967). An examination of the natural ranges of both species (Rubner and Reinhold 1960) reveals that populations exist in European Russia in climates and at latitudes equivalent to the Canadian prairies and parts of northern Ontario and Quebec. Past experience with plant introduction, especially on the prairies (Skinner 1967), suggests that Norway maple from throughout its central Russian range and sycamore maple from the limits of its northeastern extension should be sufficiently hardy when grown on the prairies and in parts of northern Ontario and Quebec. In an attempt to introduce the two species to these areas, seed was requested in the spring of 1976 from several areas in Russia through the Canada/USSR Working Group on Forest-Based Industries, Forestry Sector.

Progress

Seed was not received from all areas from which it was requested. General quantities did arrive, however, from the following areas:

Vishnevi, Kiev Oblast (51°N lat., 30°10'E long.)

Norway maple, 10 seedlots, individual tree collections.

Sycamore maple, 10 seedlots, individual tree collections.

Kashira, Moscow Oblast (55°N lat., 38°E long.)

Norway maple, one seedlot composed of seed from at least 10 trees.

Glubokoye, Vitebsk Oblast (55°N lat., 30°E long.)

Norway maple, 7 seedlots, individual tree collections.

It is intended to distribute seed to cooperators in several provinces who are in a position to grow plants on a long term basis. It is the intention to send seed to cooperators in time for spring sowing. The Ontario test will be grown at the Petawawa Forest Experiment Station and planted at a site yet to be determined along the northern edge of the Great Lakes-St. Lawrence Forest Region.

Cooperators

This experiment will be carried out in cooperation with Dr. G. Vallée, Service de la Recherche, Ministère des Terres et Fôrets, Quebec; Prof. L. Parrot, Faculté de Foresterie et de Géodésie, Université Laval, Quebec; Dr. G. Murray, School of Forestry, Lakehead University, Thunder Bay, Ontario; Dr. W.G. Ronald, Research Station, Agriculture Canada, Morden Manitoba; Dr. W.H. Cram, PFRA Tree Nursery, Indian Head, Saskatchewan; and J. Soos, Department of Energy and Natural Resources, Edmonton, Alberta.

SUMMARY

The hardwood genetics and breeding program at the Petawawa Forest Experiment Station began in 1975. The problem was analyzed and a decision was reached to study black walnut and white ash concentrating

on features which improve lumber and veneer qualities and red maple and green ash as fibre producing species. The selection of cultivars of amenity value will be a minor but active part of the program. Activity in 1976 includes an all Canadian range collection of black walnut seed sown in the nursery the spring of 1977, a cooperative all-range white ash progeny trial and a collection of Norway and sycamore maple from Russia.

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THE GENETIC BASIS OF IMPROVEMENT IN THE GENUS LARIX MILL.

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Subsequent to the retirement of Mark Holst in 1976 the larch program at Petawawa became my responsibility. At present the whole program is under review and a detailed course of action has not yet been decided upon. The general feeling is, however, that no new experimentation in exotic larch species will be initiated at this time and that emphasis will shift to our native eastern larch (*Larix laricina* [Du Roi] K. Koch). The results of research in European larch (*L. decidua* Mill.) and Japanese larch (*L. leptolepis* [Sieb. & Zucc.] Gord.) will be taken into the development phase through consultation and cooperation with interested provinces and other forestry organizations, either directly or through our regional research establishments.

The program in eastern larch will include a wide ranging provenance trial using open pollinated progenies from single tree collections. Further details will be worked out after consultation with our regional research establishments and interested provinces.

PHYSIOLOGICAL SCREENING AND GROWTH ACCELERATION OF SEEDLINGS FOR TREE IMPROVEMENT PROGRAMMES

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INTRODUCTION

Whether forest improvement is to be achieved by silviculture or genetic methods, progress is subject to the time required for research and development with tree species and to the success of production and establishment of new propagules.

Genetic improvement of trees is particularly handicapped by duration of the juvenile stage - it impedes the process of controlled breeding, the mass production of tree seed, and the process of selection itself. Required are methods for reliable prediction of performance (in particular growth rate and survival), methods for accelerating the experimental stages of selection trials, and methods for reducing the period before sexual maturity and abundant seed production.

These problems have certain elements in common with silvicultural improvement, in particular the production of stock for reforestation. As in genetic programmes, there is a need for faster growing seedlings for reforestation, and this is being pursued through a variety of controlled environment and container-production programmes in Canada. However, controlled environments necessitate environmental prescriptions for fast growth if they are to be used efficiently. Optimum prescriptions are needed for each species for each of the environmental factors that can be manipulated -- with due regard to costs and benefits. These factors include air and soil temperature (day and night), photoperiod and light intensity, rooting medium and nutrients, water, and carbon dioxide.

STUDY OBJECTIVES

1. To reduce the time required before establishment of field trials.

2. To identify and exploit the physiological basis of heritable traits, in particular those concerning fast growth and high survival.

3. To assess the range of physiological adaptation as an expression of the potential of gene resources.

APPLICATIONS OF GROWTH ACCELERATION

Earlier studies at Petawawa have shown that free growth can be readily induced in many juvenile northern conifers (Pollard and Logan 1976a). Recently, attention has turned to hardwood species. Initial attempts to induce free growth were successful for red maple (*Acer rubrum*) and sugar maple (*Acer saccharum*) but not for red oak (*Quercus rubra*). Red maple grew rapidly from seed in our standard growth acceleration system (Logan and Pollard 1976a) and readily assumed free growth. Half the plants remained in free growth and were 2 m tall in 18 weeks from seed. Sugar maple showed some initial resistance to free growth. When 2-year-old dormant sugar maple seedlings were moved into our growth acceleration system, they went through two or three cycles of flushing and dormancy before finally attaining free growth. After each dormant period, the first leaf structures to emerge were intermediate in appearance between bud scales and leaves. Average height after 20 weeks was 1.5 m.

Free growth could not be induced in red oak. Germinants went through a period of cyclical growth for 2 months, and then remained dormant. Experience elsewhere suggests that high temperature regimes (30/25°C day/night) might promote free growth in red oak.

Artificial induction of fall colour has been investigated in red maple. If successful, this technique might prove useful in early appraisal of colour characteristics for selection purposes. Dormant red maple were induced to turn colour after 3 weeks in a growth cabinet in an 8-h photoperiod and 22°/7°C day/night temperature regime. Subsequent experiments revealed that dormant seedlings required 4 weeks at a higher night temperature (22/20°C day/night regime) for red colours to appear in the subsequent 22°/7° regime. Colour rankings obtained in the growth cabinet will be compared with those obtained in a nursery planting.

Studies of the aerial environment required for maximum dry weight and height growth were extended to temperature requirements of red maple and tamarack (*Larix laricina*). Height growth of red maple increased as day temperature increased from 18-30°C, but was relatively unaffected by night temperature in the range 14-26°C. Recommended temperature regime is 26°/22° day/night. In this treatment, 8-week-old red maple grew 2.5 cm per day. Tamarack showed an extreme sensitivity to high temperature. Growth was very markedly reduced by day temperatures in excess of 30°C, and to a lesser degree, night temperatures above 25°C. The recommended day/night temperature regime was 25°/25°C.

The photoperiodic requirements for induction of free growth were examined in white spruce (*Picea glauca*) and black spruce (*P. mariana*). The experiment revealed that these two species require a minimum period of six weeks in a long (16 h) photoperiod to induce free growth. The preformed shoot is flushed out during the first six weeks from bud burst. The initial primordia which are formed at bud burst have the option of developing into bud scales or needles depending on whether or not free growth is induced.

INVESTIGATIONS RELATED TO SCREENING

Environmental and genetic factors of bud morphogenesis

Previous investigations have shown bud morphogenesis to be a key parameter of height growth in northern conifers; differences in seasonal patterns of needle initiation (within the bud) accounted for much of the variation in height growth of spruce provenances of various species. Recent work has focussed on environmental factors of bud morphogenesis, and on how genetic variation might interact with these same environmental factors.

In each of the following investigations, seedlings grew continuously from seed for twelve weeks in a growth acceleration system (Logan and Pollard 1976a). Buds developed within two weeks of reduction of photoperiod from 16 to 8 hours; treatments began at the end of this two week induction phase, and continued for 10-12 weeks. The fully formed buds were removed from the seedlings and dissected to reveal primordial shoots, on which the needle primordia formed were counted.

Temperature caused much variation in needle initiation in white spruce, with an almost two-fold increase over the range 15 to 25°C. Optimum temperature was about 25°C. Light intensity, tested in the range 3,350 - 18,400 lux, was much less effective, with only a 30% increase in initiation over this entire range. There was no perceptible effect of increase from 9,750 to 18,400 lux. Photoperiod also was quite ineffective, even over the range 6 - 15h per day. Only when very short photoperiods (1 - 6h per day) prevailed did needle initiation show a marked response (doubling from 1 to 6h per day). Response to soil moisture tension was also weak, in the range 0 to 900 kPa. Initiation dropped by about 40 percent over this range in black spruce; the treatments were almost without effect in white spruce seedlings; however, a delay in attainment of experimental tensions within plant containers may have contributed significantly to the weak effects in this experiment. The above experiments are described in detail by Pollard and Logan (in press).

By and large the environmental effects studies did not interact with provenance. Four temperatures in the range 19 - 28°C were applied during bud morphogenesis of four white spruce provenances including Beachburg (fast growing) and Orono (slow); ranking did not change significantly among the treatments, and all showed the same optimum temperature (22°C). Similarly a low temperature interruption applied for one week at the height of initiation (third week) in 10 white spruce provenances had no effect. Little or no interaction occurred among four provenances of each of black spruce and white spruce when buds developed under two extremes of nutrient. Considering the differences between the treatment - daily complete nutrient feed versus distilled water throughout the experimental period - the 50 - 60% increase in needle initiation during the nutrient treatment was modest. Four white spruce provenances were tested at three light intensities (about 4000, 8000, and 24000 lux), again with no apparent interaction resulting. One positive result of these investigations has been the emergence of a hitherto little known provenance, from French Township, Ontario, having shoot growth potential similar to that of Beachburg, as judged from its bud morphogenesis.

Frost hardiness

A method of mid-winter testing for spring frost-hardiness was tried out on three white spruce provenances. Preconditioning twigs for 20 days at 15°C followed by a sudden brief exposure to -10°C gave best results, with 50-80% of the buds dead within 5 days. Considerable within-tree variation was indicated, however, and was substantiated in another experiment based on successive sampling from 5 trees. Tests conducted at -10°C on 40 white spruce trees from each of 55 provenances revealed much interprovenance variation that correlated poorly with climate of provenance origins.

Photosynthesis

Earlier work in this laboratory has demonstrated that the efficiency of light energy utilization increases rapidly under fluctuating as compared to constant light. Fluctuations are normal in light perceived by foliage; the relative efficiencies of various provenances of white spruce were investigated through infra-red gas analysis. All provenances increased photosynthesis with higher frequencies of fluctuation (where intervals of high and low light were equal) but no provenance differences were detected.

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RED AND BLACK SPRUCE GENETICS, PETAWAWA 1975-76

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The program with red spruce (Picea rubens Sarg.) and black spruce (Picea mariana (Mill.) B.S.P.) aims to develop a scientific basis for their genetic improvement. It includes investigations (1) of species and provenance hybridization, and (2) of genetic variation and population parameters (Morgenstern 1973, 1975a). During the past two years studies in the second category have been emphasized. An on-going survey of seed production was continued because of its relevance for the development of breeding strategy.

PROVENANCE EXPERIMENTS

Ontario black spruce

The Ontario black spruce provenance experiments sown in 1964 suffer from the shoestring root rot (Armillaria mellea (Vahl ex Fr.) Kummer) at Chalk River but not at Kirkland Lake. In 1976 average mortality at Chalk River had reached 18% and was most damaging to northern sources. Results from both tests were reported at the Black Spruce Symposium held at Thunder Bay, Ontario, in 1975 (Morgenstern 1975b).

Black spruce sampled range-wide

A list of seed origin and related information for the 202 provenances included in the range-wide study was published with the assistance of all cooperators (Selkirk 1974). During the last two to three years geneticists in the United States and Canada cooperating in the study have established 33 field experiments which are distributed as shown below:

Province or State	No. of expts.	Reference or communication
Newfoundland	3	Khalil 1976
Maritime Provinces	10	MacGillivray 1976
Maine	3	Drs. R. Wilkinson & D. Canavera, pers. comm.
Quebec	6	Corriveau 1976
Ontario	5	Morgenstern and Kokocinski, 1976
Wisconsin	1	Dr. H. Nienstaedt, pers. comm.
Minnesota	1	Dr. H. Nienstaedt, pers. comm.
Manitoba	1	Klein 1976
Saskatchewan	1	Klein 1976
Alberta	1	Klein 1976
Alaska	1	Mr. R.M. Jeffers, pers. comm.
Total number	33	

Results from a nursery experiment with 100 provenances from Newfoundland to Alaska observed over three growing seasons have been summarized. Variation patterns were predominantly clinal and similar to those found in the first study based on eastern provenances. The results will be published.

Red spruce

The red spruce provenance study initiated by Mr. M.J. Holst in 1951, consisting of nine plantations in eastern Canada, is being remeasured and analyzed in cooperation with Dr. Corriveau of the Laurentian and Dr. Fowler of the Maritimes Forest Research Centres, respectively. Joint publication is planned.

Translation and interpretation of results

The results of provenance research are applicable in a wide range of silvicultural activities such as location of new nurseries, planning of nursery stock production, delineation of seed zones, and development of selection programs. In other words, they should not be considered as something useful only to the tree breeder but should be completely integrated into silvicultural programs. All too often, however, this is not done because results are published in specialized journals and expressed in genetic terms not understandable to the forestry practitioner. I tried to deal with this problem by publishing two review papers (Morgenstern 1975b, 1976) and by participating in a Forest Nursery Short Course held by the Department of Continuing Education at the University of New Brunswick in October 1976.

PROGENY TESTS

As mentioned in the report to the last meeting of the CTIA, black spruce progeny tests from open pollination have been initiated in three regions of northern Ontario in cooperation with the Ontario Ministry of Natural Resources (OMNR). These ecological regions (Hills 1961) are used in management planning and as seed zones, and black spruce planting is important in every one of them.

Region 3E

The seven tests in this region were planted in the OMNR Districts of Kirkland Lake, Chapleau, White River, Hearst, Kapuskasing, and Cochrane in the autumn of 1974 and spring of 1975. After the first growing season, survival ranged from 51 to 84%, and replacements were made in spring 1976. Progenies from the seedling-seed orchard developed by Spruce Falls Power and Paper Company at Kapuskasing were included for comparison with the unselected, general material. Fall planting, which was adopted to avoid a hectic spring season, was less successful than expected and discontinued after 1974.

Region 3W

The six tests in this region were established in spring 1976 in Geraldton, Terrace Bay, Nipigon, Thunder Bay, and Ignace Districts. The assessment of five of these in autumn 1976 showed that survival ranged from 52 to 94%, and replacements were made to increase stocking above these levels. The sixth test was destroyed by the large forest fire in Ignace District. It will be re-established in 1977. Progenies from open pollination in the grafted clonal orchard of Kimberly-Clark Ltd., Longlac, were contributed by the Company and should provide interesting material for comparisons in future years. The number of tests in this region was reduced from eight initially planned to six for financial reasons and because extra stock is needed to replace the test lost at Ignace. In view of the difficulties experienced in a very dry year with a record fire season, we should be satisfied.

Region 4S

Site preparation and plot layout were completed in five of the six tests in preparation for planting in the spring of 1977. The six tests will be in the Districts of Ignace, Sioux Lookout, Dryden, Red Lake, Kenora, and Fort Frances. Survival of the transplanted stock at Petawawa was reduced by white grubs (larvae of the June beetle, *Phyllophaga* sp.). This and financial reasons will again force us to execute a more limited program than anticipated.

SEED PRODUCTION

During the last 10-15 years Kimberly-Clark of Canada Ltd. established the first black spruce clonal seed orchard at Longlac in northern Ontario which is now a valuable research facility. In cooperation with Mr. J.A. McPherson, Research Forester, seed production in this orchard has been monitored annually since 1970. A wide fluctuation in number of cones produced per ramet and number of seeds per cone has been observed.

To develop a basis for future treatments, the nutrient status of the orchard was tested by means of foliage sampling in September 1975. Through contract arrangements with the analytical laboratory of the Pulp and Paper Research Institute of Canada at Montreal, foliage was analyzed for levels of 12 elements, i.e. N, P, K, Mg, Ca, S, Fe, Mn, Zn, Cu, Mo, and B. The same elements had been included in sampling for tree growth studies in the same general area so that comparisons could be made. Following advice from Dr. Ian Morrison, Great Lakes Forest Research Centre, it was concluded that levels of N and Mg were low and could probably be improved by fertilization. However, the definition of nutrient levels for optimum seed production in Longlac soils and climates would require a lot more research and experimentation.

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STUDIES ON TREE GENETICS AT THE MOLECULAR LEVEL

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Key words: Pinaceae, histones, non-histone chromosomal proteins, protein phosphorylation, template activity

INTRODUCTION

The objective of this study is to obtain a knowledge of the composition and metabolism of chromosomal proteins [the histones and the non-histone chromosomal proteins (NHCP)] of jack pine (Pinus banksiana Lamb.) and other economically important conifer seeds. A further objective is to gain an understanding of the role of these proteins in various nuclear events such as chromosome condensation, replication, and as part of the control mechanisms involved in specific gene activity.

Recent theories (e.g. Bonner et al. 1968, Stein et al. 1974) suggest that the specific regulation of gene transcription plays an important role in both the development and normal function of cells of higher organisms (eukaryotes). The DNA (deoxyribonucleic acid) of each cell and tissue of a higher plant and animal appears to be the same, yet each cell and tissue can perform different functions. Thus the different cells and tissues must use the information encoded in the DNA differently. It is thought by many that such control at the transcription level may be exerted through the activation and inactivation of particular regions of the genome for RNA (ribonucleic acid) (and ultimately protein) synthesis depending upon the particular function of the cell at the time.

In microbial systems a number of DNA-associated proteins which have been isolated are capable of regulating transcription. Although a search is still on for the detection of these regulatory proteins in higher organisms considerable indirect evidence suggests that the NHCP have an important role in the specific regulation of gene transcription. For example, in contrast to the histones which contain only a few proteins, the NHCP are electrophoretically complex, metabolically unstalbe and display some tissue and species specificity.

Previous studies (Pitel and Durzan 1975a and b) showed that conifer chromosomes are composed of DNA, RNA, histones and NHCP. Results with jack pine and 5 other pine species (Durzan 1975, Pitel and Durzan 1975b) showed that the histones contained 5 main fractions while the NHCP were heterogeneous (18 to 25 proteins) and had a large molecular weight range from 10,000 to over 68,000.

In the following section we describe some of the more recent studies dealing with the characterization and metabolism of the chromosomal proteins of conifers. To date these new results have not been published.

METHODS

Routine methods available for forestry workers for the extraction of the chromosomal components from conifer seed material have been developed recently (Pitel and Durzan 1975a and b).

RESULTS AND DISCUSSION

In the first study we extended previous results by examining the chromosomal proteins of dry seed from several more species of conifers. With the histones (e.g. Fig. 1) species-specific differences in the electrophoretic mobilities of the F1 subfractions were present among all 10 pine species examined. These variations may be useful for examining the phylogenetic relationships between closely related species. At the intraspecific level, however, jack pine from 8 geographic locations across Canada showed no variations in the mobilities of the F1 subfractions. Examination of the histones between roots and shoots of 14-day-old jack pine seedlings, and also between the dry diploid embryo and the haploid female gametophyte tissue ($n = 12$) only revealed minor quantitative differences. Thus histone analysis identified qualitative differences among _Pinus_ spp., but no qualitative differences could be found in a single species, jack pine, due to origin of tissue or genotype.

Comparison of the NHCP among 10 _Pinus_ spp. (e.g. Fig. 2) and also among several _Abies_, _Larix_ and _Picea_ species showed that a number of unique bands were present for each species. Also, in contrast with the histones, some qualitative variations were observed at the intraspecific level for jack pine. These changes correlate with changes in the DNA content per genome at the intraspecific level (Miksche 1971). In addition tissue-specific NHCP were present after examination of the roots and shoots of 14-day-old jack pine seedlings.

The relative proportion of histones, NHCP and chromosomal RNA and DNA of jack pine changed during germination. After 96 hrs. there was a gradual decrease in the content (value of DNA chosen as 1.00) of the histone fraction and an increase in the NHCP content. The content of RNA remained relatively constant during germination. The initiation of synthesis of the histones and NHCP during germination of jack pine occurred after approximately 48 hrs. This correlated closely with the initiation of DNA synthesis. Also during germination the amount of glutamic acid decreased along with a corresponding decrease in the acidic/basic ratio of the NHCP amino acids. The template activity (i.e. the ability of DNA to synthesize RNA) of chromatin was much lower (199 dpm RNA) than from DNA (5,081 dpm RNA) in the _in vitro_ assay for dry seeds. Addition of histones

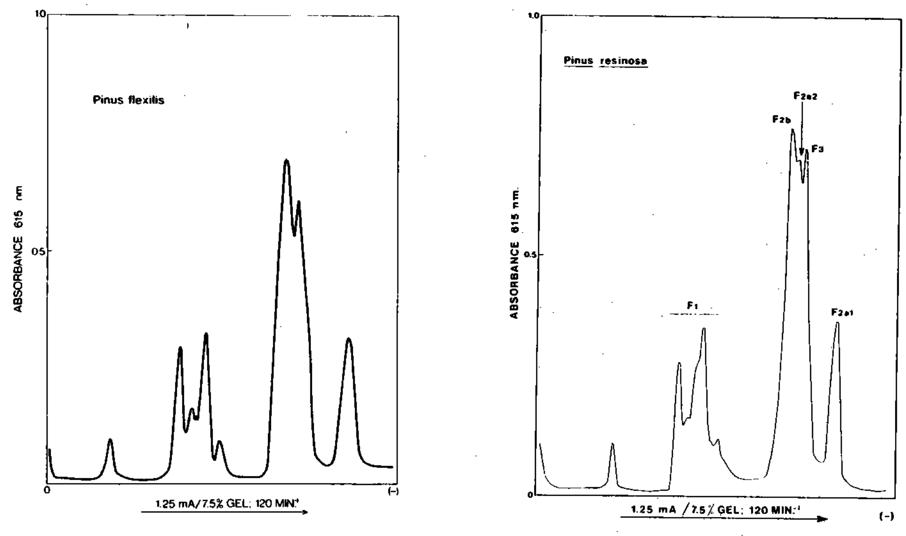

Figure 1. Histones from dry seeds of Pinus flexilis and Pinus resinosa. Electrophoresis was on 7.5% polyacrylamide gels with migration towards the cathode.

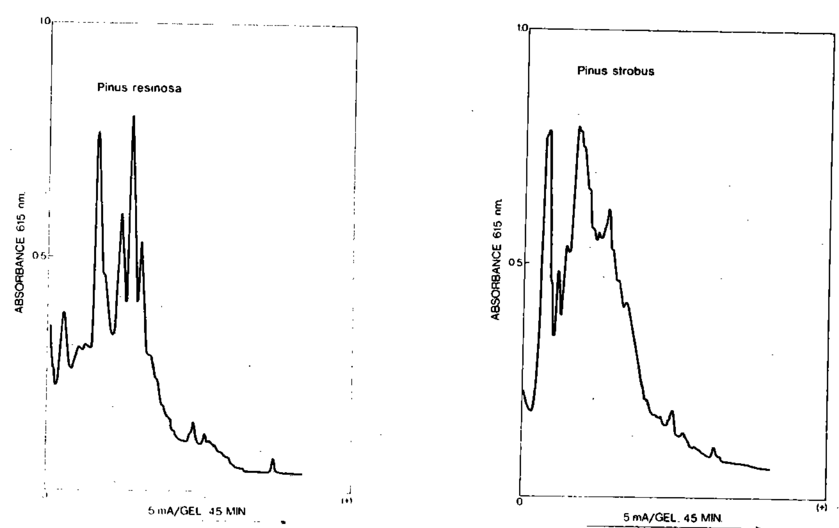

Figure 2. Non-histone chromosomal proteins (NHCP) from dry seeds of Pinus resinosa and Pinus strobus. Electrophoresis was on 7.5% discontinuous gels with migration towards the anode.

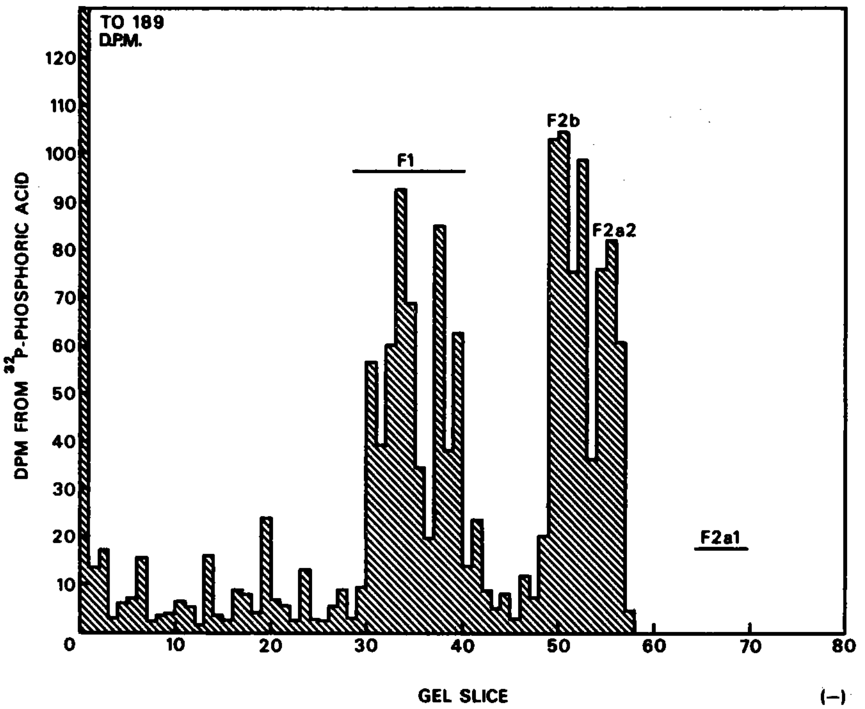

Figure 3. Distribution of radioactivity derived from ^{32}P-phosphoric acid along the length of a polyacrylamide gel that contains separated histone fractions. 96 hr germinated seeds were exposed for 3 hours to the isotope and the histones extracted.

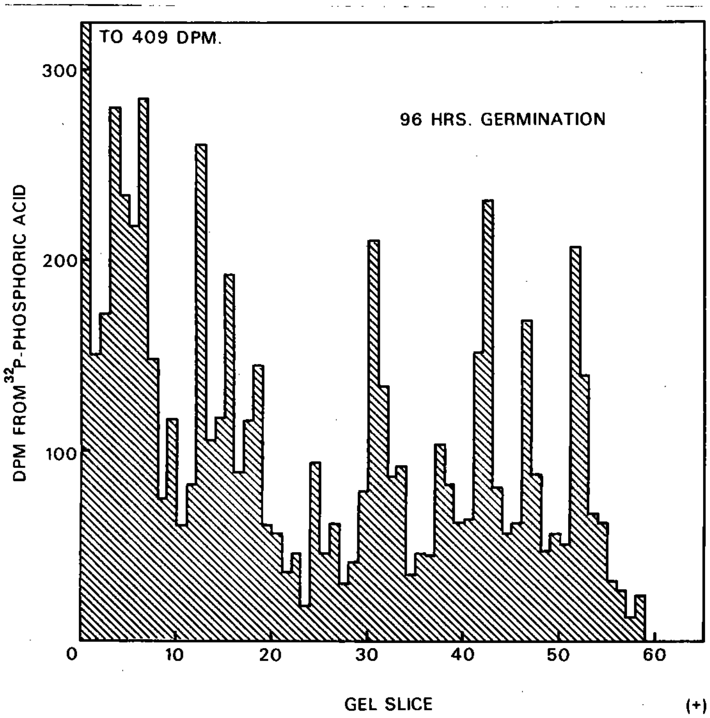

Figure 4. Distribution of radioactivity derived from ^{32}P-phosphoric acid along the length of a polyacrylamide gel that contains separated non-histone chromosomal proteins (NHCP). 96 hr germinated seeds were exposed for 3 hours to the isotope and the histones extracted.

to the DNA decreased RNA synthesis (i.e. 510 DPM). These results support similar studies with angiosperms (e.g. Lin et al. 1973) which show that the histones are capable of inhibiting DNA transcription. When the NHCP are added together with the histones in the assay of DNA, the amount of RNA is increased (i.e. 2,895 DPM). This suggests that the NHCP are capable of reversing the inhibition of the histones on DNA transcription. During germination the template activity of the chromatin increased over 250% (from 199 to 505 dpm dry seed vs 96 hr. germination). These changes correlate with previous studies showing an increased adenylate energy charge (Durzan et al. 1976), an increased population of polysomes (Pitel and Durzan 1977) and net synthesis of ribosomal proteins and r-RNA (Durzan et al. 1971) during early germination. Also recent studies (Durzan and Pitel 1977) suggest that N-phosphorylarginine may have an important role as a reservoir of energy needed for early metabolic events.

For jack pine the rate of phosphorylation of the histones (Fig. 3) and NHCP (Fig. 4) increased greatly during germination. The specific activities of the NHCP were up to 41 times greater than the histones. This suggests that these proteins have an important role (largely unknown as yet) to play in chromosome metabolism. At least 14-17 NHCP were phosphorylated. Some were labelled at all stages of germination whereas others were only labelled at specific times. It is widely believed that phosphorylation and dephosphorylation of the NHCP may be involved in the control of gene expression (Teng et al. 1971, Stein et al. 1974, Pitel 1977). Also enzymes of chromosome metabolism may be extensively phosphorylated (Trewavas 1976). Further studies in the area of identification of the phosphorylated regulatory proteins will have to involve more refinements in their extraction and resolution on polyacrylamide gels before the isolation and characterization of specific regulatory proteins (if any) can be made.

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NATIONAL TREE SEED CENTRE, 1975-76

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The National Tree Seed Centre has continued to serve its useful functions in service and research as defined under the two studies: (1) provision of information, reproductive material and seed processing services and (2) research on testing, treatment and storage of tree seed. In October of 1976, Miss Francine Sheridan was transferred to the Centre from the former Forest Ecology Research Institute in Ottawa. With her able assistance in the laboratory work, our backlog has been greatly reduced. At the end of 1976 the transfer of Mr. J.A. Pitel and Mr. G.C. Scheer from the former Biochemistry Unit of the Forest Ecology Research Institute made it possible to initiate a new seed biology study in relation to seed dormancy and seed storage problems.

PROVISION OF INFORMATION, REPRODUCTIVE MATERIAL AND SEED PROCESSING SERVICES

Information Service and Seed Distribution

Demand for these services has steadily increased. In response to 242 requests for material and information during the period 1975-76, over 1100 seed samples of 86 species and 23 pollen samples of 6 species were sent to addresses in Canada and 28 other countries. In addition to seed samples, the Tree Seed Centre prepared hundreds of cone sample packages in response to specific requests from educational institutions and for distribution by CFS personnel at meetings and displays.

The Tree Seed Centre has assisted other Federal Departments on several occasions in responding to requests received through diplomatic channels. Ninety separate packages of seed comprising 9 species were prepared for distribution by the second Canadian Forestry Mission to China. The seed brought back by this Mission was distributed to the various government agencies, universities, and botanical gardens for which it was intended, as was the seed brought back by the first mission in 1974.

A complete registration system was developed for identifying and cataloguing seedlots collected or otherwise procured for the Seed Bank. The old Forest Tree Seed Register form was revised, making it bilingual, and a new Seedlot Tag was introduced which serves to identify storage containers and sample packages. The system has been adopted as the standard for handling seed throughout the Canadian Forestry Service.

Seed Collection and Procurement

The Seed Bank is now stocked with more than 2000 seedlots of about 100 species, and continues to expand to include single tree collections from different geographic sources which are especially valuable to geneticists and other researchers, and collections of seed from species or sources which may be considered endangered.

The established world-wide network of contacts has enabled the Seed Centre to procure valuable collections of seed from Eastern Europe and other parts of the world for the Seed Bank and other programs and organizations. In response to the recent considerable interest in the genus *Larix*, the Seed Bank now contains collections of several species from both natural stands in various parts of the world and European seed orchards. Through the Tree Seed Centre's contacts, valuable collections of Norway and sycamore maple (*Acer platanoides* L. and *A. pseudoplatanoides* L.) seed of several geographic sources were procured from the U.S.S.R. for the Canadian hardwood genetic program. The shipment of the seed was greatly facilitated by the proposed channel for seed exchange, the Canadian/U.S.S.R. Working Group on Forest Based Industries. All Canadian requests for forest tree seed from the U.S.S.R. are to be compiled by the Tree Seed Centre, and all such seed will be procured through this formal channel once it is officially established.

Several special collections have been made for presentation to foreign countries. For example, in response to an official request in 1976, 5 kilograms each of red, silver, and sugar maple (*Acer rubrum* L., *A. saccharinum* L., and *A. saccharum* Marsh.) were specially collected and prepared for presentation by the Department of External Affairs to the Embassy of the People's Republic of China.

A technique has been devised to streamline the collection of many hardwood seeds by utilizing used parachutes. Time studies, which will lead to increased efficiency in the planning and execution of cone collections, were instituted.

The Tree Seed Centre again participated in the province-wide cooperative white spruce (*Picea glauca* (Moench) Voss) collection undertaken by the Ontario Ministry of Natural Resources and the Petawawa Forest Experiment Station. Almost 500 collections were made in the last two years.

Seed Processing and Seed Yield

As well as new material for the Seed Bank, the Centre's seed extraction plant processed about 1000 seedlots during 1975-76 as services to other programs and organizations. The largest component of the service work was again white spruce.

An analysis of the seed yields from the 1976 cooperative white spruce collections (Table 1) emphasizes the necessity of performing adequate cone crop surveys before committing resources to the field. Surveys should include cone cutting tests to check for acceptable numbers of filled seed (Dobbs et al. 1976). The average number of filled seed recovered from each cone, including those that failed to open because they were so poorly developed and so badly damaged by insects, from half of the sources listed in Table 1 was very low, even lower than previously reported for the 1974 eastern Ontario collection (Wang and Haddon 1976). The yields from 67% of the sources were lower than the reported Ontario average (0.73 lb./bu.) (Ontario 1966) and 27% of the sources gave yields lower than the lower limit of the previously reported range (0.38 - 1.25 lb./bu.) (USDA 1974). The extremely low seed yield was primarily due to the high percentage of unopened cones (20 - 43%) (Table 1), values which can be used as an efficiency rating index for cone collectors.

RESEARCH TESTING, TREATMENT AND STORAGE OF TREE SEED

Seed Testing and Germination

During the past two years 1,257 separate service and research tests of more than 40 species were conducted for purity, germination, moisture content, x-radiography, assessment of processing injury as well as for other special purposes. Among these were 85 tests of 10 western tree species for export.

Through routine testing it has been discovered that some of the standard prescriptions in the current international rules for testing seed (International Seed Testing Association, 1976) are not adequate for obtaining best results of Canadian seed. For example, a seedlot of ponderosa pine (*Pinus ponderosa* Laws.) from Cranbrook, B.C. was found to require 14 days longer prechilling than the prescribed period for maximum germination. Other examples that have been found are Western white pine (*Pinus monticola* Dougl.) and red maple (*Acer rubrum* L.). These international prescriptions will be recommended for amendment as more research results are known.

Continuous studies in laboratory germination criteria and dormancy variation in white spruce (*Picea glauca* (Moench) Voss) seed produced more interesting results which were presented at the 2nd IUFRO International Symposium on Physiology of Seed Germination, Tokyo, October 1976 (Wang 1976b). These studies indicated that a greenhouse germination of white spruce seed correlated well with laboratory germination tests based on previously established seedling vigour classes following prechilling treatment and that seed dormancy and germinability differed significantly among individual trees, years of collection and pretreatments. It was also pointed out from these studies that unless good seed quality producing parent trees are selected from past experience,

Table 1. 1976 White Spruce Seed Yield, Ontario Collections

Origin	No. Trees Sampled	Total No. Cones in Sample	% Unopened Cones	Total No. Cones Per hl	Total No. Cones Per bu	Yield[1] g/l.	Yield[1] lb/bu.	No. Seed[1] Per Cone	1000-Seed Wt. (g)[1] (average & range)
Moses Twp.	9	11,392	43	25,600	9,310	0.3	.02	3	2.54 (2.03-3.01)
Lorraine Twp.	12	12,856	15	17,611	7,102	7.6	.61	17	2.54 (1.85-3.30)
Hindon Twp.	8	6,611	26	14,691	5,343	4.8	.38	12	2.71 (2.29-3.26)
Peck Twp.	9	11,052	11	18,118	6,589	10.0	.80	25	2.58 (2.20-3.22)
Sinclair Twp.	10	13,621	7	17,690	6,433	5.8	.46	13	2.46 (1.94-3.20)
Armour Twp.	9	9,770	9	15,758	5,731	9.2	.74	25	2.33 (2.02-2.85)
Chisholm Twp.	10	9,274	2	13,842	5,034	11.4	.91	29	2.87 (2.50-3.62)
Mattawa Twp.	10	10,867	12	20,124	7,318	11.0	.88	26	2.06 (1.89-2.83)
Timmins Twp.	10	11,241	41	22,482	8,176	2.3	.18	4	2.63 (2.08-3.46)
Thorneloe Twp.	9	10,357	20	23,538	8,560	4.3	.34	9	2.11 (1.80-2.65)
Bonfield Twp.	10	9,095	0	14,437	5,250	11.5	.92	31	2.52 (1.87-3.09)
Bowman Twp.	10	11,291	8	14,292	5,198	9.0	.72	28	2.36 (1.73-2.65)
Robb Twp.	10	9,821	18	16,933	6,158	5.6	.45	13	2.55 (1.37-3.83)
East Mills Twp.	9	9,130	3	17,226	6,265	5.5	.44	13	2.44 (2.11-2.77)
Mulligan Twp.	10	12,428	31	25,363	9,224	3.8	.30	7	2.29 (2.05-2.54)

[1] cleaned seed

white spruce seed should only be collected in good crop years because of possible high degree of selfing or inbreeding. The risk involved in using such material of variable qualities for tree improvement research should be seriously considered by geneticists when their experimental seed material requires collections over a wide range in a number of years. Further work to confirm the relationship of poor seed quality and selfing or inbreeding in poor crop years is in progress.

Although a preliminary attempt to confirm linkage between dormancy control mechanism and pigment production in white spruce seed as reported in Douglas fir (Sorensen 1971) failed, further work appeared to confirm Sorensen's hypothesis. A note is being prepared for publication.

A paper on tree-seed quality was prepared and presented at the 1975 CTIA's Seminar on Applied Genetics in Forest Management (Wang 1976a), and a joint review of papers presented at the 1st IUFRO International Symposium on Seed Processing was published (Wang and Zasada 1976). Results from cooperative testing of fungicide-treated white spruce seeds of various Quebec provenances were published (Lamontagne and Wang 1976).

A cooperative research program on seed and cone characteristics of white spruce and lodgepole pine (*Pinus contorta* Dougl.) from Alberta was initiated with the Alberta Forest Service.

Seed Storage

Poplar (*Populus*) seed in general is known to have a short storage life. However, with the availability of sub-freezing storage facilities the life span of poplar seeds can be greatly extended. An interim check of the germinability of 23 largetooth aspen (*Populus grandidentata* Michx.) and plains cottonwood (*Populus deltoides* var. *occidentalis* Rydb.) seedlots stored for 9 years in air-tight glass containers at -18°C revealed that loss of germinability varied from a few percent to complete. The seedlots with good germinability at the beginning still maintained their high germinability with little or no deterioration whereas those with low germinability had lost all or most of it during the last four years. The lost germinability is primarily due to the great increase in abnormal germination.

As a pre-requisite to studying specific storage requirements for large-seeded hardwood seed, it is essential to know the major chemical components of seed. Based on a 1975 contract report on an analysis of chemical composition of seed of three oak (*Quercus*) and three hickory (*Carya*) species, a joint paper was written to show that amino acids and lipids represented the major food source of oaks and hickories respectively, and that the differences in these chemical components mean different requirements for seed moisture content and storage method for different species to retain their germinability in storage (Weinberger and Wang 1976).

In recent years, wet storage of agricultural, and to a limited extent, of tree seed has been studied by Villiers (1972, 1974 and 1975). He has successfully demonstrated that dry storage is detrimental to the genetic quality and germinability of seeds, and that fully imbibed seeds prevented from germination in storage are capable of maintaining their genetic quality and germinability and repair systems. Based on this evidence, a Quebec white spruce seedlot with a low moisture content (3.4%) and reduced germinability (59%) after 6-year normal storage was tested for possible damage from dry storage. It was found that germinability of the seeds was improved from 59% to 77% when their moisture content was increased from 3.4% to 35% and stored at 5°C in darkness for 6 weeks. This finding seems to confirm the long suspected theory that low seed moisture content is harmful to germinability of white spruce seed in dry storage. More research is required for the wet seed storage as it is very important to genetic quality of stored seed.

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JACK PINE GENETICS, PETAWAWA, 1975-76

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Genetic research in jack pine (Pinus banksiana Lamb.) actively pursued the objectives outlined in the previous report to the Association (Yeatman 1976a). Every opportunity has been taken to encourage foresters to apply research results in jack pine management, particularly for the long term production, collection, distribution and genetic improvement of seed.

At the same time, the practical basis for advanced-generation breeding has been explored by selecting plus trees and establishing associated progeny tests and clonal archives. A pilot breeding program conducted with the collaboration of the Ontario Ministry of Natural Resources is aimed at testing methodology and determining cost and effectiveness of creating seedling seed orchards in jack pine (Yeatman 1974b). Theoretical studies in jack pine genetics have included creation of a diallel crossing scheme, and selection and breeding within and between top ranking provenances at Petawawa.

PROVENANCE

Tree height and infection by scleroderris canker (Gremmeniella abietina (Lagerb.) Morelet) were recorded for selected seed sources in four northern range-wide provenance tests located in Ontario and Quebec (Yeatman 1976c, 1976d). These supplementary data confirmed conclusions from 1973 (10 year) observations that local or near-local seed sources of jack pine provide the best guarantee for good growth, winter hardiness and disease resistance. Jack pine found north of Lake Superior and east of Lake Nipigon appears to be an exception, for in this region provenances from east and west are superior to the local in height growth.

Pronounced genotype x environment interaction adds further weight to the argument for strict control over production, collection, identification, selection and distribution of seed for reforestation.

In some regions, e.g. western Quebec and southeastern Ontario, large differences (10 to 20%) are evident in mean tree height between geographically and climatically associated provenances. It is likely that systematic sampling and testing of major concentrations of jack pine will identify the better populations for seed collection and genetic improvement. Such tests will also permit setting of boundaries of seed zones and breeding districts on the basis of population response within the species rather than on site regions generalized for all species.

Heights were recorded for 16 Lake States provenances growing in a replicated test at Petawawa and in large, unreplicated plots near Grenville, Quebec, when the trees were 23 and 24 years from sowing, respectively. Seed origin ranged from southern Michigan to northern Minnesota (King 1966). Although the statistical discrimination in the test at Petawawa was weak, two southern Michigan provenances were in top rank and Minnesota provenances occupied the lowest 3 ranks. This is consistent with the overall clinal trend with latitude and summer climate found in other jack pine provenance tests (Yeatman 1974a).

The Grenville test site is superficially uniform and the results are worthy of consideration. The provenance means are based on the heights of 75 to 100 trees per plot. The ranking of this alluvial site in the Ottawa Valley is almost the reverse of that at Petawawa, with Minnesota provenances in top rank and southern Michigan and a southern Wisconsin source in lowest ranking. The rank correlation (Steel and Torrie 1960) based on provenance means at Petawawa and Grenville is negative and non-significant ($r_s = -0.29$). However, the correlation of rank at Grenville with the order of planting of the provenances in the plantation is 0.76 ($t = 4.38$, highly significant). Each provenance was planted in a long 3-row plot running parallel to an abandoned railway right-of-way. Provenance mean height increases with distance from the old railway. The apparent gradient in site quality over-rides provenance differences in the plantation and the results are of little value for genetic interpretation.

PROGENY

Two replicated tests were planted of 64 open-pollinated progenies of trees selected for growth and form from eight stands in the Upper Ottawa and Bonnechere Valleys in eastern Ontario. In each stand, four trees were selected for outstanding height and diameter and good form, i.e. plus trees, and four minus trees were selected as having extremely poor form. The progenies will be compared in due course to determine the effect of parental phenotype on growth and tree quality and a small demonstration seedling seed orchard was established with progenies of the plus trees. Grafts of selected plus- and minus-trees from Petawawa were planted to test the interaction of spacing and genotype. These clones were also planted side by side with their progeny for demonstration and to be available for controlled breeding.

SELECTION

The initiation of a trial of mass selection in young jack pine was reported previously (Yeatman 1976a). Grafts of the 100 plus trees and 100 control trees are ready for planting in the breeding arboretum in 1977. The select and control trees were released from immediate competitors in an attempt to promote flowering and seed production. The problem may lie with squirrel activity as much as with paucity of flowering.

Grafting plus trees selected in the Côte Jaune seed production area in Quebec (Yeatman 1976c) was only partially successful because the scions had to be stored for long periods (6 to 14 months) before root-stocks were ready for grafting. Tests are underway to improve methods of scion storage and for the rapid production of rootstocks.

A pilot jack pine improvement program has been initiated near Spoor Lake, Algonquin Park, in cooperation with the Ontario Ministry of Natural Resources. Young stands suitable for seed production have been surveyed and the first 100 plus trees selected on the basis of 1/4 ha plots. Assistance in the field operation has been given by Algonquin College staff and students who use the opportunity as a training exercise.

BREEDING

Collection of seed of provenance hybrids was completed and the seed extracted, cleaned and counted. A series of field trials will be planned cooperatively with our colleagues in the Lake States. The first test using 16 crosses within and between 4 widely separated provenances is being run in controlled environments to examine photoperiodic response.

A count was made of one-year conelets in 15-year-old jack pine growing at two spacings, 7 and 14 ft. An equal number of conelets were found on an area basis, but there was a more consistent and more abundant cone set on the trees at wider spacing. Replicate thinned plots were created in 11-year-old natural regeneration to evaluate the effect of thinning on cone production.

Further pollinations were made to augment the seed required for a diallel crossing scheme among seven random jack pine trees of Petawawa origin. A new breeding test was initiated among plus trees crossed within and between top-ranking provenances at Petawawa.

EXTENSION

A forest genetics exhibit was created by the Canadian Forestry Service and has been displayed before a number of forestry and public audiences in eastern Canada ranging from Gander, Newfoundland to Sault Ste. Marie, Ontario. The assistance of association members in supplying colour slides is gratefully acknowledged. In addition to a trans-Canada slide review of tree improvement, the exhibit highlights, by models, photo-posters and captions, seed production, the effects of photoperiod on seedling growth of three species in relation to geographic origin, provenance effects on growth and disease resistance in jack pine, seed production areas, and genetic improvement by plus tree selection and the establishment of seed orchards. Packets of cones and seed, a poster on seed production and plus tree selection, and selected reports for give-aways were useful adjuncts to the exhibit. Copies of the Proceedings of the 14th and 15th Meeting of the Canadian Tree Improvement Association were displayed to forestry audiences together with application forms for corresponding membership in the Association.

Other activities of a more general nature included running training courses on tree climbing and the preparation of a manual on methods and equipment. Over 20 Ontario provincial forestry staff received instruction to aid them in seed and scion collection from standing trees. A report to update research and application of genetic improvement of forest trees in Canada was presented at the 1976 annual meeting of the Woodlands Section of the Canadian Pulp and Paper Association (Yeatman 1976b). The paper was based dominantly on recent reports by active members to the Canadian Tree Improvement Association.

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WHITE SPRUCE GENETICS, PETAWAWA 1975-76

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I joined the Petawawa Forest Experiment Station on 1 March 1976 and subsequently was put in charge of the genetic program with white spruce (Picea glauca (Moench) Voss). My priorities are (1) to organize and carry out the new cooperative range-wide study, and (2) to evaluate established trials as a basis for the further development of the breeding strategies. Progress since the last report (Morgenstern 1975) is summarized here.

NEW RANGE-WIDE STUDY

By the end of 1976, seed from over 300 stands had been gathered for this study. About 80% of the seed had been collected on the basis of individual trees, and approximately 1500 single-tree seedlots are now available. Collection in Ontario represents the joint effort of P.F.E.S. and Ontario Ministry of Natural Resources (Mr. D.A. Skeates). A number of people including Drs. J.I. Klein and N.K. Dhir in Alberta; Mr. F.W. Flavelle in Saskatchewan; Mr. R.F. Calvert (now Researcher at P.F.E.S.) in Manitoba; Dr. A. Corriveau and M. Yves Lamontagne in Quebec; Dr. S.A.M. Manley in Prince Edward Island; Mr. T. Mullin in Nova Scotia; and Dr. M.A.K. Khalil in Newfoundland have contributed and will contribute seeds from outside Ontario.

In the past the original stands of the desired sources often disappeared after the completion of the provenance tests. To avoid this problem, 5 to 10 grams of seeds of each seedlot have been designated for long-term storage under the conditions prescribed by the Seed Centre (Wang 1975). Those seeds will be available to the cooperators for establishing seed orchards or other purposes once desired provenances have been identified.

Eight federal and provincial organizations and the University of Maine, U.S.A., will participate in this program. Field tests will be established beginning in 1980.

COMBINATION STAND-PROGENY TEST OF OTTAWA VALLEY WHITE SPRUCE

In cooperation with the Ontario Ministry of Natural Resources (Mr. D.A. Skeates), planting stock for three tests in Region 5E, Ontario are being prepared. Each test will contain about 350 families from 60 stands. The area sampled is roughly south of latitude 48° and between longitude 72° and 78°. There is strong evidence that white spruce from this area may contribute excellent breeding materials for southwestern Ontario, Maritime provinces, Lake States and Northeastern United States (Genys 1965, Nienstaedt 1969 and Teich et al., 1975). These experiments will be designed to estimate (1) the extent of stand differentiation and (2) variation between families from the same stand.

RESULTS OF SOME CURRENT PROGENY TESTS

Family effect on growth was significant, but no differences between stands was found in three single-parent progeny trials of Upper Ottawa origin (Dhir 1976). Results from four 22-year-old progeny tests indicate that phenotypic selection for growth rate in forests on the basis of simple comparison is not effective. Family correlation in height growth between age 22 and 10 was high. Early selection is feasible. Family selection or combined selection, taking into account the family average plus individual-tree performance, would likely give the greatest gain.

White spruce progeny from Menominee County, Wisconsin (Lat. 45°) outgrew the local control by 15% at the age of 12 years on a poor sandy site. It appears that some of the materials can be incorporated into our white spruce program.

COMPARISONS AMONG WHITE, SITKA, ENGELMANN SPRUCE AND THEIR HYBRIDS

Experiments to compare (1) Sitka spruce and its hybrid with white spruce were established on the Station in 1960 (Exp. 139) and (2) Engelmann spruce and hybrids with Engelmann and white spruce in 1967 (Exp. 233). Both tests were measured and evaluated in 1976. The results clearly indicated that both pure Sitka and Englemann spruce were not hardy enough and suffered repeated winter injury. The response of the hybrids was generally intermediate. Two white spruce provenances from northern Manitoba and Black Hills, South Dakota of the United States had 80 percent survival and averaged 280 cm in height ten years after planting. One of them (S.3116) produced a heavy cone crop in 1976 on 75 percent of the living trees.

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FOREST GENETICS AT THE SCHOOL OF FORESTRY LAKEHEAD UNIVERSITY

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The primary responsibility of the School of Forestry at Lakehead University is "to educate young people in preparation for the challenge of managing and restoring the land based resources of the boreal forest region" (Science Council of Canada 1973). It is considered essential that this education should include experience in the field, laboratory, and classroom that will provide all students with a basis for an appreciation of the principles, objectives, and value of tree improvement.

UNDERGRADUATE PROGRAMME

All undergraduate students in the four-year degree programme study the basic principles of genetic variation and tree improvement during their silviculture courses. Laboratory and field work completed by all students includes collection, treatment and germination of tree seed, vegetative propagation by grafting and cuttings, and evaluation of a provenance test and seed orchard. Senior students have the option of attending a course in which forest genetics is studied in greater depth. Titles of research projects undertaken by some of these students in 1976-77 are given below.

1. Variation in branch characteristics in a jack pine (Pinus banksiana Lamb.) provenance test.
2. Provenance-related variation in root regeneration and early growth of white spruce (Picea glauca (Moench) Voss) seedlings.
3. Infra-red gas analysis as a means of comparing photosynthetic rate of white spruce seedlings.

Results of these studies will be presented as undergraduate theses in April 1977.

GRADUATE RESEARCH

In September 1977 the School of Forestry will enroll the first students in its new Master of Science programme. This programme will have a strong silvicultural emphasis and will provide opportunities for graduate research on tree improvement with particular reference to the boreal forest.

ARBORETUM

The Lakehead University Arboretum (Day *et al*. 1976) was officially opened in July 1976. In addition to its educational value it is expected that this arboretum will serve as a northwestern Ontario test site for material produced by the Canada Department of Agriculture.

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TREE IMPROVEMENT PROGRAMS CONDUCTED BY THE PROVINCE OF MANITOBA

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INTRODUCTION

The basis of tree breeding in Manitoba is genetic diversity between and within populations of the three main species, white spruce (Picea glauca (Moench) Voss), jack pine (Pinus banksiana Lamb.) and black spruce (Picea mariana (Mill.) B.S.P.), though major efforts in the realm of genetic improvement and seed production would be directed towards white spruce and jack pine. Currently at various stages of nursery and field trials are local and all range provenance studies of white spruce (Segaran, 1977a), local provenance studies of jack pine (Segaran and Meseman, 1977a), local and all range studies of black spruce (Segaran 1977b). Field trials of hybrid Populus Walker (formerly known as hybrid Populus 44-52) throughout the province on three different soil types indicate a mean annual increment of 1.76 cm dbh and 2.31 metres total height on triable clayey loam soils of high organic matter content, a high phosphate supply and a pH greater than or equal to 7 (Segaran, 1976c). Trials of exotic species, namely, Norway spruce (Picea abies (L.) Karst.), Scots pine (Pinus sylvestris L.), Korean pine (Pinus koriensis) and larch (Larix gemelini var. olgensis) are also underway and the successful provenances would ultimately enhance local seed sources besides obtaining homoclimal information.

Vegetative propagation techniques of grafting and rooting for white spruce commenced in 1976 to continue the parental hereditary superior traits into the asexually regenerated progeny under conditions of controlled genetic environment (Segaran and Meseman, 1977b). The scions were collected from phenotypically superior plus trees (Segaran, 1976b) using a multiple selection index criterion. Grafting would continue to play an important part in the establishment of clonal seed orchards in the province (Segaran, 1976a) until some light is shed on the time period between rooting and seed production.

A master plan is now being prepared for the establishment and management of the first clonal seed orchard in the province (Segaran, 1977c). Besides selection, progeny testing and genetic crossing, cultural techniques for precocious flowering, continuous and early, regular production of abundant quantities of seed would also be incorporated. The exogenous application of the plant hormone gibberellin to terminate the long juvenile phase and consequent promotion of early and enhanced flowering would also be endeavoured.

In the summer of 1977 it is also hoped to undertake an evaluation of the different container systems used in the commercial plantings of jack pine in the Province, during the last five years.

TREE BREEDING OBJECTIVES

1. To determine the nature of the distribution, genetic diversity, clinal growth patterns over variant ecogeographic ranges of both local and all range provenance trials of white spruce, black spruce and jack pine.

2. To discover, segregate and evaluate the promising provenances for more intensive trials.

3. To obtain fundamental quantitative criteria for seed movement and seed transfer, and thus establish the zonation of seed boundaries.

4. To search and locate plus trees, with a broad genetic base, that possess external superior manifest growth rates and disease-resistant characteristics for obtaining scions for grafting and rooting.

5. To formulate standardized procedures for vegetative production of propagules.

6. To establish seed production areas of known geographic origin with isolation barriers, and carry out parent-progeny tests to ascertain if any variation exists in the combining ability of individual selected phenotypes.

7. To conduct trials of exotic species and determine the provenances that would perform well in Manitoban climate on short rotations with a high volume outturn, and also in terms of wood hardiness, good growth rates, disease and weather resistance characteristics.

8. To draw up a management report for the establishment of clonal forest seed orchards of white spruce incorporating management procedures and cultural treatments for early precocious flowering and consequently enhancing of seed yield.

LOCAL PROVENANCE TRIALS

1. Jack Pine

Seeds from 17 sources throughout the Province were collected in the winter of 1972-73 and sown at the Pineland Research Nursery in the spring of 1973. Two year old nursery stock was field planted on five scarified locations in the spring of 1975. Growth data are recorded annually. At the end of one year from seeding three provenances appeared promising as ascertained from a single environment (Segaran and Meseman, 1977b).

2. Black Spruce

Seeds, collected from 17 stands in the Province, in the winter of 1973-74, were sown in #313 paperpot containers in flats at the nursery. The seedlings were given an 18-20 hour photoperiod with a regular schedule of fertilizer application. The material was field planted on five different locations in the spring of 1976. Annual growth measurements will be taken.

3. White Spruce

From 15 stands distributed throughout the Province, seeds were collected in August 1973 and sown in #313 paperpots in the spring of 1974. Weekly applications of liquid fertilizer (15-15-30 at the rate of 2 teaspoons per double row) were applied in 1975 and 1976. They will be planted in nursery seed beds in 1977 and field planted in the spring of 1978.

ALL RANGE PROVENANCE TRIALS

4. Black Spruce

Surplus nursery stock was procured from the Canadian Forestry Service, Edmonton, in 1975. The stock from 12 eastern seed sources was planted on a moist site in the vicinity of Marchand.

5. White Spruce

Seeds, from 65 seed sources were procured from Petawawa Forest Experiment Station, and were sown in flats of peat moss in July 1974. Weekly applications of liquid fertilizer were applied in 1975 and 1976. Due to frost damage on some of the provenances only 42 provenances would be planted on nursery seed beds in 1977 and field planted in 1978 (Segaran, 1977a).

A further trial from 100 seed sources would be undertaken in a cooperative genetic white spruce study with the Canadian Forestry Service from the summer of 1978.

PLUS TREES AND SEED ORCHARDS

In the fall of 1976, plus trees of white spruce with a broad genetic base have been located in the Pine Falls - Wallace Lake region. Scions have been taken in February 1977 and would be grafted on to compatible rootstock of the same species in April 1977. These materials would form the base of the first population of clonal forest seed orchards to be established in the Province (Segaran; 1976a, 1976b). A master plan incorporating the establishment, management and cultural treatments are being drawn up for the first clonal seed orchard in the Province (Segaran, 1977c).

VEGETATIVE PROPAGATION TECHNIQUES

In 1976 grafting and rooting trials were carried out at the Research Nursery, mainly to attain the finer aspects in the mastery of grafting and to gain an insight into the physiological problems affecting rooting. A report on these has to be published (Segaran and Meseman, 1977b). In 1977 grafting of 200 scions of white spruce would be undertaken, as well as the inducing of rooting of 200 cuttings.

TRIALS OF HYBRID *POPULUS* WALKER (FORMERLY KNOWN AS *POPULUS* 44-52)

These trials were commenced in 1968 and are currently at varying stages of growth. Growth statistics up to the fall of 1976 have been written up as an Information Report No. 3 (Segaran, 1976c). In 1978, it is hoped to extend these trials on a broader basis.

SEED PRODUCTION AREAS

In the late summer of 1977, it is expected to locate 2 areas of white spruce as temporary sources of seed until seed orchards attain commercial production of certified, high quality seeds.

TRIALS OF EXOTIC GENERA

Four exotic species are now under test, Scots pine, Korean pine, Norway spruce and larch. Requests for seeds of other exotic genera have been made and are expected to arrive later this year.

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TREE IMPROVEMENT IN ALBERTA, 1976-77

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Approximately 24,000 ha of forests are logged annually in Alberta. Much of the cutover area is site prepared and regenerated through direct seeding or planting by the Alberta Forest Service and forest industries. In fall 1975, the Alberta Forest Service embarked upon a systematic tree improvement program in order to provide genetically superior seed for reforestation programs of the province. Shortly thereafter, North Western Pulp & Power Ltd. and Proctor & Gamble Cellulose, Ltd. also initiated their own tree improvement programs to cover their extensive lease areas located respectively in the forests of Edson and Grande Prairie regions. This report briefly describes progress on forest genetics and tree improvement work carried out by the Alberta Forest Service and Proctor & Gamble Cellulose, Ltd. during the past one and a half years.

CONE COLLECTIONS

In 1976, cone crop in most areas of Alberta was fair to moderate. Extensive cone collections were made across the province to build up seed inventory for tree breeding and related experimental work. A total of 735 cone collections were made from ten species (Table 1) with most emphasis being placed on collection of cones from phenotypically desirable trees of white spruce and lodgepole pine. Seed extraction and processing work was completed with the assistance of Petawawa Forest Experiment Station which kindly processed a sizeable portion of our cone collections.

SEED PRODUCTION AREAS

Two seed production areas were developed in the province in 1976. Proctor & Gamble Cellulose, Ltd. initiated the development of a 9.7 ha white spruce seed production area in the Grande Prairie Forest. This project will be completed in spring 1977. Alberta Forest Service developed a 1.2 ha black spruce seed production area at Nipisi in the Slave Lake Forest.

Work was initiated on a project aimed at screening and testing seed production area trees to identify parents possessing excellent seed production capacity as well as superior progeny performance potential for nursery stock production. Seed production areas located at Weberville (Peace River Forest) and Mitsue South (Slave Lake Forest) were chosen and trees with phenotypically more desirable attributes marked and described. A total of seventy trees were selected for initial testing and the project will be expanded to include more trees in later years. Cone crop rating and seed yield per cone of individual trees varied substantially. Seed quality evaluations and germination tests on the selected trees have been completed. Short term nursery testing of this material is planned for spring 1977. These trials will evaluate open pollinated progeny performance of seed trees in containers and nursery beds.

Table 1. Summary of cone collections made during 1976.

Species	Number of Collections	
	Single tree	Bulk
White spruce	318	6
Lodgepole pine	231	2
Tamarack	61	13
Black spruce	60	19
Alpine larch	9	2
Alpine fir	-	1
Douglas-fir	5	1
Limber pine	-	4
Whitebark pine	1	-
Engelmann spruce	-	2
TOTAL	685	50

SELECTION AND BREEDING

It was decided that tree breeding work in the province will be initially restricted to white spruce and lodgepole pine with most emphasis on the former species. Target area for tree breeding projects covers the forests located in the central and northern portion of western

Alberta which produces approximately 90 percent of the timber cut in the province. This area was divided into six Breeding Regions (Figure 1). Each region is to be covered by a separate and independent breeding program restricted initially to the most important tree species of the region. Regions A and B were earmarked for lodgepole pine improvement and regions C, D, E and F for white spruce improvement.

During 1976, field work was started on a number of breeding programs. Alberta Forest Service and Procter & Gamble Cellulose, Ltd. jointly initiated a lodgepole pine improvement program for breeding in region B. Natural stands in the central part of this region were surveyed and 201 superior tree selections made to provide genetic stock for further selection and breeding. Selected trees on an average showed 17 percent height superiority and 33 percent diameter superiority over random trees (excluding suppressed trees). Further selections will be made over the next two years to complete assembly of base material for lodgepole pine breeding in region B. Prescribed breeding strategy consists of establishing seedling seed orchards based on simple recurrent selection of half-sib selection schemes.

Selection of white spruce superior trees was confined to breeding regions C and E. A total of 143 selections were made and cones collected from the individual trees. The selection criteria emphasized stem form and branching characteristics along with a requirement of above average height and diameter growth. Supplemented with additional selections in later years, this material will be used to establish seedling seed orchards which will be rogued on the basis of half-sib progeny tests.

A large number of white spruce seedlings were potted to provide steady supply of rootstock material for grafting plus tree scions to establish clonal seed orchards of this species. White spruce plus tree selection and grafting program at operational level is planned to be initiated in 1979.

PROVENANCE STUDIES

In 1974, Alberta Forest Service started a series of white spruce and lodgepole pine seed source trials to assess the effect of seed source movements over relatively longer distances in Alberta. Two experimental plantations were established at Nojack (Latitude 53° 36', Longitude 115°32') and Mile-250 north of High Level (Latitude 59°16', Longitude 117°32'). Every spring since 1974, three to eighteen provenances of each species were outplanted at each of the two sites. Field planting on these trials was continued in 1976 when 3 lodgepole pine and 16 white spruce seed sources were outplanted at each site. The plantations were also assessed for survival in fall 1976. Significant differences in field survival attributable to planting years, locations, seed sources and species were observed. However, poor experimental design of these field tests limits the value of information that can be obtained from these trials. Therefore, a new series of white spruce provenance trials was initiated in 1976.

A number of seedlots representing the geographic range of white spruce in Alberta were obtained for establishing a number of seed source test plantations across the province. A total of fifteen field tests are planned. Each test will compare the performance of a set of 20 seed sources common to all tests with varying set of 5 to 10 local seed sources. Nursery sowing of the first three tests of this series was completed in spring 1976.

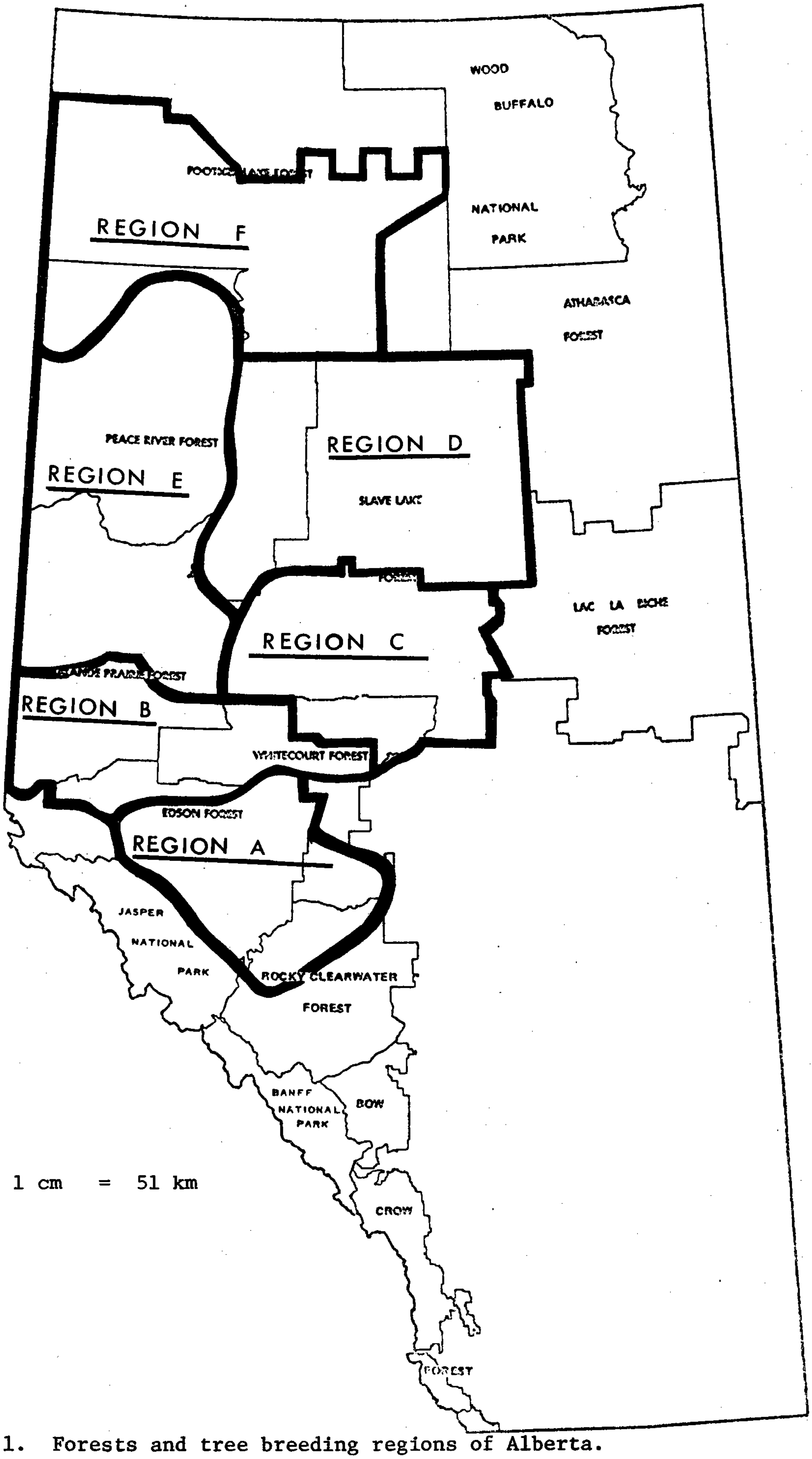
OTHER STUDIES

Two research studies were initiated in cooperation with The National Tree Seed Centre of Petawawa Forest Experiment Station. These are:

1. Evaluation of geographic variability in cone size, and seed yield, size and quality of lodgepole pine in Alberta.
2. Seed germination requirements and behaviour of white spruce seed sources originating from sites of diverse moisture regimes.

Collection of cones to provide seed material for these studies was completed and sent to Petawawa Forest Experiment Station which is conducting the laboratory investigations.

The Alberta Forest Development Research Trust Fund administered by the Department of Energy and Natural Resources is providing a grant to develop a system of biogeoclimatic classification for the forests of Alberta. This study is being conducted by Dr. S. Kojima of The Canadian Forestry Service and expected to be completed in 1980. The results of biogeoclimatic classification will provide a sound basis for developing tree seed zones for Alberta.



Scale: 1 cm = 51 km

Figure 1. Forests and tree breeding regions of Alberta.

JACK PINE BREEDING AND PROVENANCE EXPERIMENTS WITH CONIFER SPECIES IN THE PRAIRIE PROVINCES, 1975-77

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The jack pine (Pinus banksiana Lamb.) breeding program initiated in 1967 passed a milestone with the planting in 1976 of the third family test, the last one planned for the first selection cycle. A site was selected and prepared for the regional clone bank. At 15 and 14 years from planting, red pine (Pinus resinosa Ait.) from Regina Bay, Ontario and Norway spruce (Picea abies (L.) Karst.) from Bashkir A.S.S.R. had survived and grown better than other introduced populations in their respective tests, but were not good enough to be recommended for operational use (Klein 1976a, 1977). The range-wide black spruce (Picea mariana (Mill.) B.S.P.) geographic variation study was planted in three locations in 1975.

JACK PINE BREEDING PROGRAM

Family Test Establishment

The central breeding district family test was planted in spring 1976. This test, the third and last planned for the program, contains 48 trees in each of 214 open-pollinated progenies and two stand collections. Each of the test's four plantations has one cubic lattice unit of three replicates. Parent trees were selected in and around the morainic uplands of western Manitoba and eastern Saskatchewan, roughly between Dauphin and Carrot River. The four plantations are in representative locations within this area, on soils ranging in texture from sandy loam to clay. A slightly coarser group of soils might have been preferable, but relatively fine-textured parent materials seem to be more characteristic of this breeding district.

Rearing of planting stock for the family test was done in 40 x 40 x 100 mm containers, beginning in June 1975. Beginning in December, photoperiod was shortened, greenhouse temperatures were reduced, and nitrogen feeding was stopped. The container strips were then rearranged from three sowing replicates into four plantation groups of three replicates with 36 pre-determined 6-plot blocks in each replicate. The seedlings were kept in a cold room at +2°C for slightly longer than a month before being removed in early May, 1976, for transfer to a staging area near one of the sites. This regime appeared to suit the seedlings.

Clone Bank

A 5 ha site has been prepared for the regional clone bank at the Chip Lake Research Planting Area, 120 km west of Edmonton. Climate and soil of this area were described previously (Klein 1976b). Parts of the area lack the layer of till between the loess cap and the weathered sandstone, but the requisite digging was done to ensure that the entire clone bank planting site has the till layer. Poplar and conifer trees of commercial size were cut and removed, then all residual woody material was chopped into mulch and left on the ground. Stumps were cut low and left in place. No scarification other than spot scalping will be done prior to planting of the grafted ramets.

Over 1200 ramets grafted from 1974 to 1976 were wintered in pots under wood shavings inside a wall 0.6 m high. These will be planted in 1977. Ramets to be grafted in 1977 may also be planted in 1977. If they are, they will require a lot of tending in their early years, but would sustain less root deformation than if kept in pots longer. Facilities for lining out grafted ramets are not available to this program.

Grafting Technique

For greenhouse grafting of jack pine, we built a light wood frame over the benches to hold 2-mil vapour barrier. Results seem to be best when the bench covers are kept closed tight for two months after grafting, and the grafts taken outside as soon as the covers are opened. Many apparently successful grafts died in the greenhouse during or after gradual opening of covers.

A new method of obtaining rootstocks is being tried this year. Instead of potting-up bare-root nursery stock, 40 x 40 x 100 mm containers were seeded in May 1976. The seedlings were chilled outdoors, potted-up in peat in November, then maintained in the greenhouse under growth-stimulating conditions. At the beginning of March, about 10% of the trees appear to be large enough for grafting. There should be enough good-sized rootstocks by May, when grafting begins.

PROVENANCE EXPERIMENTS

Red Pine and Norway Spruce

A red pine experiment in southeastern Manitoba, and a Norway spruce experiment in Riding Mountain National Park in western Manitoba both showed significant differences among populations in survival and height growth at 15 and 14 years after planting, respectively (Klein 1976a, 1977). Neither experiment's results would justify introduction of any non-native populations into operational planting. There was no clear indication from the results that new provenance tests with red pine or Norway spruce would or would not reveal populations genetically superior to species and populations now in use.

The red pine experiment has a local population of red pine (Sandilands) planted between plots of the other populations. This arrangement allowed reasonably valid comparison with Sandilands. Sandilands trees were near bottom rank in height in earlier measurements, but were only slightly behind the tallest population, Regina Bay, in total height and current periodic height growth rate at this measurement. The slight advantage of Regina Bay was considered inadequate to recommend its use in view of its poor performance in a plantation near Dryden, Ontario, and other factors. Survival differences could not be clearly attributed to genetic adaptation, because nearly all of the mortality or recorded injury occurred before the first examination, two months after planting.

White spruce (Picea glauca (Moench) Voss) trees of Riding Mountain origin were planted around the margin of the four separate areas cleared and scarified for the Norway spruce experiment, but they were not planted between the plots. Consequently, the better growth of the white spruce trees may be partly the result of growing in a habitat less degraded than that of the Norway spruce trees. Results to date indicate that Norway spruce from Bashkir A.S.S.R. survives and grows better than Norway spruce from milder source areas on sites scraped with a straight blade in Riding Mountain National Park.

Black Spruce

The Northern Region component of the range-wide black spruce study was planted in spring 1975. Planting sites are located in western Manitoba (52.7°N, 101.4°W, elevation 760 m), in central Saskatchewan (54.2°N, 104.4°W, 640 m), and near Peace River, Alberta (56.0°N, 116.6°W, 750 m). The Saskatchewan plantation has 49 populations of virtually range-wide provenance, the Manitoba plantation 49 with few from north of 55°N, and the Alberta plantation 30 with few from south of 50°N. One northern population in the Alberta plantation, and another in the Saskatchewan plantation, both short of trees when planted, were replaced in July 1976 with seedlings of a population collected in fall 1975 north of Watson Lake by the Yukon Forest Service. The seedlings were grown in 50 x 50 x 200 mm containers from immediately after seed extraction until they were planted. All three plantations were measured in late summer and fall of 1975. Documentation of the plantations is in progress.

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NORTH WESTERN PULP & POWER TREE IMPROVEMENT PROGRAM

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North Western Pulp & Power Ltd. is based in Hinton, Alberta, 180 miles west of Edmonton, and operates on a lease area of 3,000 square miles. The main species harvested are lodgepole pine and white spruce, with some black spruce and subalpine fir. Only lodgepole pine and white spruce are used in our planting program. The pulp mill has a capacity of 550 tons of high grade Kraft pulp per day. In 1973 a stud mill, with a production rate of 50 million fbm per year, was added.

The position of tree improvement forester was filled in July of 1976. Tree improvement work had not been carried out on a continuing basis before this time, and the improvement program is still at a planning stage.

Short term objectives, which are primarily aimed at increasing control over wild seed collections, and providing some genetic gain, will be met through a program which has already been started. This short term program involves: one white spruce seed production area at present, pre-commercial thinning in 15 to 20 year-old lodgepole pine stands, and careful matching of seed source to planting site for both species. The pre-commercial thinning allows some phenotypic selection and an improvement in genetic quality is expected. Seeds produced in these blocks will be of higher quality as a result.

The short term program can be extended over more of the lease area each year, and could eventually result in an upgrading over the entire lease, with an anticipated genetic gain of 2 to 5%.

A long term program, to provide material and information for efficient breeding, is presently at a conceptual stage. Testing of local populations, within our lease area, for seed zonation has the main priority, with planting planned for 1978 and 1979. Beyond that the program will likely be based on selection of plus trees and progeny testing, seed orchards and controlled breeding. Preliminary scheduling provides for sufficient information to select plus trees by 1979 or 1980, establishment of progeny tests and seed orchards by 1981 or 1982, initial breeding by 1990 and efficient, reliable breeding by about 2025. Research to provide information to this program will include studies of future product requirements, markets, technological change, and land use, as well as research of biological aspects.

This program will involve cooperation with other agencies. Preliminary discussions have been held with geneticists at the Alberta Forest Service, Canadian Forestry Service Northern Forest Research Centre, and the University of Alberta.

North Western Pulp & Power Ltd. will be also involved in a cooperative selection project with the Alberta Forest Service in 1977. This project is described by Dhir and Vincent in their member's report.

NATURAL VARIATION AND GENECOLOGY OF SPRUCE, BIRCH, AND ASPEN IN ALBERTA

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Key words: Provenance tests, chromatography, genetic differentiation, Picea glauca, Betula papyrifera, Populus tremuloides.

Tree improvement activities at The University of Alberta have been concentrated in the areas of natural variation and genecology. Over the past two years, three projects involving native species have been initiated. The overall objectives of these studies are: 1) to determine patterns of genetic variation of several traits of these species and any relationship of these patterns with environmental variables, 2) to clarify some confusing taxonomic and genetic relationships among two reported taxa (birches), and 3) to provide guidelines for seed collection and a framework for later selection and breeding.

NATURAL GENETIC VARIATION OF WHITE SPRUCE

Seed from 27 seed sources of white spruce (Picea glauca (Moench) Voss) was obtained from the Alberta Forest Service seed bank. The sources were selected along latitudinal gradients in eastern and western Alberta; in addition, in the foothills of western Alberta, the populations were selected along four elevational transects. The seed was germinated and the seedlings grown in Spencer-Lemaire Ferdinand containers in each of two controlled environments simulating the photoperiod, temperatures, and humidity during a growing season in northern and southern Alberta. Seedling heights were measured every two weeks during the growing season. After one simulated season, the seedlings were placed in a cold room (4°C) for 12 weeks. After this chilling period, they were again placed into their respective growth chambers for a second simulated growing season. During both growing seasons, all seedlings were fertilized every two weeks. At the time of writing, final measurements have been made. Some seedlings of each source have been destructively sampled for dry weight, and others have been sampled for needle extracts. Separations of the needle terpenes are being conducted using thin-layer and gas-liquid chromatography. First-year results are presented below. Mr. Glen Dunsworth will report on the final results of these studies in his M.Sc. thesis this summer.

In addition to this material, open-pollinated seed was collected in 1975 and 1976 from 243 white spruces in 29 populations systematically selected to sample the various spruce sites and environments across Alberta. Progeny from most of these populations was sown in containers in the greenhouse last spring. The remaining populations, collected in 1976, will be sown in March. Material for this provenance-progeny test will be outplanted at two locations. This study has been supported by the Alberta Forest Development Research Trust Fund.

The following results and conclusions have been obtained from one year height growth data from the 27 Alberta Forest Service sources of white spruce. Height growth data was analyzed by analysis of variance. After one year there are indications of some genetic differentiation among the populations. There were significant ($P < .01$) differences among sources in each environment. In the southern environment, there was an inverse relationship between height of the provenances and latitude corrected for elevation (Wiersma, 1963). Northern sources generally grew more slowly than southern sources. The provenances representing elevational transects in the foothills exhibited the most direct relationship between height and corrected latitude. In three of the elevational transects (at latitudes of Pincher Creek, Calgary, and Hinton), sources from low elevations grew better than the high elevation source at each latitude. Only in the Grande Prairie area, with a relatively narrow elevational gradient, did the middle elevation source out-perform the low and high elevation populations.

In the northern environment, the latitudinal trend was not so apparent. Here, southern sources still tended to do better, but a source from extreme northwestern Alberta grew the tallest. Sources along the elevational transects exhibited almost the same relationships as they did in the southern environment, with the exception that the high elevation sources from the Hinton and Calgary latitudes grew taller than the middle elevation sources at the same latitudes. All of these results should be viewed with some caution; analyses of the second-year data should result in a clearer picture of the pattern of variation in height growth, along with other characters.

GENECOLOGY OF THE PAPER BIRCH COMPLEX IN ALBERTA

During 1975 and 1976, 20 populations of paper birch (*Betula papyrifera* Marsh.) and Alaska paper birch (*B. neoalaskana* Sarg.) were located and examined in an attempt to clarify the genetic, ecological, and morphological relationships between, and the validity of, these two confusing taxa. Various characteristics of the leaves, fruits, and pollen from 183 birches have been measured, and the data are being analyzed. Open-pollinated progeny from these birches have been raised in a uniform greenhouse environment and in controlled environments. Periodic height measurements and leaf measurements have been made. Mitotic and meiotic material was collected in an attempt to determine chromosome numbers of some of these trees. Leaf extracts of some of the birches will be analyzed this summer by gas chromatography. This study has been supported by a grant from the National Research Council.

NATURAL VARIATION OF TREMBLING ASPEN IN ALBERTA

In 1976, we collected root sections from 115 clones in 23 populations of trembling aspen (Populus tremuloides Michx.) across much of its forest range in Alberta. The province was divided into physiographic units and the populations selected to sample the different types of aspen sites in those units. Suckers from these root sections have been rooted, and the ramets grown in the greenhouse. As soon as we have sufficient material from all clones, some will be outplanted and tested at two to four locations and the remainder used for experiments in the greenhouse, growth chamber, and gas chromatograph. We have had serious problems with mortality during the propagation and rooting stages and hope to minimize these losses this year. This study has been supported by the Alberta Forest Development Research Trust Fund.

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FLOWERING PROMOTION IN THE PINACEAE

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In the last four years promotion of early and enhanced flowering in a number of Pinaceae species has become a reality through the use of certain of the less polar gibberellins, especially when applied with an auxin and with other cultural treatments such as water stress, non-destructive cambial girdling and nitrate fertilization. Especially effective are the mixture of gibberellin $A_{4/7}$, gibberellin A_9, alone, in combination with each other, and in combination with an auxin, napthalene-acetic acid. These successes with Pinaceae species follow two decades of steady progress by a number of workers (especially in Japan) whereby early and enhanced flowering in the Cupressaceae and Taxodiaceae could be readily induced by gibberellin A_3 (the most readily available gibberellin), as well as the less polar gibberellins (i.e. $GA_{4/7}$ and GA_9). However, for reasons not yet clear, Pinaceae species did not respond readily to GA_3 application by flowering -- in fact with few exceptions, GA_3 has been rather ineffective in Pinaceae species with regard to vegetative growth phenomena.

Research beginning some ten years ago with Drs. Lorne Ebell, John Rediske, S. Cade, S. Ross, and others began to correlate the flowering situation in several Pinaceae species with enhanced endogenous concentrations of "less polar gibberellins" (i.e. gibberellins with few or no hydroxyl groups which exhibit a non-polar chromatographic mobility), whereas a strictly vegetative situation in these same species was correlated with reduced levels of the less polar gibberellins and elevated levels of gibberellin A_3 (Douglas fir) and other "more polar gibberellins".

Field testing of certain of the less polar gibberellins began some five years ago, and collaborative experiments with various scientists throughout the world have shown success in flowering by gibberellin $A_{4/7}$ mixture in *Pseudotsuga menziesii*, *Picea abies* and *P. glauca*, and *Pinus contorta*. Independent studies by other workers have extended this success to *Picea sitchensis*, *Pinus sylvestris*, *P. taeda* and *P. radiata*. Gibberellin $A_{4/7}$ mixture has proven the most effective, especially in combination with an auxin (NAA), or in combination with gibberellin A_9.

Although flowering promotion in the Pinaceae by the use of certain plant hormones is now a reality, the technique is not a simple one. Additional cultural treatments (i.e. girdling, nitrate fertilization, water stress, root pruning, etc.) may be necessary on certain sites to enhance the effect of hormone treatment. Timing of application is important, and will vary with species and location. Mode of application can involve spray or injection techniques, but again will vary with site and species. A standard "cookbook" approach does not appear feasible at the present time, and each geneticist and seed orchard manager may have to design, with a physiologist collaborating, a sequence of trials to test the best hormone/cultural treatment combinations for each species on each site.

A BREEDING PROGRAM IN COASTAL DOUGLAS FIR (P. MENZIESII MIRB. (FRANCO))

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Plus tree selection in a program for improvement in Coastal Douglas fir was started for the B.C. Forest Service in 1957 by Dr. Alan Orr-Ewing and was continued until 1966 by which time a workable breeding population had been collected. Help was provided by the forest companies and the University of B.C. The selected trees were grafted into first level seed orchards and into the breeding clone bank at the Cowichan Lake Experiment Station. As male and female strobili appear it is possible to move into the more advanced phases of the program.

Although some buds appeared in 1966 and 1968 at Cowichan it was not until 1971 that enough clones produced strobili to make a start on the more applied side of the program. Some crosses were made in that year but following consultation with Dr. Gene Namkoong in 1972 when the options available for a long term program were discussed, a double-pronged approach has been adopted. Since then some pollinations have been possible in each year and the breeding program is moving ahead.

RECURRENT SELECTION PROGRAM

First priority has been given to a recurrent selection program in a population of selected trees from Coastal British Columbia and Northern Washington. Eventually about 350 trees will be involved and the project is designed to provide material and information from which future, reconstituted seed orchards may be developed. Its chief impact will be on the lower to middle elevation zones.

The objectives are:

(a) the production of progenies by crossing between selected plus trees and their establishment in test plantations for second generation selection.

(b) the estimation of genetic parameters to guide future breeding decisions.

(c) the study of the occurrence and importance of genotype by environment interactions so that the populations may be grouped effectively.

(d) the testing of the parents to permit some culling of the first seed orchards through a ranking of general combining ability.

A disconnected modified diallel mating design is being used and five crosses per parent should provide adequate information and yet represent a feasible project. Each cross will be represented in the field tests by almost 200 seedlings and the sites will be distributed to sample the range of coastal environments.

Each modified diallel comprises six parent trees taken in theory at random from the population and as reciprocal effects are being ignored for the present, the allocation of parents will depend on the available numbers of reproductive buds. In this way a completed diallel will contain 15 crosses. Groups of 5-10 of these diallels are being used in a single year of field testing and overlapping crosses will provide some control between years of planting.

RECIPROCAL RECURRENT SELECTION PROGRAM

The second approach has been loosely termed Reciprocal Recurrent Selection and is designed to follow up some of the encouraging results of Dr. Orr-Ewing's interracial crossing studies reported elsewhere. Here an incomplete factorial mating design is being used with two populations designated "Local" and "Exotic"; five crosses will be made with each parent brought into the program. The parents for the local population have been taken from Lower Coastal B.C. and Northern Washington as in the recurrent selection program while the "exotic" population is being drawn from some trees from the Northern British Columbia Coast (e.g. Bella Coola) and trees from Southern Washington, Oregon and Coastal California. The first crosses for this program were made in 1975.

PROGRESS

Since this project was outlined in the previous biennial report to the C.T.I.A., two series of plantations have been established in the field and stock for a third series is now growing in the greenhouse at Cowichan Lake.

In February, 1975, 177 crosses from ten diallels were sown in the greenhouse and raised as long-season styro-8 plugs for planting in the fall 1975 and spring 1976. (E.P. 708.03). The sites are spread from Harrison Lake to Gold River on the western side of Vancouver Island. Eleven sites have been used and although the original plan called for two replications of nine tree row plots per entry per site, the design has been changed to give four replications of four tree row plots per site. This design requires approximately 3 1/2 hectares per site and with the difficulties experienced in finding uniform areas of this size, a change to increase replications at the expense of plot size became desirable.

Crossing was continued where suitable buds were found and in 1976 a further 156 crosses were sown at Cowichan (E.P. 708.05). These consisted of five new diallels of the recurrent program, with which two, five by five factorials of the wider crossing program were included as although the analyses of the two programs will differ, the need to sample a full range of environments applies to both and the stock can be treated in the same field designs. This sowing also included a 10% sample of the crosses sown in 1975 to provide a tie between sites and years. A further eleven sites have been used for these crosses and while ten have been planted, the eleventh is in a heavily browsed area and 1+1 stock will have to be used. In this series, all sites have four replications of four tree plots.

Initial survival has been good with first year mortality about 3%. Locally severe browsing by rabbits, grouse and deer has increased this figure but all the dead trees have been replaced from spare stock. The small numbers of trees per cross makes this "beating up" desirable.

1976 proved a good year for reproductive buds on the clone banks at Cowichan Lake and a larger crossing program was carried out. It was then possible to sow another 165 crosses of the recurrent selection program in February 1977 and a further series of sites is being prepared.

Although early differences in growth may not be useful on their own, a contract has been given to Mr. Chio Woon to study and record variation of the crosses in the greenhouse and a report will be prepared. A record of early growth may prove useful for later studies of juvenile - mature correlation when field measurements are tabulated.

The aim of the program is to include about 350 trees in the parent population, and so the project will be continuing on a similar scale for several years yet. At present 144 selected parents are represented by growing seedlings.

A PROGENY TEST OF COASTAL DOUGLAS FIR

Before the long term program was drawn up, a balanced factorial progeny test involving four tester males and 26 selected plus trees was in process of establishment. A change of priorities led to a reduction in the effort that could be put into this project and the trees were only planted out in two test sites near Victoria and Cowichan. The trees were planted in fall 1973 and spring 1974 and are now established. Early measurements of height growth have been taken and are presently being analysed. These results will give experience in data handling and analysis procedures.

PROVENANCE RESEARCH BY THE BRITISH COLUMIBA FOREST SERVICE, 1975-76

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The broad objectives of provenance research in British Columbia are to guide seed transfer in reforestation, and to facilitate and complement tree improvement programs. Concomitantly, gene pool samples are being conserved in situ, in seed storage and in plantation archives (arboreta) for future genetic, educational and other scientific uses.

Genecological and seed source studies date from the mid-sixties and deal mainly with coniferous species of prime economic importance, viz. Douglas fir, Sitka spruce, lodgepole pine, white and Engelmann spruce and, more recently, western hemlock. The objectives, methods, extent and progress made in the most advanced of these studies, i.e. with the first three of these species, have been described (Illingworth, 1976a). A summary of activities and highlights of the past two years follows.

SITKA SPRUCE

Provenance research with this species includes participation in the International Ten Provenance Experiment, a study coordinated through the International Union of Forest Research Organizations (I.U.F.R.O.). On the basis of seed and seedling traits, the ten provenances fell into two main groups, within each of which trait variability was clinal and habitat-correlated. Significantly, the apparent discontinuity between groups coincides with the southern limit of late-Pleistocene glaciation and a physiographic barrier (Juan de Fuca Strait) restricting gene interchange. This coincidence should be considered when interpreting the pattern of geographic variation in Sitka spruce (Illingworth, 1976b).

Field trials of the Ten Provenance Experiment have been established at eight locations on Vancouver Island, the Queen Charlotte archipelago and in north coastal valleys. Phenological observations in these trials indicate that planted Sitka spruce commence shoot elongation early in May at northern locations, and that northern and inland provenances flush somewhat earlier, although less uniformly, then southern and littoral provenances.

Two years after planting, provenances differed significantly in height and suceptibility to cold injury. Predictably, the incidence and severity of cold injury increased sharply with elevation and with distance of test site from the open ocean, being most severe at 46 Mile, Nass Valley (32 percent) and at 6200 m, Maroon Creek, near Kitsumkalum Lake. At these locations, the geographic pattern of injury was strongly clinal with respect to latitude and distance of seed source from the ocean. Thus, the hardiest provenances were from Yakutat, Alaska, and the near-local Kitwanga, Skeena River (6 percent injured). An Oregon provenance suffered 100 percent severely to lethally injured. Damage to the Queen Charlotte provenance was only 14.8 percent, but among the Vancouver Island sources it ranged from 25 to 50 percent. Clearly, despite their attractive vigour, the unsuitability of these and American seedlots for reforestation in north mainland valleys is already apparent.

Thirty eight provenances, planted at five locations on the Queen Charlotte Islands, were assessed in 1976, three years after planting (six from seed). Still apparent is a tendency for height to vary inversely with latitude, altitude and distance of seed source from the outer coast, a pattern which was established in the nursery. However, regional groups of provenances show significant differences in vigour which, if continued, will substantially alter earlier rankings for height growth. For example, the three provenances from the Sechelt and lower Fraser Valley region, although initially tall, have grown significantly less than any other group. The Vancouver Island provenances continue to be the tallest, most vigorous group, closely followed by those from the Queen Charlotte Islands. The mid-Skeena and Nass River provenances have not continued their initial promise of high vigour (Illingworth 1976a) and, together with the Alaskan group, fall below average in height and growth. Examples of within-group variation are the consistently outstanding performance of the Usk Ferry (mid-Skeena) provenance and, within the Q.C.I. group, the significantly poor performance at all five test sites of the Copper River provenance.

DOUGLAS FIR

Test plantations ranging in area from one to ten ha have been established within the coastal Douglas fir zone. Completion of scheduled assessments during 1975 and 1976 bring to 27 the total number of plantations for which six year data (eight years from seed) are now available. Fifteen of these plantations are part of a series specifically designed to probe genotype x environment interactions and to delineate hardiness zones for Douglas fir. Each trial incorporates an identical set of five provenances from contrasting climatic zones, together with one or more local provenances. They were planted in a randomized complete block design with 35-tree line-plots in four blocks at each location.

In general, mortality has been low and differences among provenances were statistically significant at only one test location. Although consistent they were small (10 percent) and are not at present explainable. Mean tree heights and volumes varied markedly between test sites. However, substantial within-plot variation was encountered, and statistically significant differences among provenances were detectable at only 10 of the 15 test sites. Although the Hoh Valley (Wash.) provenance ranked first or among the best at nine of these 10 sites, the 'local' provenance was not statistically inferior to the best 'standard' provenance in seven out of ten cases. Indeed, at Chehalis and Quadra Island, the local provenances were outstanding. Exceptions were at Gold River, and Coal Harbour (Vancouver Island), where the local sources ranked below the plantation mean. In general, however, these early data provide little justification to depart from the current, conservative practice of using local seed when this is available.

LODGEPOLE PINE

In 1971, three-year old trees of 30 seed sources grown at two nurseries, Cowichan Lake and Red Rock, were planted in a split, randomized complete block design at two locations; Cluculz Lake in central British Columbia, and Negro Creek in the southeast part of the province (Illingworth 1975).

Six years after planting, these provenances differed very substantially in height and height increment, but not in mortality which was negligible. It is of particular interest to find that the effects due to nursery of origin, which initially had actually exceeded provenance effects, were no longer statistically apparent. Thus, provenance performance can be discussed without reference to nursery source.

Average height and growth at the two sites did not differ appreciably, although sites had a major influence in interaction with provenances. At Cluculz Lake, the most vigorous provenances appear to be the relatively local Ft. St. James, Puntchesakut Lake, Burns Lake and Punchaw Lake. At Negro Creek, the most promising are the mainly southern Cherryville, Trapping Creek and Marl Creek, also Kersley and Strathnaver although these and a few other more northerly sources performed relatively well at both locations.

In a more comprehensive experiment, third year data for 10 provenances planted at 60 test sites, which represent 12 broad latitudinal and climatic regions, are currently being analyzed. Despite extensive damage at some sites by rodents and ungulates, mean survival exceeds 90 percent. Regions differed substantially in mean plantation growth, the most vigorous plantations being in the Upper Fraser, followed by the Takla Lake, McKenzie and East Kootenay regions - regions for which 'plus' tree selections for clonal propagation and breeding have and are being made (c.f. Wheeler, N.C. _in_ Proc. 16th Meeting, Can. Tree Imp. Assoc. 1977). The phenotypic stability of the provenances varied markedly; some, such as Fly Hills, Nechako and Purden Lake ranked consistently high; others, such as ZigZag and Petersburg were consistently poor, while others varied strongly with site, e.g. Lower Post (Yukon - B.C. border) and Horne Lake (Chilcotin plateau). Similar patterns are also evident among overlapping sets of 50 provenances planted at these sites.

In coastal trials, geographic variation in the susceptibility of lodgepole pine to an unknown disorder was first observed in 1970, on 2-0 seedlings at Cowichan Lake. The damage comprises the chlorosis, distortion and stunting of needles and shoots. An investigation of its cause by R. Bowden-Green (B.C.F.S.) and Dr. R. Hunt (C.F.S.) showed it to be associated with an eriophyid mite *Trisetacus campnodus*, n. sp. (Keifer and Saunders, 1972). The problem has since been observed to occur widely in lodgepole pine plantations throughout coastal British Columbia, reaching serious levels among certain inland provenances. There is little doubt that it will necessitate a modification of plans to utilize the inland form of contorta pine on difficult sites in this region.

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COWICHAN LAKE EXPERIMENT STATION

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Routine work at the Station includes the raising of 100,000 seedlings annually for a variety of research projects and maintaining 75 hectares of clone banks and breeding arboreta.

The 1975-76 report on research projects follows.

GROWING MEDIA FOR CONTAINER STOCK (E.P. 779.01)

The effect of different types of peatmoss for raising container seedlings has been studied. Seedlings in this study were stored outside in the Styroblocks from late January until transplanting in mid May. Assessment in November revealed that seedlings raised in Queen Charlotte Island peat, a coarse peat with low degree of decomposition, were the best. These seedlings had superior root development and had significantly better height growth in the second growing season than other lots, such as Fraser Valley. After transplanting, seedlings on the coarse peat had developed roots from the whole plug, while on the finer peats, the root development had been largely restricted to the upper half or one third of the plug.

The conclusion is that seedlings raised on Q.C.I. peat had much less root dieback during winter storage.

ROOTED CUTTINGS IN YELLOW CEDAR (E.P. 750) (Chamaecyparis nootkatensis (D. Don) Spach)

A plantation was established at the Mission Tree Farm in October 1976 to compare the survival and growth rate of yellow cedar plants originating from seed and from rooted cuttings. Included in the test are (a) one year old seedlings which are compared with (b) one year old rooted cuttings established from material taken from trees of three different age groups. The seedlings and two of the cutting lots originate from the same seedlot and the plantation is located in the area where that seed was collected. This test is designed to compare growth performance of rooted cuttings and seedlings and indicate the best material for the reforestation of this species.

COMPATIBILITY TESTING OF ROOTSTOCKS (E.P. 648.02)

In March of 1976, 260 greenhouse grafts were made on one year old rootstocks from the more compatible families in the Douglas fir breeding program (E.P. 708). Following grafting however, the mortality of the rootstocks was high, probably due to drainage problems in the pots. Only 50% had survived in the fall. In November of 1976, 200 1+1 rootstocks from the same crosses were potted. Grafting on these took place in March 1977. An additional 300 grafts were made on 1+0 stock originating from a crossing program in 1975 which used clones then considered to be the most compatible in the Experiment Station clone banks. The graft unions of these three lots will be tested in the fall of 1978 or 1979 by the use of the micro-technique method. (Copes, 1967).

In 1976, following the compatibility screening of clones using the micro-technique method (E.P. 648.01), 38 successful crosses were made on the 10 best. Seed from these crosses and four seedlots obtained from Cornvallis, Oregon from Dr. Copes' most compatible crosses were sown in the greenhouse in February 1977. These seedlings will be transplanted in the fall of 1977 and grafted onto in the spring of 1979. The graft unions from these rootstocks will be tested for compatibility in the fall of 1980.

GROWTH RATE OF DOUGLAS FIR GRAFTS ON DIFFERENT UNDERSTOCK (E.P. 648.03)

In March of 1976, a study of the effects of rootstock origin on scion growth was started. Twenty-five rootstocks from each of nine provenances were grafted onto with scions from 25 different coastal plus tree clones. The rootstock provenances were selected to cover coastal, transition and dry interior types. The grafting was successful with 94% survival after one year. Height growth assessment of the scion in the fall of 1976 showed significant differences between the rootstock sources, with grafts on Colorado understock being the shortest and on Vancouver Island stock the tallest. Some of the grafts produced reproductive buds in the spring of 1977. Grafts on stock from the dry interior zone had significantly more flower buds than other rootstock sources. Should these grafts, particularly on Colorado understock prove to be compatible, and not affected by Rhabdocline, they may in time offer an alternative type of graft for the coastal Douglas fir which is slow growing and early cone producing.

FLOWER STIMULATION (E.P. 780.02)

Various treatments have been used in an attempt to increase cone production in the Douglas fir clone banks. The treatments employed were: root pruning, root pruning + potting, girdling and enclosing ramets in plastic tents. The root pruning of 7 to 12 year old grafts using a Vermeer Tree Spade was the most promising, since this treatment caused no mortality during the first year following treatment. In addition, it gave the highest percentage of cone producing ramets. Lifting the ramets and placing them in pots gave a response similar to root pruning by itself. However, some mortality occurred the first year in this treatment. Different types of girdling produced relatively more male buds per tree than any other treatment. Girdling however, weakens the stem, and some breakage from wind and snow has occurred. In mid May of 1975, some ramets were enclosed in plastic tents in order to increase the temperature during the period when reproductive bud initiation occurs. There was no response to this treatment.

At time of cone collection in the fall of 1976 it was found that the cones were generally smaller on the root pruned trees than on the control. This also was true for the cones produced on girdled trees. As shown in the table, root pruning and girdling increased cone production, but had very little affect on filled seed per cone.

Treatment	No. of ramets treated	Percent cone producing ramets	Cones per ramet	Filled seeds per cone
Root pruned Oct. 1974	88	70	135	29
Control	88	12	24	32
Girdled May 1975	47	51	188	30
Control	47	13	39	32
Plastic tent	6	0	-	-
Control	6	0	-	-

SUPPLEMENTAL POLLINATION IN DOUGLAS FIR (E.P. 780.04)

Supplemental pollination or pollen boosting on an operational scale was done on 16 clones in the clone banks at Cowichan Lake Experiment Station in 1976. Large quantities of pollen were obtained by raking off the buds using a vacuum cleaner and then extracting the pollen in a heated room. The pollen was blown over the trees with a power sprayer equipped with a dusting attachment. On the average, the seed yield was increased by 21%, and the seed estimated to originate from boosting pollen averaged 61% for low elevation clones and 29% for the high elevation ones. Phenological differences and time of application account for this contrast. This increase in seed set is satisfactory, particularly since seed yield from open pollination was generally high in the area in 1976. Figures of seed originating from boosting pollen are encouraging, but could be improved by closer monitoring of boosting in relation to receptivity of flower buds.

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IMPROVEMENT OF WHITE AND ENGELMANN SPRUCE COMPLEXES OF BRITISH COLUMBIA

PROGRESS REPORT*

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The objective of this project is the production of genetically improved seed of white - and - engelmann spruces (Picea glauca (Moench) Voss and P. engelmanii Parry respectively).

Progress of our project is proceeding reasonably close on schedule. In anticipation of our large-scale controlled crossing program we commenced establishing two breeding arboreta in the Okanagan Valley. One of these breeding arboreta, which eventually will contain our permanent breeding centre with offices, laboratories, and greenhouses, is in the city of Vernon established in a 10 hectare plot. At this site four ramets will represent each of our selected families. In addition to these families we are establishing another Picetum for eventual use in interspecific crosses. It will also be invaluable for educational purposes.

The second breeding arboretum is established east of Enderby on a Research reserve near Trinity Creek. Six additional ramets of the same families that were planted at the Vernon site will eventually be established in this breeding arboretum. Presently only a fraction of the total number of grafts is planted due to shortages of grafts in many families. Grafting for the arboreta is going to continue until both arboreta are filled.

Spacing at both sites is 5.5 x 5.5 meters. The Vernon arboretum is at a lower elevation (about 460 metres above sea level) and in a drier climatic regime than that of the Trinity Creek one. For this reason irrigation of the Vernon arboretum will be necessary. We are planning on using treated sewage water supplied by the city of Vernon for this purpose. We assume that no irrigation will be necessary for our Trinity Creek arboretum. Since this site is about 570 metres a.s.l. and in a much higher snow fall area we anticipate that trees in this arboretum will commence bud burst at a later date in the season than trees on the Vernon site. This will permit us to stagger our workload in the busy spring season and increase the amount of crossings that can be done each year.

*Previously reported in: Proceedings of 12th, 13th, 14th, and 15th meeting of CTIA (and CFTBC).

The clone banks established at The Red Rock Research Centre near Prince George will be maintained for extra protection against losses. During the summer of 1975 a small scale experiment employing various hormone treatments to induce flowering was carried out on selected families of this clone bank by Dr. R.P. Pharis with encouraging results.

Seven replications of the open pollinated progeny trials for the Smithers selection unit families (about 12,000 seedlings) have been measured during the fall of 1976 after three growing seasons in the field. The rest of the seedlings are slated for measurement in the spring of 1977 before active growth commences.

The *Piceta* at Chilliwack and Red Rock continue making excellent progress. Some individuals of Sitka and Norway spruces at Chilliwack surpassed 4 meters in height.

SEED PRODUCTION PROGRAM

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INTRODUCTION

Since the Crown controls 93 percent of the productive forest land in British Columbia, the Forest Service has an overriding responsibility to see that adequate supplies of quality seed are maintained. With the recent expansion in artificial regeneration mainly by planting, this need has become critical. To meet this need a seed production section has been set up in the Reforestation Division with the following objectives:

1. to ensure procurement of sufficient seed from natural stands and to provide technical guidance and training assistance to enable improvement on the overall quality of seed from natural stands,

2. to process, test, register, store, and maintain an inventory of all seed and prepare for use in nurseries, direct seeding, and other purposes,

3. to establish first phase seed production orchards either by grafting of scions or use of seedlings from selected high quality parent trees to produce regular supplies of seed with higher germinative vigor and wide adaptability,

4. to review, integrate and control, and provide technical guidance to company programs which are on an approved forestry cost basis[1/],

5. to establish second-phase seed orchards from progeny tested breeds of proven superior genetic quality produced by the tree improvement program of the Research Division.

Currently a proposal requesting support for an expanded and cooperative Government-Forest Industry Tree Improvement Program is underway. The proposal will be submitted to Government in order to obtain the much needed financial commitment and support for a long-term Tree Improvement Program.

1/

Forestry Costs - on certain forest tenures or licences to harvest timber on Crown lands management functions such as reforestation (e.g. seed procurement and seed production) have been delegated to the licensee. The term "forestry costs" refers to specific forestry projects approved (by the Forest Service) and the costs incurred for undertaking such projects are reimbursed to the licensee. Forestry costs do not include operational costs involved in timber extraction.

The following is a very brief summary of seed production program activities in 1975 and 1976.

1975 SEED PRODUCTION ACTIVITIES

A total of 1216 kg of seed was withdrawn from storage and sown in forest nurseries throughout the province. This sowing should produce 77,400,000 trees for replanting logged-over lands.

4868 hectolitres of cones were processed at the Duncan Seed Extraction plant. A light-medium spruce cone crop occurred throughout the central interior regions.

The tree seed register data was placed in computer and the resulting variety of listings are valuable for planning and operations purposes.

Seed production orchard activities continued during 1975. On the coast a 7.2 hectare Douglas fir orchard was established in Saanich. In the central and southern interior zones, selection of parent trees and propagation of stock was continued for development of orchards.

1976 SEED PRODUCTION ACTIVITIES

Seed Centre Activities

A total of 1106 kg of seed was withdrawn from seed storage for use in forest nursery sowings. These sowings will produce approximately 80,000,000 trees.

The extraction plant at Duncan processed 4587 hectolitres (12,614 bushels) of cones which yielded 3040 kg of seed. A mobile seed extraction unit, to regionalize seed extraction capability, is scheduled for delivery early in 1977.

Seed Orchards

Development activities were continued which include parent and/or plus tree selection, collection of propagating materials from selected trees and propagation of stock for orchard and clone bank establishment. The major species included in the program currently are: coastal Douglas fir and hemlock and Interior spruce and lodgepole pine.

In the interior, spruce orchard development activities were continued to establish orchards to produce seed for the Smithers area and the Thompson-Okanagan area.

A total of 8320 grafts were completed at the Skimikin Nursery to produce orchard stock for the above areas.

A safety plan in the use of helicopters to collect propagating material has been prepared through inputs of various agencies, including the Workers' Compensation Board. This procedure should expedite this particular phase of seed orchard operations.

The coastal Douglas fir seed orchards have begun to produce significant amounts of improved seed for use in the reforestation program. A total of 104 hectolitres (290 bushels) of cones were collected from four seed orchards (two Forest Company and two B.C. Forest Service) located on the southeast coast of Vancouver Island. This amount represents enough seed to produce 2,900,000 trees. The 1976 cone crop on seed orchards was heaviest in the Saanich Peninsula, confirming the importance of orchard location in seed production management. Selection and propagation of western hemlock plus trees for the coastal area was continued and further planning for seed orchard development was done.

SUMMARY OF SEED ORCHARDS

A summary of the seed orchards established as of July 1976 is shown in Table 1. The seed orchard seed utilization area can be delineated on the Forest Tree Seed Zones map of British Columbia in Figure 1.

To achieve objective (3) stated previously, three administrative zones have been established to date. A seed orchard forester is assigned to plan and supervise developments and manage seed orchards in each zone. One is located at the Koksilah Nursery at Duncan on Vancouver Island to serve the south coastal area, another at the Skimikin Nursery near Salmon Arm to serve the southern interior regions and the third at the Red Rock Nursery near Prince George to serve the Central Interior Regions.

TABLE 1 - SUMMARY OF SEED ORCHARDS
ESTABLISHED IN PROVINCE OF B.C. (as of June, 1977)

Seed Orchard No.	Agency	Date(s) Est. i.e. Graft'd or planted	Orchard Location	Spp.*	Seed Orchard Seed Utilization Area Seed Zone	Elev. Band (m)	Type of Orchard	Present Orchard Size/ha
1	B.C.F.S.	1963	Campbell R.	Df	1020	450-610	Clonal + Seedlings(O.P.+C.P.)**	6.6
2	Tahsis "A"	1962-69	Gold R.	Df	1010	0-450	Clonal	2.2
3	B.C.F.P.	1963-64	Caycuse	Df	1010-1020	400-660	Clonal	1.8
4	C.Z.	1964-65	Courtenay	Df	1020-1030	0-450	Clonal	1.8
5	C.Z.	1964-65	Nanaimo L.	Df	1020-1030	450+	Clonal	1.8
6	Rayonier	1964-65	Gordon R.	Df	1010-1020	450	Clonal	4.1
7	Tahsis "B"	1964-68	Gold R.	Df	1010	450+	Clonal	1.8
8	Tahsis Local	1968-75	Gold R.	Df	1010 Nootka PSYU only.	0-910	Clonal	2.3
9	Pacific Log.	1966	Saanich	Df	1020	0-450	Clonal + Seedlings(O.P.)	1.8
10	Pacific Log.	1966	Saanich	Df	1020	550	Clonal + Seedlings(O.P.)	3.4
11	Tahsis "C"	1968-75	Saanich	Df	1010 Low Coastal	0-450	Clonal + Seedlings(C.P.+O.P.)	4.9
12	Rayonier	1968	Jordan R.	Df	1010-1020		Seedlings(O.P.)	0.4
13	Rayonier	1969	Pt. McNeill	Df	1010-1020		Seedlings(O.P.)	0.4
14	B.C.F.S.	1970	Duncan	Df	1040,1050 1060	450-640	Seedlings(O.P.)	4.5
15	B.C.F.S.	1971	Campbell R.	Df	1030	0-300	Seedlings(O.P.) + Clonal	4.9
16	C.F.P.	1971	Sechelt	Df	1020	450-610	Clonal	8.2
17	Tahsis	1969-70 1970-75	Gold R. Gold R.	Hw Hw	1010 1010	0-910 0-910	Clonal and Seedlings(O.P.)	3.7
18	Tahsis	1973	Saanich	Ss	1010	0-450	Clonal	0.8
19	B.C.F.S.	1974	Red Rock	Pl	6050-6060		Clonal	4.1
20	B.C.F.S.	1975	Saanich	Df	1050,1060 1070	760-1070	Seedlings(O.P.) + Clonal	7.4
21	Pacific Log.	1976	Saanich	Df	1020	550	Seedling(C.P.)	6.0
							TOTAL	72.9 ha

* Df = Douglas fir
Hw = Western Hemlock
Ss = Sitka Spruce
Pl = Lodgepole pine

** O.P. = seedlings resulting from open pollination
C.P. = seedlings resulting from controlled pollination

Note: Pacific Logging Seed Orchards are for reforestation in Private Lands.

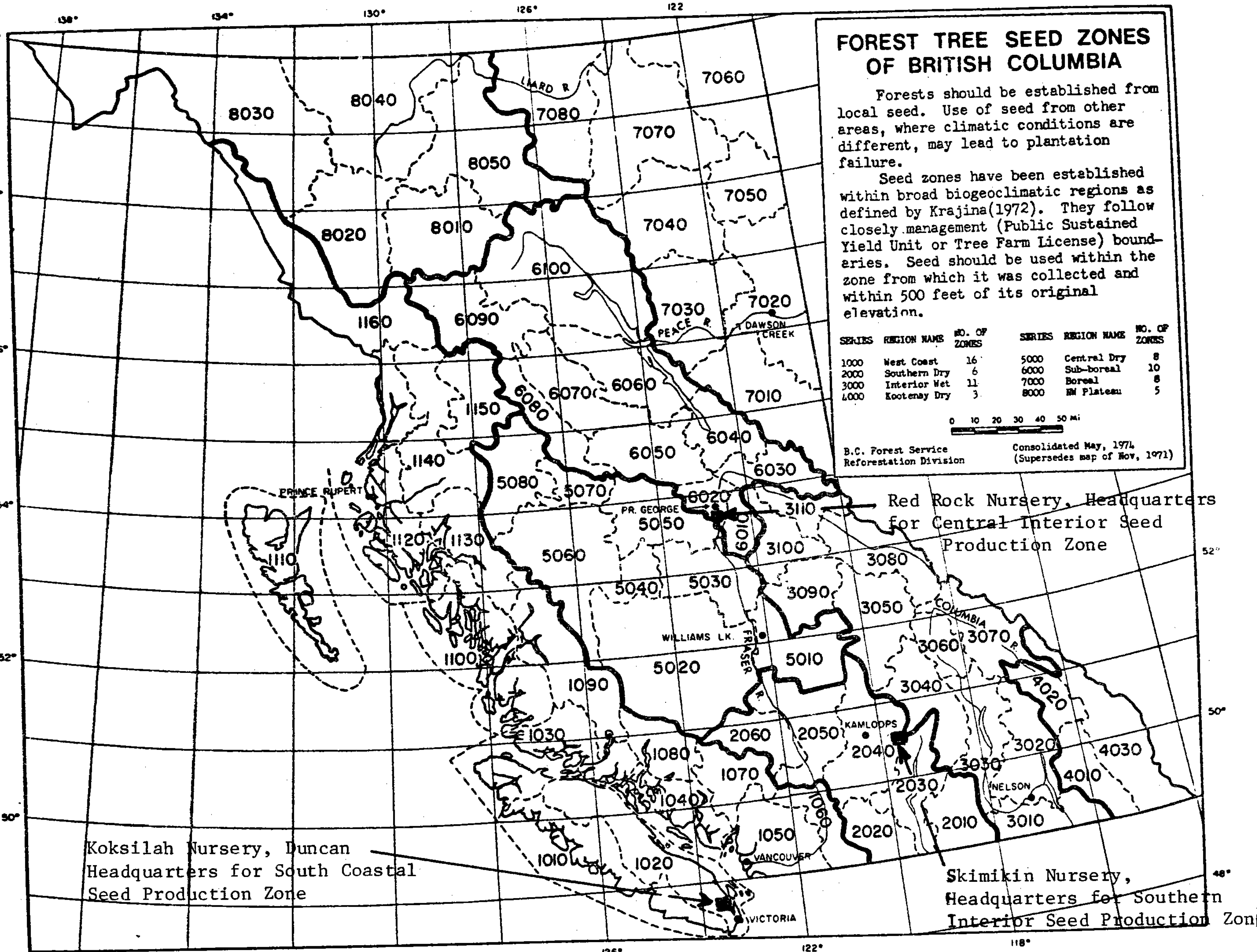

Figure 1. Forest Tree Seed Zones of British Columbia.

C.T.I.A. BIENNIAL PROGRESS REPORT

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Following identification of western hemlock as a major species for coastal reforestation in 1975 a B.C. Forest Service position to plan and direct a breeding program in that species was created in 1976. Selection of good phenotypes began many years ago, but most of the 313 trees selected to date have been chosen and propagated since 1966. Further selections are planned from both industrial and Crown lands and all trees, including some from the northern U.S., will be candidates in the breeding program. Provenance studies will be included.

Close cooperation will be maintained with the hemlock genetics programs of the Canadian Forestry Service, Victoria and of other Canadian and U.S. Agencies.

BREEDING *PSEUDOTSUGA* IN COASTAL BRITISH COLUMBIA

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RACIAL CROSSES WITH DOUGLAS FIR

It is hoped that the results to date of the racial crossing program will be published shortly. The last measurements were completed in early spring 1976 and the analyses are now being made. The calculations for volume have been changed from the 1965 report as a more accurate method developed by Kovats (1977) has been devised. In brief, the results have been variable but it is already evident that the best of the racial crosses exhibit both superior height and diameter growth on the more productive test sites. Survival has varied widely from test site to test site, the major cause for mortality being from such pathogens as *Rhizina undulata* Fr., *Armillaria mellea* (Vahl ex Fr.) Kummer and *Phellinus weerii* (Murr.) Gilb. These pathogens which attack the root systems of both young and older trees are a serious problem in second growth Douglas fir and the situation is aggravated by the monocultural system practiced in the Douglas fir region. There have been some problems with defoliation by the needle cast disease, *Rhabdocline pseudotsugae* Syd. but these have been specific for certain crosses. The major problem is undoubtedly the root rot fungi which appear to be non-specific in attack and worse on some test sites than on others. There is an urgent need for much more research on these fungi as they can completely disorganize progeny testing. It is indeed possible that resistance to their attacks may have to be included in future breeding on the coast.

INBREEDING STUDIES WITH DOUGLAS FIR

A summary of the inbreeding arboretum at Lake Cowichan is being prepared. Two papers "Inbreeding Douglas Fir to the S_3 Generation" and "Female Sterility in Douglas Fir" have been accepted for publication in Silvae Genetica and should appear shortly.

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THE LODGEPOLE PINE IMPROVEMENT PROGRAM IN BRITISH COLUMBIA

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Keywords: Lodgepole pine, selection, flower induction

INTRODUCTION

Since the assignment, in 1975, of a full-time breeder to lodgepole pine, considerable effort has been made to formulate a comprehensive working plan for a long-range, tree-breeding program. Extensive field operations during the last 2 years have provided the initial parent-tree selections for the establishment of a breeding population. Three related support studies intended to elucidate the effect of cultural treatments on flower induction and enhancement are presently underway.

The natural range of lodgepole pine includes almost the entire province of British Columbia. The species grows across a wide gradient of environments, from xeric interior plateau to hydric, coastal muskegs. Lodgepole from the interior of B.C. (Pinus contorta ssp. latifolia (Englemann ex Watson)) is by far the most economically important pine in the province. In 1975, lodgepole pine ranked third in B.C. in total volume harvested, just behind the spruces and hemlocks and ahead of Douglas fir. Almost 3 million cunits of lodgepole are being cut annually.

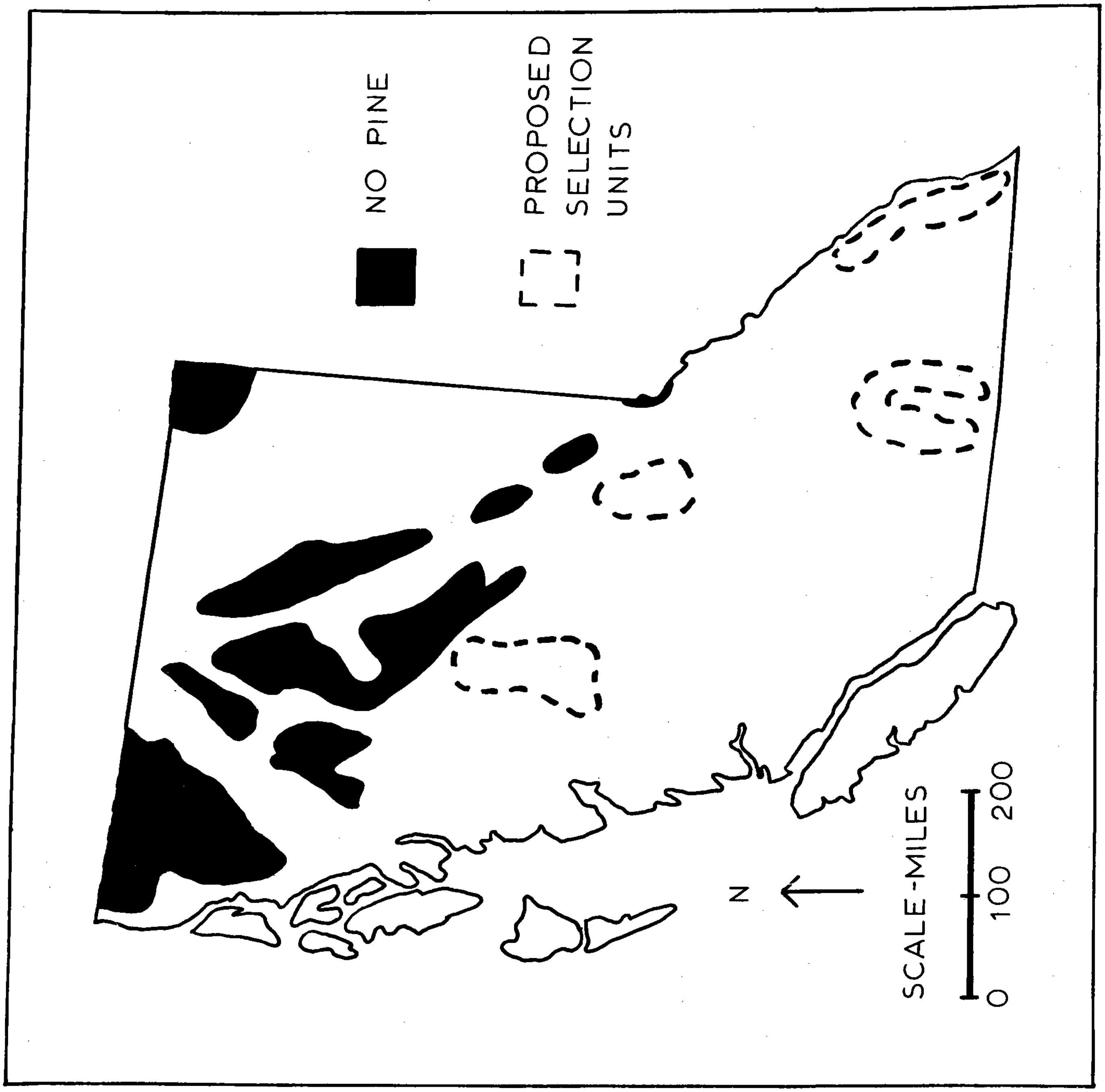
SELECTION UNITS

Four selection units, or geographical regions in which parent-tree selections are concentrated, have been delineated within the province (Figure 1). In general, these selection units represent semi-mountainous, wet transition zones with relatively high site productivities. In contrast to the dry plateau country of B.C. where natural regeneration of pine is normally abundant after harvest, these areas often require planting for proper reforestation. In addition to meeting certain bio-geo-climatic restrictions, the selection units represent areas in which economic development of the forest resource is relatively advanced.

PARENT-TREE SELECTIONS

Over 300 parent-tree selections have been made in the 2 northern selection units. A relaxed, roadside selection method has been employed. Work was concentrated in uniform, even-age stands of pine to eliminate environmental bias as much as possible. The majority of

Figure 1. Lodgepole pine selection units delineated within British Columbia.



selections have been made in stands of rotation age and younger (40 to 120 years). Under these conditions, the identification of superior phenotypes is remarkably easy.

Selection criteria are weighted with emphasis on volume production. Height superiority is our first consideration. Diameter superiority, although closely correlated with height, is not given equal importance because of our inability to quantify the historic influence of stand density on stem diameter. This influence can be considerable in stands with 2500-5000 stems per hectare at establishment. Relatively narrow crowns with fine branches are favored although a wide variety of crown forms have been incorporated in the selections to maintain a broad genetic base. Observations indicate that variation within stands of lodgepole pine is substantial. If heritabilities for growth characteristics are even moderate, considerable genetic gain should be obtainable in the first generation of selection.

Selection in the 2 southern areas of the province will commence this field season and should be completed by early 1978. It is anticipated that the working breed population will number between 600 and 1000 by 1980.

CLONAL ORCHARDS

Preparations have been made to establish the first breeding orchard in May, 1977. A first-phase clonal seed orchard of the same materials will be established the following year on a nearby site. Both orchards will be maintained at the Red Rock Forest Reserve near Prince George, B.C. Additions will be made to the breed orchard every year until the projected date of completion around 1980. Clones will be represented in the orchard by 10 ramet, line plots, designed to facilitate ease of access and location. Additional grafted materials will be maintained in separate clone banks to ensure against natural and man-caused disasters.

RELATED SUPPORT STUDIES

Two studies have been initiated, with the cooperation of Dr. Richard Pharis, to determine the influence of exogenous applications of gibberellins on flower induction and enhancement in grafts and seedlings of lodgepole pine. Applications of GA 4/7 to expanding terminal buds of grafts at 10 day intervals between May and August were made to determine whether flower production on mature grafts could be enhanced. Although statistical analyses are not completed, large differences in flower production existed between treated and control ramets and among treated clones. A second study, using 7 year-old seedlings, commenced in 1976. Girdled branches were treated with auxins and gibberellins throughout the summer. Applications were made with an atomizer to terminal branch buds. Results will be gathered in the spring of 1977.

A third study, designed to shorten the juvenile period of growth and promote precocious flowering in lodgepole pine seedlings, is presently underway. The inspiration for the study came from the varied success of Young and Hanover (1976) working with Picea species.

Wind-pollinated seed from 8 selected trees were sown in January of 1976 and grown under 24-hour photoperiods for 6 months. Artificial lighting was supplied by several banks of VHO fluorescent tubes, providing 700 to 1,000 foot-candles of light. Control replications of the same experiment were established in the nursery the following spring. Grafted materials from the 8 selections were grown under the lights and under control conditions during the same period. Seedling growth rates were dramatic, averaging 30 cm after 6 months of growth. The tallest seedlings were nearly 50 cm in height, having set buds and flushed several times. The most important practical result, however, was obtained not with seedlings but with grafted materials. Grafting success was nearly 25% greater for material grown under lights than for control-grown plants. In addition, accelerated grafts grew, on the average, 3 cm longer than control grafts. A number of newly-grafted scions grew over 15 cm in length in 6 months under continuous light. Performed on a large scale (1,000 grafts), a success differential similar to the one experienced in our trial would mean a savings of around $2,500 per year. Consequently, a production grafting program has been set up under lights at Red Rock this winter.

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POPULATION AND QUANTITATIVE FOREST GENETIC STUDIES IN BRITISH COLUMBIA 1975-76

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This report describes recent tree improvement activities that served to supplement the established genetic programme of conifer species in the Province of British Columbia. Aspects related to juvenile-mature relationship and to population structure in Douglas fir (*Pseudotsuga menziesii* (Mirb) Franco) are being examined.

EXPECTED GENETIC GAINS UNDER EARLY AND LATE SELECTION

In tree improvement programmes, if costs are to be reduced, and if improved breeds are urgently needed to increase the economic potential of production forests on a practical scale, it is worth investigating procedures which can reduce the duration of field testing.

Theoretical consideration on genetic gains, using the concept of direct to indirect selection (Falconer 1960), indicated that substantial genetic gains could be experienced in late stages of a testing programme even when selection was practised at the early stage. The necessary and sufficient conditions were: - (1) that the genotypic heritability estimates at early stage (h^2_{G1}) was much greater than late stage (h^2_{G2}) and/or (2) that the genotypic correlation (r_{G12}) between early and late performance was high. Gains for the ratio of early to late selection for varying combinations of h^2_{G1}/h^2_{G2} and r_{G12} were simulated (Table 1).

Table 1. Ratio of expected genetic gain at early to late selection when the selection intensity at the two stages are identical.

r_{G12}	h^2_{G1} / h^2_{G2}			
	2	3	4	5
1.00	1.41	1.73	2.00	2.24
0.80	1.13	1.39	1.60	1.79
0.60	0.85	1.04	1.20	1.34
0.40	0.57	0.70	0.80	0.90
0.20	0.29	0.35	0.40	0.45

In practice, most traits in testing populations experienced a reduction in genotypic heritability as they become older due to increasing field experimental error. Thus, the practical values of early selection should be thoroughly evaluated, especially when considering genetic gains per unit time.

Estimates of genotypic heritability and correlation in early and late stages are being collected for testing populations in British Columbia. The implication and bearing of these estimates on future breeding alternatives and designs will be evaluated.

APPLICATION OF GEL ELECTROPHORESIS IN FOREST GENETICS RESEARCH

The study of genetic variations at the enzyme level provides an option in identifying and using population subdivisions for present and future breeding alternatives, and provides the opportunity for wider use of correlated trait breeding and for quantifying population and trait architecture (Yeh 1976).

To date, several enzyme loci have been identified and their inheritance pattern determined in Douglas fir (Pseudotsuga menziesii (Mirb) Franco.). Results of a study from 2,400 genotypes to estimate population parameters such as inbreeding and random genetic drift in natural population of coastal Douglas fir has been reported (O'Malley and Yeh 1976). Further analyses based on 4,800 samples and descriptions of enzyme systems used in Douglas fir will be published shortly.

Other continuing activities in gel electrophoretic research included (1) studies on the possible association between enzyme loci and quantitative traits of economic value and (2) studies to provide data for use at the provenance taxonomic level.

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TREE SEED RESEARCH, PACIFIC FOREST RESEARCH CENTRE, B.C.

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Keywords: germination, prechilling and compound stratification, cone crops, cone collection and handling, seed sorting.

The program of seed research at the Pacific Forest Research Centre has expanded since 1969, to 12 on-going seed studies involving 10 scientists; problems ranging from enhancing cone crops to improving the use-efficiency of seedlots, of cone and seed insects and major diseases, are covered. In 1970 the OECD Seed Certification scheme was implemented in B.C. under the leadership of R.F. Piesch whose detailed progress report can be found elsewhere in these proceedings. Since several reports have already been published only highlights will be presented here.

WESTERN HEMLOCK

With the advent of container nurseries, additional information on the germination requirements of western hemlock (Tsuga heterophylla) was required, and studies were begun in 1969. Although western hemlock seeds cannot be considered dormant, they respond to prechilling (stratification) and this pretreatment is almost obligatory for nursery sowing. Prechilling increases germination rate but has not been found to affect germination capacity in B.C. seedlots; germination of prechilled seeds is not only more rapid, but is also more dependable and uniform.

Western hemlock is also light sensitive, although the responses are smaller than those brought about by prechilling. Similarly, light is not essential for hemlock germination, but there is a slight stimulatory effect on rate when photoperiods of less than 8-h duration are used. Photoperiods longer than 8-h depress germination rate, and under continuous light germination is incomplete after 4 weeks. Germination is better under fluorescent, rathern than fluorescent-incandescent sources, especially at intensities of 1000 lux. Higher light intensities, even from fluorescent lamps, tend to slow germination down. All the earlier work was conducted at a constant 20°C, as recommended in the international seed testing rules, but our latest results indicate faster germination in prechilled seeds at 25°C. Below 20°C, germination rate is approximately halved for each 5° drop in temperature, i.e. it takes twice as long to reach 50% germination at 15°C than it does at 20°C.

YELLOW CEDAR (OR CYPRESS)

Pretreatment requirements for yellow cedar (Chamaecyparis nootkatensis (D. Don) Spach) have been under investigation since 1972. In a first series of tests, unpretreated seeds germinated 31% after 15 months, while seeds prechilled for 4 months gave the "best" germination of 38% after 12 months. More than 30 combinations of warm and cold treatments have since been tested; some of the results, based on a 16-week germination test period, are shown in Table 1.

Table 1. Effect of prechilling and compound stratification on yellow cedar germination.

Seed Pretreatment[2/]	Germination Percentage[1/] --weeks of germination test-- 4	8	12	16	Total germination[3/]
Unstratified	0	0	0	0	0
2MC	0	0	0	0	0
4MC	0.5	0.75	1.25	2.75	3.25
6MC	0.25	0.25	0.75	0.75	2.5
8MC	0.75	1.0	1.50	1.50	2.5
10MC	0	0	4.0	10.0	30.25
1MW	0	0	0	0	0
1MW + 2MC	6.5	8.0	8.25	10.25	24.75
1MW + 4MC	6.0	6.75	7.75	7.75	65.25
1MW + 6MC	77.25	77.75	78.5	78.75	79.75
1MW + 8MC	28.75	30.5	33.75	33.75	72.75
1MW + 10MC	3.5	4.75	5.25	5.25	69.0

1/ Normal germinants only.

2/ MC - months' of cold (1-4°C) stratification.
MW - months' of warm (30°C) stratification.

3/ Includes abnormal germinants (as defined by the International Seed Testing Rules, 1976).

Combined treatments greatly stimulated germination in all instances although a considerable quantity of abnormal germinants occurred after prechilling for shorter and longer than 6 mo. Work is continuing to determine the optimum combination of treatments and the retention of viability in stored seeds. Seeds stored at approximately 4°C showed a 5% loss in germination after 1 year.

Studies have also been conducted on the feasibility of producing reforestation stock from rooted cuttings. Using 2 to 5 year-old seedlings, cuttings have rooted well without hormone treatment; the time of year (January, August or December) of taking the cuttings has not been found to be critical.

WHITE SPRUCE

In 1973, a good cone crop year, a study was initiated (conjointly with Dr. R.C. Dobbs) to study the effects - on both seed germinability and seedling growth - of time of cone collection, cone storage conditions and seed pretreatment for B.C. sources of white spruce (*Picea glauca* (Moench) Voss). Collections were made (by climbing) from 4 study trees, on August 1, 15 and 29, and September 12 and 26 (by which time natural seedfall had begun). Cones were shipped in ice to the laboratory where they were processed promptly and germination tests initiated. All trees responded to date of collection and to cone handling in an almost identical manner. The responses for one study tree are shown in Figure 1. Manual extraction (ME) of seeds from green cones was used as a base-line for comparison of other cone handling procedures since it represented, as near as possible, germinability at the time of collection. Prechilled (3 wk at 2-4°C) seeds collected on the 1st and 15th of August germinated, 35% and 79%, respectively. Progressively later collections produced increasing germination with prechilled seeds germinating 10 - 13% higher than their unprechilled counterparts. Prechilled seeds from air dried cones (2 wk at room temperature) germinated 94 - 97% irrespective of collection date. When green cones were placed in a 40°C oven for 2 wk, then refrigerated at 1°C for 5 wk, unprechilled seeds from cones collected on August 29 survived the treatment relatively well and germinated 47%. Prechilled seeds from heated-refrigerated cones germinated over 95% for the last four collection dates. Storing cones under cool (10°C) ventilated conditions for 7 wk produced large increases in germination with unprechilled seeds from cones collected on August 1st germinating 58%; prechilled seeds of this collection date germinated 85%, while prechilled seeds from the last 4 collection dates germinated 96 - 98%.

The results indicate that white spruce seeds may be collected up to 4 wk prior to natural seedfall and that good germination can be obtained regardless of cone handling procedure provided the seeds are prechilled. Later cone collections are less sensitive to cone handling treatments but continue to benefit from cool cone storage.

Normal germinants from unprechilled seeds from one study tree were potted-up into a 3:1 peat: vermiculite medium and cultured under 16-h "days" at 24°C and "nights" at 16°C. Light intensity (incandescent and fluorescent) totalled 20k lux. After 17 wk, seedling sizes varied significantly among collection dates and cone storage treatments. In general, the largest seedlings were obtained from seeds collected mid-August to mid-September. Seeds manually extracted (ME) immediately upon cone collection produced significantly larger seedlings in terms of all

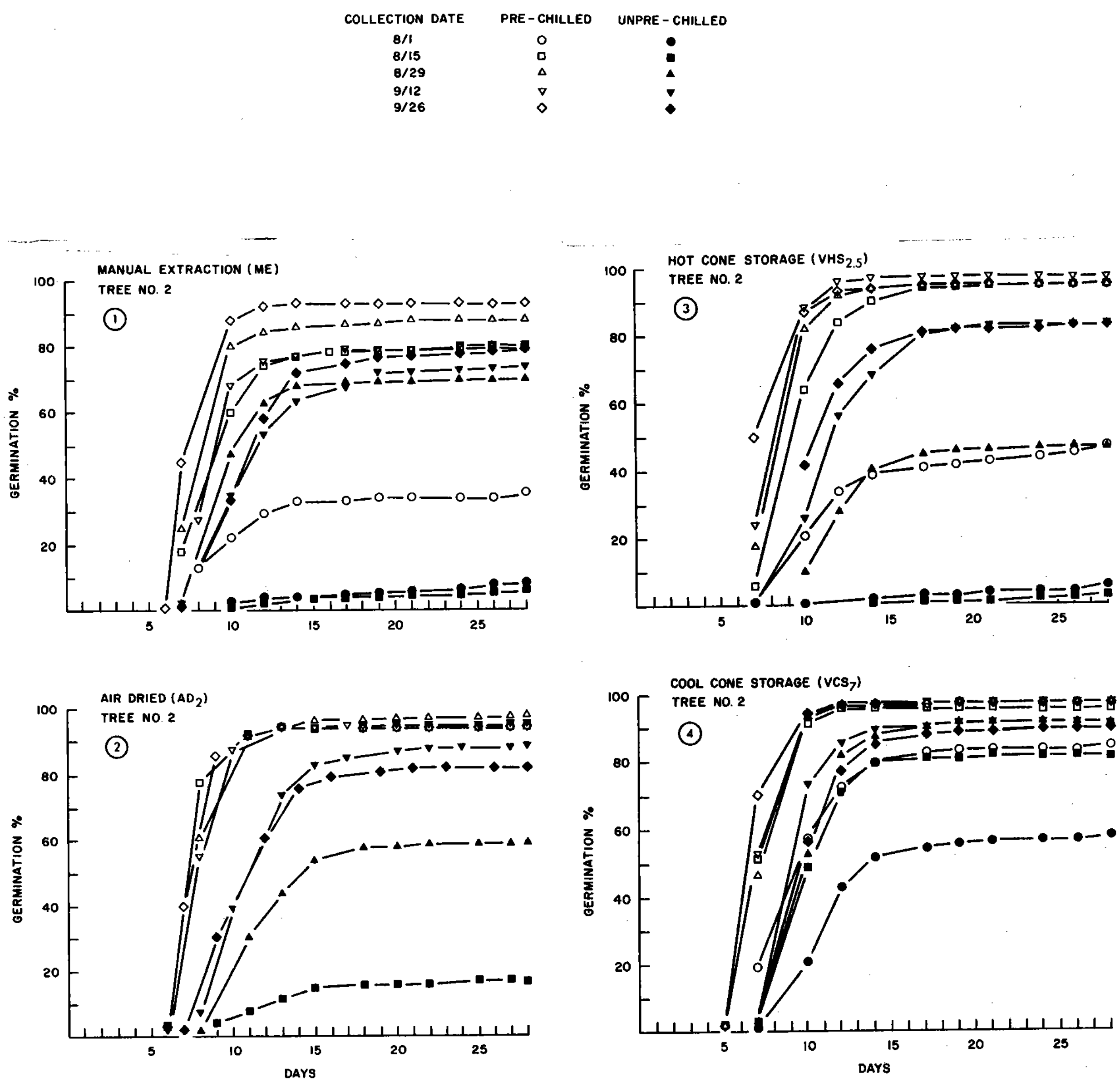

Figure 1. Effect of cone collection date, cone handling treatment and prechilling on white spruce germination. 1. Manual extraction of seeds from fresh cones. 2. Cones air dried 2 wk. 3. Cones oven dried 2 wk then refrigerated 5 wk. 4. Cones stored under well ventilated conditions at 10°C for 7 wk.

measured parameters; differences between seedlings derived from cones that were heated and refrigerated, and those stored under cool, ventilated conditions were not significant.

In 1974, attempts to repeat the experiment were thwarted by poor cone and seed development due to cool, wet spring weather, and insect depredations further reduced seed numbers so that no germination was obtained until the collection of August 20. The relative effects of collection dates (August 20, September 3 and 17) on seed quality were almost identical with those observed in 1973; judging from the levels of germinable seeds, it was estimated that the August 20 collection corresponded with the August 1 collection in 1973. However, natural seedfall began almost a week earlier in 1974. Effects of cone handling treatment were studied on four trees, two at 700 m and two at 1000 m elevation, for a single collection date (September 3) approximately 2 wk prior to natural seedfall. No differences due to elevation were observed. Cool, ventilated cone storage (7 wk) produced the best germination in both prechilled and unprechilled seeds.

Seedling development was again studied in 1974. Numerous significant interactions between collection date and study tree were recorded, making generalized conclusions impossible. However, oven dry masses of seedlings from prechilled seeds were consistently significantly ($P = 0.01$) lower than seedlings from unprechilled seeds. When cone handling treatments were compared prechilled seeds were tallest, but had the smallest stem diameter. Seedlings from manually extracted or air dried cones had greater mass if the seeds had been prechilled, while seedlings from stored cones had reduced mass if the seeds were prechilled.

In 1975 cones were collected from six trees on a single collection date some 2 to 3 wk prior to seedfall, and subjected to handling treatments similar to those used in 1973 and 1974 as well as storage under cool (10°C) ventilated conditions for 4 wk, unventilated cool storage for 7 wk and unventilated storage at room temperature for 7 wk. Seeds were tested immediately upon extraction from the cone (as in 1973 and 1974) and retested after cold storage for 8 to 9 mo. The 1975 data confirmed that cool, ventilated storage (for 7 wk) greatly improved seed quality compared to other forms of storage, or no storage. Seeds from properly stored cones germinated readily, gaining slight benefit (germination rate and capacity) from prechilling. Conversely, prechilling produced significant benefits when cones were not properly stored.

Following approximately 9 mo. of refrigerated storage, seed quality was found to be slightly lower than before storage, in most instances. Differences due to cone handling treatments were still apparent. Germinants were again potted up, but heavy mortality caused this part of the study to be abandoned. Further cone collections are planned for 1977.

GRAND FIR, AMABILIS FIR

A study was initiated late in 1976 to find means of improving the use efficiency of conifer seedlots, by identifying and separating germinable from non-germinable seeds. During measurements on the rate of water uptake by seeds of Abies amabilis (Dougl.) Forbes and A. grandis (Dougl.) Lindl., it was observed that filled seeds (previously sorted by x-ray procedure) usually sank at a faster rate than empty seeds. An experiment was initiated to test (i) the extent to which filled and empty seeds could be separated by removing the floating seeds from the container after a given period of time; and (ii) if there were differences in germinability among the seeds that sank after various time periods. Paired samples of seeds from each of one seedlot of A. amabilis and three lots of A. grandis were placed in distilled water at approximately 25°C and at 5°C. One sample was continuously stirred while the other was stirred briefly, by hand, just before sunken seeds were removed. Seeds that sank were separated from those still floating

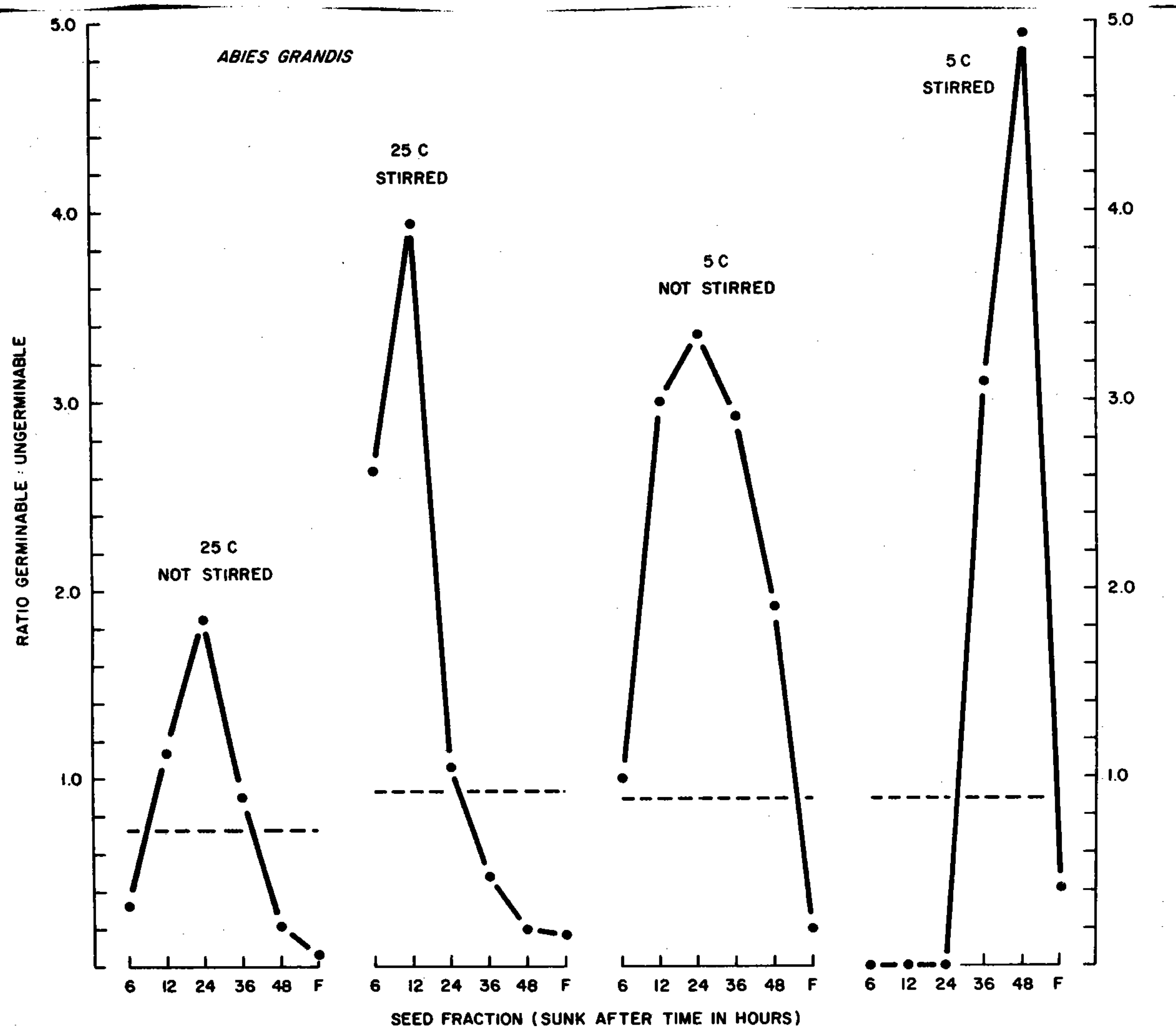

Figure 2. Ratio of germinable: non-germinable seeds of Abies grandis after immersion in water at 25C and 5C, with and without continuous stirring. Dashed line indicates ratio of germinable: non-germinable seeds for unsorted seedlot.

after 6, 12, 24, 36 and 48 h, then replaced in water so that all seeds were imbibed for 48 h. After 48 h, water was drained off and the seeds were prechilled for 4 wk prior to a germination test.

To examine what gains in seed quality might have been achieved, the ratios of germinable: non-germinable seeds for each temperature - stirring combination were compared. Results for one A. grandis, lot are illustrated in Fig. 2. In relation to the ratio for the original (unsorted) seedlot, indicated by the broken line, gains in seed quality were limited to certain time periods. For example, at 25C without continuous stirring, a substantial gain was made in seeds that sank between 12 and 36 h. When stirred, a large gain was noted at 6 h and again at 12 h; at 24 h, since most of the germinable seeds had already sunk, little further gain was found. When stirred at 5C, an increase of more than 5-fold in seed quality was observed in those than sank in the final 12 h. From a practical point of view, the proportion of the original seedlot represented in the different time periods must be taken into account. At the time of writing the practical, economic significance, if any, was still under study.

In association with this sorting work on Abies seeds, Mr. E. Van Eerden undertook an appraisal of the MSS-110 Electronic Seed Germination and Vigor Analyser developed and manufactured by Agro-Sciences, Inc., Ann Arbor, Michigan. This instrument computes an electronic current through the seed when an individual seed is momentarily held in forcep-electrodes; according to Agro-Sciences, a high current flow indicates a seed of low vigor and, conversely, a low current flow indicates high vigor. The tested seeds are electronically assigned to one of eight possible classification levels. Various tests have been conducted to determine whether sort categories of Douglas fir (Pseudotsuga menziesii (Mirb.) Franco) seeds exhibited different germination capacities and whether these varied with seedlot or length of prechill. So far no direct correspondence between current category and germination capacity although seeds giving reading less than 2µa usually have germinated better than seeds with readings above 2µa. The distribution of sorted seeds shifts towards higher current categories after prechilling. Attempts to sort Abies seeds by this method have failed; it is believed that the resinous exudate from the seedcoat, which leaves a gummy deposit on the electrodes after only a few seeds have been tested, eliminates any meaningful reading.

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PROGRESS TOWARDS UNDERSTANDING DEFENSE REACTIONS AND ITS SIGNIFICANCE IN SELECTION AND BREEDING PROGRAMS

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Keywords: Criteria for stock selection, non-specific defense reactions, characterization of host-components in defense, reduction in wood defects, increased resistance to pathogens.

Since 1907, when Biffen first demonstrated that the susceptibility and resistance to disease is under genetic control, we have sought to develop criteria associated with resistance to aid selection of disease resistant stocks. In spite of extensive correlative studies at ecological, morphological, histological and molecular levels, our knowledge of selection criteria directly associated with resistance remains vague. The inadequacy results largely from the lack of knowledge of the nature of host response when attacked by a pathogen*. This report presents a conceptual overview of the significance to tree improvement of the progress we have made over the last 10 years towards understanding the nature of host response in pathogenesis.

Although, health is the norm, diseases and epidemics do occur under certain environmental conditions. We want to know therefore, what in the plants defensive capabilities is affected by environmental conditions that predisposes it to pathogenesis.

If a house fire is analogus to disease then the fire brigade would be the host defence reaction. If the house fire is not contained (susceptibility) then, because we know from start to finish what the successful fire-fighting should be, we can analyze what went wrong with the defense reaction in susceptibility. Further, on the basis of this knowledge we can examine other houses and assess their potential "resistance" to the fire (disease) and possibly take preventive steps to strengthen them.

The knowledge of plant's defensive capabilities is necessary to the development of sound criteria for selection of resistant genotypes. The need is much greater in tree improvement programs than in agricultural crops since the generation time is much greater and errors in selection may show up years after the fact and invalidate much, or all of the work done in the intervening years.

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* Pathogen is defined as any agent (insect, microbe, parasitic plant) which causes chronic physiological disorder (pathogensis) in the host.

Our studies have shown that plants respond in non-specific ways to the entry of any pathogen and that there may only be a few such non-specific responses. For example, phellogen (cork cambium) is the first living tissue interacted with during penetration of any pathogen. Phellogen is vital for maintaining skin-like epidermis or periderm. Regeneration of lost skin tissue as occurs in animals by in-growth of existing skin cells from the wound edges does not occur in plants. Damaged epidermis or periderm is invariably replaced through a process of phellogen restoration involving dynamic metabolic and anatomical alterations over a period of several weeks. The process of phellogen restoration constitutes a non-specific host response which is activated whenever phellogen becomes non-functional, regardless of the cause. Pathogens must either avoid triggering or must successfully interfere with it to complete their life cycle. Failure to successfully interfere should result in resistance. Penetration without interfering the phellogen function would prevent triggering the process and should frequently lead to susceptibility. Our studies show that environmental fluctuations promoting pathogenesis adversely affect this restorative process. Specific interactions of a pathogen with this non-specific dynamic physiological process under varying environments may produce specific disease symptoms and syndromes.

When a pathogen penetrates deeper in the bark, the non-specific process of vascular cambium restoration is triggered. In order to avoid systemic spread of pathogens, the non-specific process of blocking sapwood conduction occurs when a pathogen reaches still deeper in the bark. A detailed account of these appears in Volume 11 of the Recent Advances in Phytochemistry (1977).

My work has centered on interactions of the balsam woolly aphid (BWA) (Adelges picea Ratz.) with members of the genus Abies (true firs). Having delineated the non-specific host processes (Mullick 1977) I am currently involved in an intensive study of BWA interactions which should provide a firm understanding of BWA - Abies interactions from which criteria for selection resistant Abies should be possible. I feel similar studies on other host-pathogen interactions should yield results allowing selection and testing of stocks for breeding and outplanting respectively, providing added surety of successful reforestation programs.

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TREE IMPROVEMENT AT THE PACIFIC FOREST RESEARCH CENTRE 1975-76

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Keywords: Tsuga heterophylla, provenances, controlled pollinations, culture of detached branches, flower enhancement with gibberellins, cutting propagation, OECD seed certification.

Tree improvement activities at the Pacific Forest Research Centre emphasize genetic improvement of western hemlock (Tsuga heterophylla (Raf.) Sarg.), development of rooting techniques for important conifers of British Columbia, and certification of forest tree seeds collected for export under the OECD (Organization for Economic Cooperation and Development) Scheme. Several other studies, conducted both in-house and through grants and contract research, support tree improvement in general. Detailed reports of two areas of related research are given elsewhere in these Proceedings by Drs. D.G.W. Edwards (tree seed research) and B. Mullick (fundamental research delineating the nature of resistance of trees to insects or pathogens, to aid selection and breeding programs).

WESTERN HEMLOCK TREE IMPROVEMENT

Population study

Assessment of height growth and survival, identification and retagging of all planted trees and the cleaning and removal of natural regeneration within plots has continued in the four 25-acre plantations comprising the population study. Six-year height data (4 years after outplanting) were collected and preliminary results were reported (Piesch 1977a). Considerable variation in mean heights was apparent among populations within plantation locations. The most vigorous population in each of the four plantations averaged 92, 85, 61 and 53% taller than the least vigorous, and 15, 32, 26 and 28% taller than the mean for each plantation, respectively. Several populations consistently ranked above average for all plantations, while others consistently ranked below. Formal analysis of the data should be completed this summer.

Breeding studies/seed yields

Over the past 2 years, further studies have been conducted on determining appropriate controlled pollination procedures and breeding techniques. The syringe-technique for controlled pollinations have been very effective in western hemlock, with average yields of 20-25 filled seeds per cone, compared to 3-5 filled seeds per cone following wind pollination (Piesch 1977a). Terylene and kraft pollination bags are being used to isolate the female flowers, although a slight chance for contamination (penetration by foreign pollen) has been shown to exist with the terylene bags. The semi-rigid acetate tubes proved unsuitable as isolation chambers because of excessive condensation within the tubes.

A feasibility study, using detached branches for controlled pollinations in the laboratory, was undertaken in 1975. Control-pollinated seeds were successfully produced on branches which were detached from the ortets prior to pollination and subsequently cultured in aqueous solutions. Although seed set was considerably reduced and the mature seeds were only half normal size, the resulting seedlings grew vigorously. While seedlings from the detached branches were initially two to three times smaller than those from intact branches, height differences decreased with age, so that at 6 months, mean heights differed by only 20%. A detailed report on this study will be published in Bi-Monthly Research Notes in the near future (Piesch, 1977b).

Cone production of rooted cuttings

Cone production of outplanted rooted cuttings, derived from sexually mature trees, continues to increase each year. In 1976, 7 years after rooting, 72% of the 102 clones bore seed cones and 10% bore pollen cones. A total of 2600 seed cones were produced, averaging more than 3 cones per ramet (all ramets included) or 10 cones per producing ramet.

The potential for cone production of potted rooted cuttings was recently indicated by three rooted cuttings which had been retained in pots in the shadehouse since being rooted 9 years ago. While all three have borne moderate crops in past years, they bore "bumper" crops of pollen and seed cones in 1976; one produced over 300 seed cones, i.e., a potential seed crop of 8000 seeds.

Flowering enhancement studies

In 1976, a study designed to enhance cone production in sexually mature clones of western hemlock was initiated in cooperation with Dr. S. Ross, Weyerhaeuser Company, Western Forestry Research Centre, Centralia, Washington. About 175 6-year-old rooted cuttings were given, intravascularly, various treatments of gibberellins (GA's) or auxin, in combination with a soil fertilizer treatment. Female and male flower counts were made in April 1977. Pronounced treatment effects were observed, with a highly significant promotion of female flowers resulting from the exogenous application of GA's. The flowers were hand pollinated to determine whether the GA treatments affect subsequent cone and seed development. Reports will be written for publication. Further studies will investigate what effects time of GA application and age of the tree material have on promotion of flowering.

Flower enhancement has also been successful in Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco). In 1975, Dr. G. Puritch and Mrs. E. McMullen, PFRC, and Dr. M. Meagher, B.C. Forest Service, established a test of the effectiveness of GA's and auxin, alone and in combination, with and without girdling, on cone enhancement in two clonal and two seedling seed orchards. Results showed a highly significant enhancement of male and female flowers by GA at one clonal and one seedling seed orchard, but not at the other two. Girdling and/or auxin did not affect flower production. GA was effective at enhancing flower production in already productive orchards, but was ineffective in nonproductive orchards. Results of this study will be published when seed germination tests have been completed.

Review paper

A paper covering the status and potential of tree improvement in western hemlock was presented to the Western Hemlock Management Conference in May, 1976, at Union, Washington (Piesch 1977a). A general overview of programs in the region was presented, as well as a review of several genetic studies conducted at the PFRC. The paper will be included in the Proceedings being published by the University of Washington, College of Forest Resources.

ROOTING OF CUTTINGS FROM CONIFERS

Studies were undertaken by Dr. H. Brix on the rooting of cuttings from young and old trees, particularly of western hemlock, in relation to fungicide and hormone treatments, size of cuttings, retention of basal leaves and time requirement for rooting. While past studies concentrated primarily on effecting root development in cuttings from mature trees, current work includes studying the subsequent growth performance and characteristics of rooted cuttings, derived from both juvenile and mature trees. Two papers on rooting have been published since 1975, one summarizing rooting studies of western hemlock (Brix and Barker 1975), and the other, a joint report with the B.C. Forest Service, reviewing the use of rooted cuttings in reforestation (Brix and van den Driessche 1977).

A feasibility study for producing reforestation stock from rooted cuttings of yellow cedar (Chamaecyparis nootkatensis (D. Don) Spach) seedlings was undertaken by Dr. D.G.W. Edwards. Cuttings rooted well with or without hormone treatment. The time of year during which cuttings were removed from the seedlings (January, August or December) was not critical.

CERTIFICATION OF FOREST TREE SEED UNDER THE OECD SCHEME

The Canadian Forestry Service is responsible for certifying forest tree seeds collected in Canada for export under the OECD scheme. The PFRC, as certifying agency for B.C. and the Yukon, certified 36 "source-identified" seedlots during 1975-76, bringing to 155 the total number of seedlots certified in B.C. and the Yukon since the scheme was implemented in 1970. Total weight of seeds certified during that period was approximately 9000 kg, representing 11 conifer species.

In 1976, PFRC staff were involved in several meetings with other participants of the scheme. Designated Authorities responsible for the scheme met in Paris, France in February, and the CFS (Designated Authority for Canada) was represented by R. Piesch, project leader for the scheme in B.C. and the Yukon. Renewed interest was generated for implementing seed certification programs and several OECD countries indicated that they planned to require, in the near future, that forest tree seeds be imported only in compliance with the scheme. As a result, representatives of the European Economic Community (Common Market) and several European countries visited the PFRC during the summer to discuss the operation of the scheme and the availability of certified seeds from B.C. and the Yukon.

Regulations pertaining to certification of Canadian source-identified forest tree seed under the OECD scheme have been updated and published in both English and French editions (Piesch and Stevenson 1976a, b). A report was also prepared, summarizing the operation of the scheme in B.C. and the Yukon since its implementation in 1970 (Piesch 1977c).

RELATED STUDIES

Cone and seed insects

Further studies were conducted by Mr. A. Hedlin on the nature, extent of damage, and species involved of graft-mining *Dioryctria* in Douglas-fir seed orchards. Also, cones collected from 165 Douglas-fir clones were examined for insect-caused seed losses. Studies on sex pheromones of the Douglas-fir cone moth (*Barbara colfaxiana*) and the spruce seed worm (*Laspeyresia youngana*) were continued, and a report was written (Weatherston, *et al*. 1977). Primary attractants of the Douglas-fir cone moth have recently been studied by attempting to isolate volatile materials from female flowers which attract female moths.

Grant- and contract-supported research

The following studies were supported through departmental grants or contracts:

Studies	Grant or contract recipient
Phenology of bud development in white and Sitka spruce (*Picea glauca* (Moench) Voss and *P. sitchensis* (Bong.) Carr. respectively).	Dr. J. Owens University of Victoria
Precocious flowering of Douglas-fir and lodgepole pine (*Pinus contorta* Dougl.) through the application of gibberellins.	Dr. R. Pharis University of Calgary

Pollen storage and testing.	Dr. D. Ballantyne University of Victoria
The influence of competition from nearby trees on the selection of western hemlock plus trees.	MacMillan Bloedel Limited Nanaimo, B.C.
Inspection services in the administration of the OECD seed certification scheme.	Mr. V. Phelps Victoria, B.C.

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PROGRESS REPORT 1977

R.D. Stevens

MacMillan Bloedel
Nanaimo, B.C.

Development of MacMillan Bloedel Ltd.'s Tree Improvement Centre near Nanaimo included final clearing and preparation of our 50 acre site, construction of a field office, greenhouse and other propagation facilities, and expansion of Douglas-fir, Sitka spruce, and western hemlock clonebanks. Breeding strategies have been prepared for these species and plans are also being developed for Amabilis fir, lodgepole pine, western white pine, western red cedar and yellow cypress. Initial clonal Douglas fir and western hemlock seed orchards were planted in the spring of 1977.

A study of the effects of varied competition from nearby trees on the selection of western hemlock plus tree candidates was begun in 1976 under funding by the Department of Supply and Services, Canada. Charles Thomas, a University of British Columbia graduate student, has collected considerable phenotypic data to supplement the existing data base from long term, stem-mapped permanent sample plots. Phenotypes with greater than expected growth rates identified by confidence limits of regressions of competition index on actual growth rates, are generally not the same as those chosen by classical phenotypic selection methods. Additional field work and computer simulations are continuing in 1977. The Pacific Forest Research Centre, C.F.S., Victoria is currently rooting cuttings and growing half-sib seedlings from several tentative selections and standard, phenotypically-selected "controls". Clonal tests on variable spaced plots are contemplated.

A test of rooted cuttings from one- and four-year old ortets from 20, full-sib Douglas-fir families provided by the B.C. Forest Service (E.P. 707) was planted on a cultivated test site this spring. The test also includes seedling progenies from all families.

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

O. Sziklai

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

UNDERGRADUATE PROGRAM

Forest genetics as an elective course for undergraduate students has been offered at U.B.C. since 1950 as Biol. 331, For. 352, and For. 302. The objectives of the course are to provide students with:

a) the fundamental principles of variation and inheritance as mainly applied to trees;

b) the most frequently used methods and techniques in forest genetics and forest tree breeding;

c) the role of forest genetics in relation to intensive forestry practice.

During these 27 years, approximately 600 students have been exposed to forest genetics principles. During the last five years the student enrollment has fluctuated as follows: 17, 18, 25, 32 and 15 students per year.

GRADUATE PROGRAM

Graduate programs are concentrated on studies related to variation and heritabilities of western conifers. M.F., M.Sc. and Ph.D. programs are offered in close cooperation with other Faculties. There has been a total of eight Ph.D., eight M.F. and two M.Sc. degrees awarded to date. Since the last report, Meagher (1976) completed his Ph.D. program ("Studies of variation in hemlock (Tsuga) populations and individuals from southern B.C." 381 pp.). Cam Bartram is close to completing his M.F. program and his thesis deals with "Early results of Douglas-fir cooperative progeny tests." Galloway is finishing up his first year course work and looking for a suitable thesis topic for his M.F. degree.

RESEARCH PROGRAM

Research concentrates mainly on "Study of variations and heritabilities of progenies and provenances of selected western North American conifers in Pinaceae family", founded by NRC.

Douglas-fir

1. Open-pollinated seed samples were collected from 1,823 trees in 1966 and in 1968 by I.U.F.R.O., Section 22, representing 132 provenances from the entire range of the species. Seedlings from a few selective provenances were planted out at U.B.C. Research Forest in 1971, and after five growing seasons, the height growth was measured and analyzed (Kvestich, A. 1976. "Studies in height growth of selected Douglas-fir provenances and progenies". Faculty of Forestry, U.B.C. B.S.F. Thesis. 55 pp.).

   The variation in percent gains and percent losses in the maximum or minimum family of the best or poorest provenances was substantially larger (Table 1) to reconfirm the importance of individual tree selection.

Table 1. Percent Gains and Percent Losses in 1975 Total Height Possible by Selection of the Maximum Family Within the Best Provenance or the Minimum Family Within the Poorest Provenance.

Seed Zone	Percent Gain Maximum Family in Best Provenance	Percent Loss Minimum Family in Poorest Provenance
1	47.4	48.2
2	25.3	58.3
3	34.7	72.0
5	37.3	45.4
7	47.8	31.0

2. The 1968 cooperative pollination program provided enough seed to establish a pilot, single tree progeny test (t = 98, k = 16, spacing 10' x 10') in three different locations on Vancouver Island.

   55 full-sibs crosses (1+1)
   15 half-sibs from clone banks (1+1)
   21 half-sibs from original plus trees (1+1) and
   7 "run-of-the-mill" control seedlings (2+0) were planted in spring, 1971.

   Cam Bartram analyzed the data in his thesis and the following Table 2 indicates the height differences after five growing seasons.

Table 2. Average Growth of the Different Progeny Types after Five Growing Seasons (in cm).

	PLANTATION			
Progeny Types	Caycuse - B.C.F.P.	Courtenay - C.Z.	Gold River - Tahsis	Mean
Half-sibs (clone bank)	127.8	94.2	106.2	109.4
Full-sibs	111.9	90.4	101.7	101.3
Half-sib Plus Trees	108.7	75.6	80.2	88.2
Control	102.6	69.0	80.8	84.1
Mean	112.7	82.3	92.2	95.7

Contorta Pine

3. Selection of contorta pine plus trees (Sziklai 1970) located one tree (#88) outside the previously reported range (Fig. 1) and two trees exhibited few three-needle fascicles.

Fig. 1. Location of Selected Contorta Pine Plus Trees Between 56° and 64° Latitude.

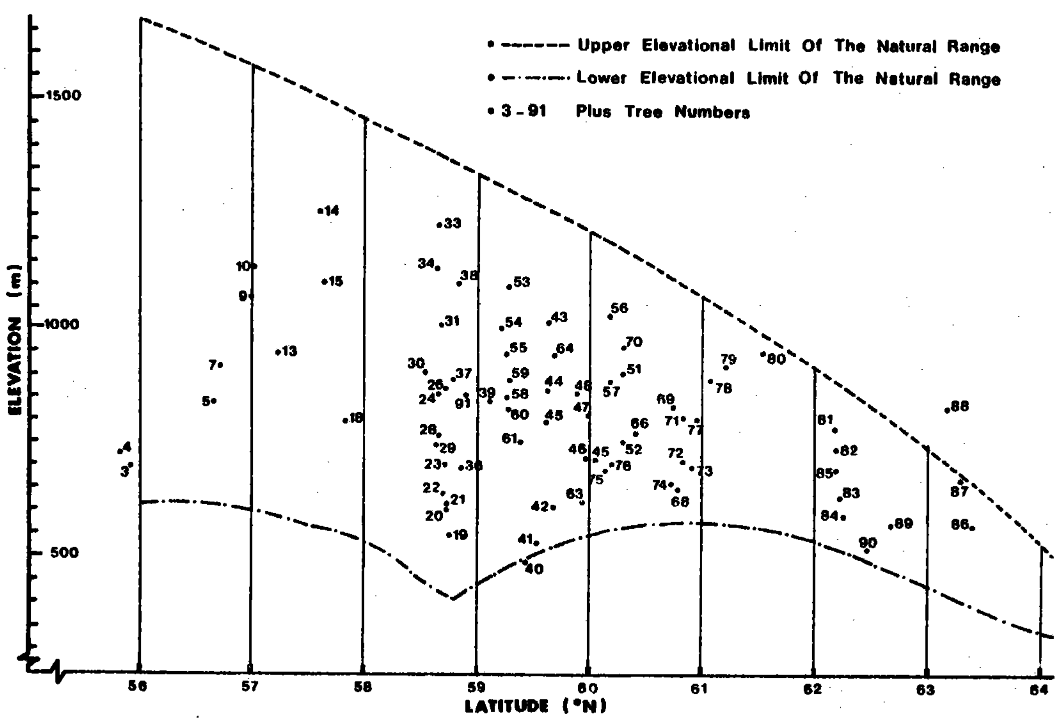


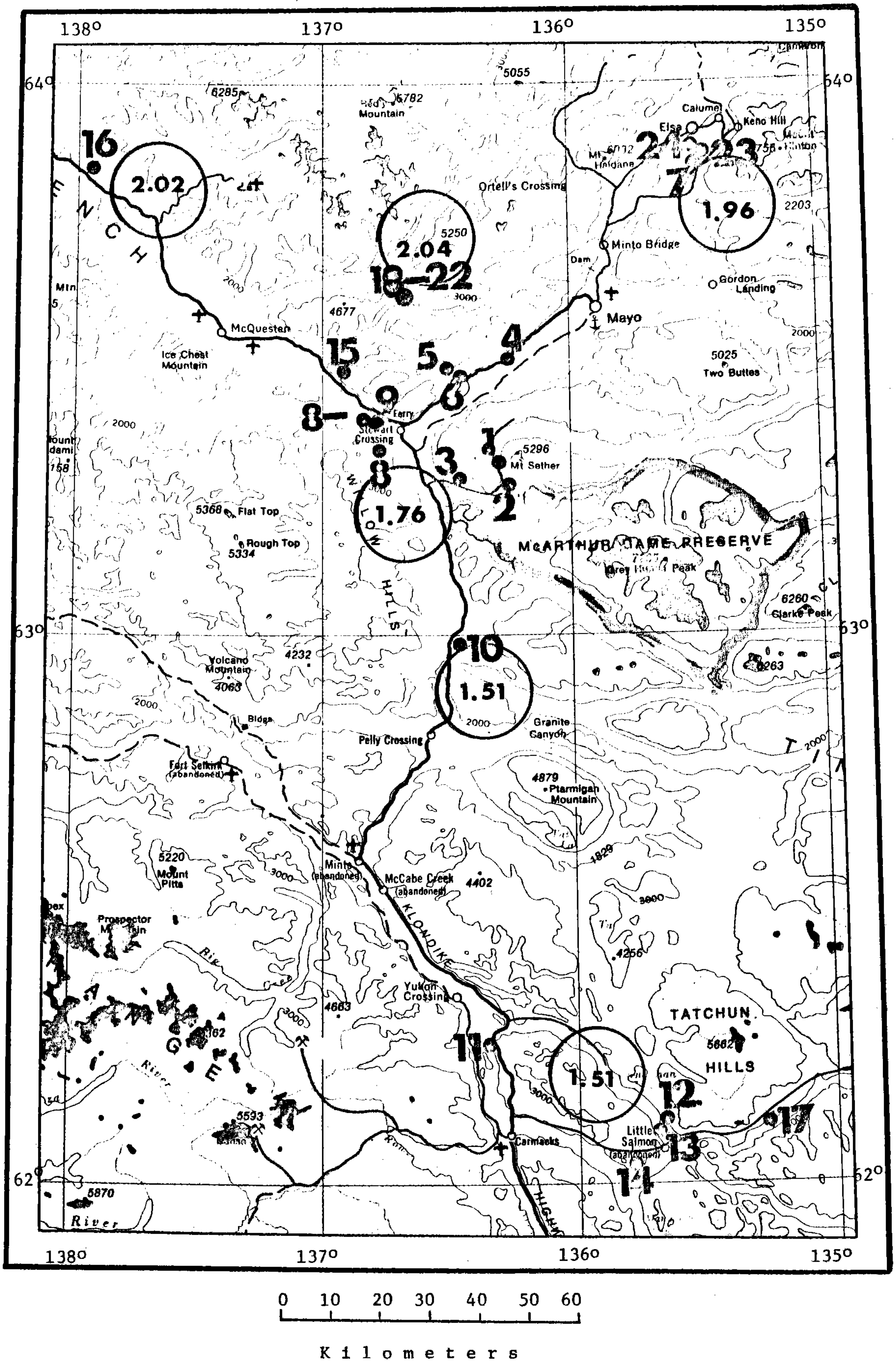
FIG.1 . LOCATION OF LODGEPOLE PINE PLUS TREES SELECTED IN 1970.

Further selections in 1974 revealed more about these marginal populations. The needle characteristics (Fig. 2) and isozyme indicated that these trees are different from the southerly samples and may exhibit larger variation than the more adapted populations.

Not fully developed embryos were 23 times more frequent and polyembryos 13 times more frequent in the northerly samples than the southerly ones.

Presently, seedlings are growing in the nursery and growth characteristics will be studied in a few year's time.

Fig. 2. Ratio of the total number of stomata from the dorsal and from the ventral side (TD/TV) (1 to 24 number and location of plus trees. 1.51 to 2.04 TD/TV).



PROCEEDINGS, PART 2/COMPTES RENDUS, PARTIE 2

Symposium:
THE CONTRIBUTION OF FOREST GENETICS
TO THE URBAN ENVIRONMENT

LA CONTRIBUTION DE LA GÉNÉTIQUE FORESTIÈRE
AU MILIEU URBAIN

CONTENTS/CONTENU

FIELD TRIPS
JUNE 28, 30

EXCURSIONS SUR LE TERRAIN
LE 28 ET 30 JUIN

MORDEN RESEARCH STATION - June 28

The Agriculture Canada Research Station at Morden, Manitoba is situated about 100 km southwest of Winnipeg. The horticultural section of the Station has been involved with tree breeding and species introduction for many years and is Canada's main centre for improvement of woody ornamentals. The Station plantings consist of a test area, a 25 hectare arboretum and a 5 hectare nursery. Many of the specimens are also used in a demonstration of hedges in the well kept gardens and lawns that beautify the Station headquarters making it a most attractive place to visit.

Dr. Eric Patt, Director of the Station, welcomed us and gave us a brief talk about Morden. Following this Dr. Wilbert Ronald led the morning tour through the arboretum. This collection of over 2,000 woody plant taxa is recognized as the most extensive in the northern plains. The arrangement of plants in generic blocks facilitates evaluation and taxonomic comparisons which are a major part of the Morden program. Outstanding among the more than 50 poplar clones were the fast growing _P. euramericana_ 'Serotina de Selys', the columnar _P. tremula_ 'Erecta' from Sweden, two complex aspen - white poplar hybrids from Maple, Ontario and native large toothed aspen (_P. grandidentata_) and cottonwood (_P. deltoides_). Provenance plantings of cottonwood demonstrated that only those clones from the northern plains of the U.S. and the prairie provinces withstand the winter stresses of low temperatures and dessication.

The tour of shade tree production nursery and testing facilities was of special interest in view of the spread of Dutch elm disease (D.E.D.) to the prairies. Boulevard tree alternatives to white (American) elm included seedles 'Patmore' green ash and 'Fallgold' black ash cultivars, Japanese elm, Manchurian ash, and several linden (basswood) species. Other genera and species growing at Morden include _Acer_ (maples), _Crataegus_ (hawthorns), _Quercus_ (oaks), _Juglans_ (walnuts), _Phellodendron amurense_ (Amur cork tree), _Celtis occidentalis_ (hackberry) and _Ostrya virginiana_ (ironwood). Particular interest was shown in hardy specimens of _Juglans nigra_ (black walnut), _Acer saccharum_ (sugar maple) and D.E.D. resistant _Ulmus japonica_ (Japanese elm) which rivals _U. americana_ in appearance. The production and growing area for 60 entries in the Prairie Regional Shade Tree Evaluation program demonstrated propagation and production practices needed for alternative shade trees.

Several breeding projects were viewed, including that with poplar. Columnar selections with potential as shelterbelts and "living screens" were among the 3,000 seedlings under test. Recently produced intersectional hybrids of aspens with balsam and cottonwood types were seen.

Tour participants enjoyed a noon meal in the picnic grove and then moved to view seed introduction frames, mist propagation facilities and landscaped grounds. Several older conifer plantings of particular interest included swiss stone pine, ponderosa pine, mugo pine and Austrian pine. Following the grounds tour, participants met for a brief business meeting and coffee break before embarking on buses for the return to Winnipeg.

Members and guests of the C.T.I.A. expressed their appreciation for the generous hospitality shown by Dr. Patt and his staff.

The trip and luncheon were sponsored by:

Abitibi Paper Co. Ltd.
Manitoba Paper Division
Pine Falls, Manitoba

Manitoba Forest Resources Ltd.
The Pas, Manitoba

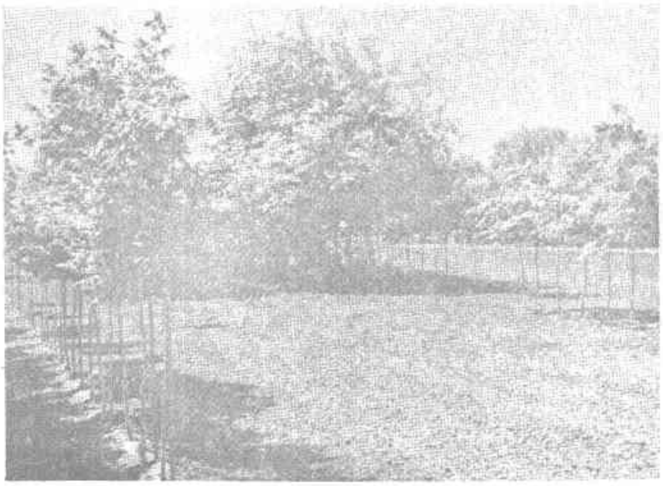
Morden Nurseries Ltd.
Morden, Manitoba

Their support is greatly appreciated.

R.F. Calvert
W. Ronald

MANITOBA SNAPSHOTS

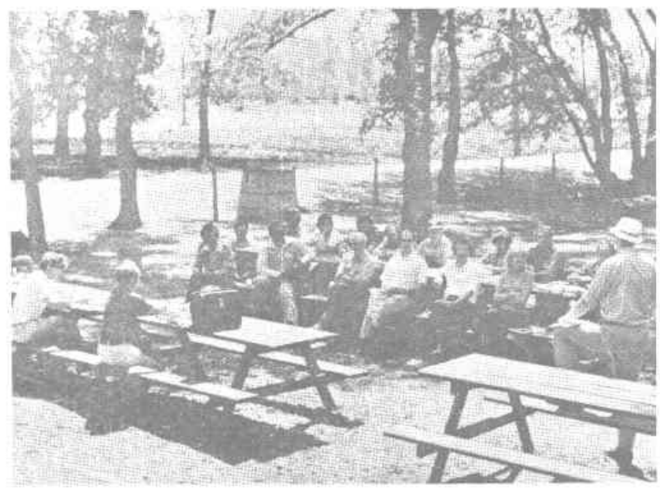
MORDEN RESEARCH STATION - JUNE 28, 1977



Selections of green ash ready for prairie city test sites.

Wilbert Ronald demonstrating the green and albino leaves of a poplar chimera.

Disease-resistant Japanese elm growing in the Morden Arboretum.



Ron Calvert addresses the business meeting of the C.T.I.A./A.C.A.A. held in the picnic grove.

Bruce Dancik and Cheng Ying express their appreciation of the generous western hospitality extended to C.T.I.A. members.

GENETIC IMPROVEMENT OF JACK PINE - SANDILANDS - June 30

An experimental seedling seed orchard, an interim clone bank, a family test plantation, and a provenance experiment were visited. All but the clone bank were planted in spring of 1972. Field trip notes including maps, source lists, design information, and extracts from results were distributed to participants.

Birds Hill Research Nursery

This property, located about 40 km northeast of the University of Manitoba, was intended to serve as a rearing and planting area for the federal forestry research establishment which was then in Winnipeg. Apart from the genetics materials, there is little activity at the nursery now.

Seedling Seed Orchard

Genetic improvement is being sought in this plantation by phenotypic selection of one tree out of 20 planted on a 2.4 m by 3.0 m plot. Each tree on a plot is from a different open-pollinated progeny, but all are from the same general source area. The 11 plots in a block contain trees from 11 eastern Manitoba source areas. The first thinning in 1976-77 left five trees per plot and increased mean height from 190 to 217 cm. Following the final thinning, probably by 1983, cone stimulation treatments can be applied, and genetic gain can be measured using comparison plantations with seed from the orchard. It is hoped that the design features will promote effective selection and a reasonably tractable tree distribution, while ensuring genetic diversity among neighbouring trees in the final stand.

Interim Clone Bank

Ramets grafted in 1967-68 were lined out in the seedbed area in 1969 and are now from 40 cm to more than 3 m in height. Scions are collected here and grafted in Edmonton for planting in the regional clone bank in Alberta. The larger ramets have substantial cone production.

Sandilands Provincial Forest

The trip from Birds Hill Research Nursery to Sundown Research Planting Area was routed through part of Sandilands Provincial Forest to allow viewing of jack pine stands typical of this area. A fried chicken lunch provided by the Northern Forest Research Centre was served in the picnic area at the Marchand forestry office.

Sundown Research Planting Area

The plantations examined here are on a quarter section of Crown land reserved by the province for federal forestry research. Both plantations are on an orthic eutric brunisol developed on rapidly drained calcareous sand and gravel deposits. Native vegetation of scattered pine, grasses, and low shrubs reflects a history of repeated fire. The pines were removed and furrows made with shark-finned barrels in summer of 1971 to prepare the site for planting.

Family Test Plantation

This plantation, with three replicates, is one of four in the test. All have the same 209 open-pollinated progenies from eastern Manitoba plus seven other entries, four-tree row plots, and cubic lattice design. Results will be used to select superior source stands for immediate seed collection, and superior parental and progeny genotypes for propagation of seed orchard trees.

Analysis of height at five years from planting, for this plantation only, showed a significant F-ratio, 16% reduction in error variance due to removal of inter-block effects within replicates, and 19% mean height superiority of the tallest decile of progenies over the 78 cm plantation mean. Except for the poor performance of progenies from north of the Winnipeg River, no clear geographic pattern is evident in the results.

All-range Provenance Experiment

This plantation included 78 populations from the Petawawa series plus three western populations composited from single-tree progenies. Design is lattice square with five replicates and four-tree row plots. After the fifth growing season from planting, mean heights ranged from 50 cm (Nova Scotia) to 109 cm (Minnesota). Other high-ranking populations originated 0.2° to 1.4° north of the planting site, as far east as Quebec. The shortest trees are from near the eastern, southern, and northwestern limits of the species' range.

J.I. Klein

C.F.S. JACK PINE GENETICS PROGRAM
SANDILANDS - JUNE 20, 1977

Jerry Klein, centre, and Chris Heaman, right, walking from the eastern Manitoba regional provenance/progeny test planted.

Drs. Khalil, Heimburger, Gordon and Dancik inspect the jack pine seedling seed orchard, Birds Hill Research Nursery.

Dr. Klein explains the design and management of the jack pine seedling seed orchard planted in 1972 with 3-0 seedling stock.

ATTENDANCE

Sixteenth Meeting, Canadian Tree Improvement Association
University of Manitoba, Winnipeg, June 1977

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