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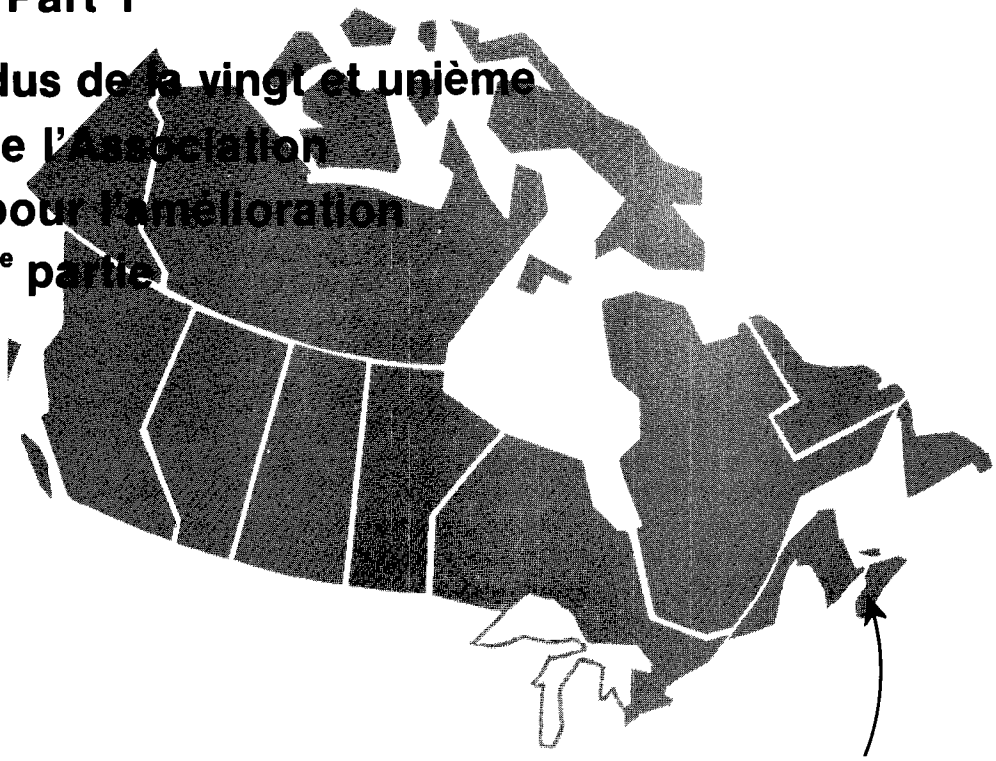
Proceedings of the twenty-first meeting of the Canadian Tree Improvement Association: Part 1

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



Truro, Nova Scotia
August 17-21, 1987
du 17 au 21 août 1987

Minutes and members' reports

Procès-verbaux et rapports

PROCEEDINGS

OF THE

TWENTY-FIRST MEETING

OF THE

CANADIAN TREE IMPROVEMENT ASSOCIATION

PART 1:

MINUTES AND MEMBERS' REPORTS

HELD IN

TRURO, N.S.

AUGUST 17-21, 1987

EDITOR:

T.J.B. BOYLE

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

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Produced by
Canadian Forestry Service,
for the
Canadian Tree Improvement Association,
Ottawa, 1988

COMPTES RENDUS

DE LA

VINGT ET UNIÈME CONFÉRENCE

DE

L'ASSOCIATION CANADIENNE POUR L'AMÉLIORATION DES ARBRES

PARTIE 1

PROCÈS-VERBAUX ET RAPPORTS DES MEMBRES

TENUE À

TRURO (N.-É.)

DU 17 AU 21 AOÛT 1987

RÉDACTEUR

T.J.B. BOYLE

Partie 1. Procès-verbaux et rapports des membres

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Publié par le
Service canadien des forêts
pour
l'Association canadienne pour
l'amélioration des arbres,
Ottawa, 1988

PROCEEDINGS OF THE TWENTY-FIRST MEETING OF THE CANADIAN TREE IMPROVEMENT ASSOCIATION

With the compliments of the Association

Enquiries may be addressed to the authors or to Mr. J.F. Coles, Executive Secretary, C.T.I.A./A.C.A.A., c/o Ontario Tree Improvement Council, Johnston Hall, University of Guelph, Guelph, Ont. N1G 2W1.

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The Twenty-second Meeting of the Association will be held in Edmonton, Alberta, August 14-18, 1989. Speakers will be invited to address the topic of "Test results and their application in tree improvement". Canadian and foreign visitors are welcome. Further information will be distributed in the winter 1988 to all members and to others on request. Enquiries concerning the 22st Meeting should be addressed to: J.I. Klein, Canadian Forestry Service, Northern Forestry Centre, 5320-122 Street, Edmonton, AB T6H 3S5.

To: *T.J.B. Boyle, Editor, C.T.I.A./A.C.A.A.*
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La vingt-deuxième conférence de l'association aura lieu à Edmonton, en Alberta, du 14 au 18 août 1989. Des orateurs seront invités à adresser le sujet de <<Résultats d'expériences et les applications à l'amélioration des arbres>>. Les intéressés au Canada et à l'étranger sont les bienvenus. Des renseignements supplémentaires seront distribués au cours de l'hiver de 1988 à tous les membres et à tous ceux qui en feront la demande. Si vous avez des questions à poser concernant la 22e conférence, veuillez les adresser au: Canadian Forestry Service, Northern Forestry Centre, 5320-122 St., Edmonton, AB T6H 3S5.

À: *T.J.B. Boyle, rédacteur, A.C.A.A./C.T.I.A.*
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720 CHEM MIN ENG BLDG
EDMONTON AB
T6G 2G6

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BC MIN OF FORESTS & LANDS
1450 GOVERNMENT ST
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ZSUFFA L DR
FACULTY OF FORESTRY
UNIVERSITY OF TORONTO
TORONTO ONTARIO
M5S 1A1

BUSINESS MEETING MINUTES

COMPTES RENUS DE LA REUNION D'AFFAIRES

BUSINESS MEETING - MINUTES

Mr. T. Mullin chaired the 21st Business Meeting of the CTIA/ACAA held in the Cox Institute, Nova Scotia Agriculture College, Truro, Nova Scotia, on Wednesday, August 19, 1987. He opened the meeting at 0835.

237. MINUTES OF THE LAST MEETING

Motion: That the Minutes of the 20th business meeting be approved as published.

Moved by R.M. Rauter, seconded by C. Heaman. Carried.

238. MEMBERSHIP

a) The names of new sponsoring members were read as follows:

G. Ainscough	V.P. and Chief Forester MacMillan Bloedel Ltd. Vancouver, British Columbia
D.C. Davies	Director of Seedling Production N.B. Dept. Forests, Mines & Energy Fredericton, N.B.
W.J.B. Devitt	Chief Forester CIP Inc. (Tahsis) Vancouver, British Columbia
W.H. Martin	V.P. Natural Resources & Administration CIP Inc. Montreal, Quebec
D. Oxley	Woodlands Manager J.D. Irving Woodlands Saint John, New Brunswick
R. Trudel	Recteur, Univ. Québec en Abitibi-Temiscamingue Rouyn, Quebec
L. Walsh	Deputy Minister Dept. of Energy & Forestry Charlottetown, Prince Edward Island
Director General	Prairie Farm Rehabilitation Administration Agriculture Canada Regina, Saskatchewan

Motion: That the new sponsoring members be elected.

Moved by J. Klein, seconded by F. Yeh. Carried.

b) The following were nominated as new active members:

Mr. G. Adams	J.D. Irving Ltd., New Brunswick
Mr. J.D. Brophy	Ontario Pulp & Paper Co.
Mr. R.J. Barber	Forintek Canada Ltd., Eastern F.P. Lab.
Mr. P. Corbeil	Waferboard Corp., Ontario
Ms. J. Gonzales	Forintek Canada Ltd., Western F.P. Lab.
Mr. R. Hunt	Canadian Forestry Service - Pacific
Mr. M. Innes	Abitibi-Price Inc., Ontario
Mr. R. Leblanc	Fraser Inc., New Brunswick
Dr. D.T. Lester	University of British Columbia
Dr. J. Loo-Dinkins	University of British Columbia
Dr. S. Magnussen	Canadian Forestry Service - Petawawa National Forestry Institute, Ontario
Mr. A.G. Mathews	Boise Cascade Canada Ltd., Ontario
Mr. A. Nanka	Canadian Forestry Service - Winnipeg
Mr. T. Nieman	Canadian Forestry Service - Petawawa National Forestry Institute, Ontario
Mr. A. Raineville	Ministère de l'Energie et des Ressources, Quebec
Dr. O.P. Rajora	University of Alberta
Ms. D. Rogers	Ontario Min. of Natural Resources, Timmins
Mr. D. Schoen	McGill University, Montreal, Quebec
Dr. T. Thorpe	University of Calgary, Alberta
Ms. K. Tosh	New Brunswick Dept. Natural Resources & Energy
Mr. M. Villeneuve	Ministère de l'Energie et des Ressources, Quebec
Dr. E. White	Canadian Forestry Service - Pacific
Ms. J. Wild	Ontario Min. of Natural Resources, Sudbury

Motion: That the nominated new active members be duly elected.

Moved by D. Simpson, seconded by B. Wang. Carried.

It was noted that a letter was received requesting that the membership status of Mr. J. Bégin be changed from Active to Corresponding.

c) Membership report: Tim Boyle noted that there are a number of members 'on-the-books' who are longer actively involved in tree improvement. However, he also raised the point that the constitution prohibits purging or changing the status of an Active member without a written request unless that individual has failed to submit a progress report for three consecutive meetings.

239. CHAIRMAN'S REPORT

Tim Mullin highlighted the accomplishments of the CTIA/ACAA over the past two years and noted that the success of these activities was due to the efforts of many people. He thanked the outgoing executive; T. Boyle, J. Coles, H. Frame, K. Morgenstern, and C. Yeatman for their efforts over the past two years. He also thanked the chairmen of the standing and ad-hoc committees: publishing (T. Boyle), incorporation (J. Coles), standing advisory committee (D. Fowler) and education (F. Yeh). Finally, he acknowledged the efforts of the local planning committee; T. Bulley, P. Chapman, D. Fowler, and B. White.

240. FINANCIAL STATEMENT

The financial statement prepared by Treasurer C. Yeatman was tabled for membership information and acceptance (see Attachment #1). The statement shows an account balance of $481.08 as of August, 1987.

Motion: That the financial statement be accepted as presented.

Moved by C. Heaman, seconded by A. Gordon. Carried.

241. FINANCIAL CONTRIBUTIONS

Tim Mullin read a list of agencies which provided contributions to this meeting:

Bowater Mersey Paper Company
Canada/Nova Scotia Forest Resources Development Agreement, Technology Transfer Project
Canam
Minas Basin Pulp and Power
Nova Scotia Department of Lands and Forests
Ropak
Scott Worldwide, Canadian Timberlands
Stora Forest Industries

Motion: That the CTIA/ACAA express our sincere appreciation to these contributors.

Moved by C. Yeatman, seconded by G. Powell. Carried.

242. EDITOR'S REPORT

Tim Boyle presented the editor's report for the information of the membership. Noted was that for the last proceedings, 500 copies of part I, and 800 copies of Part II were printed. He expressed concern that the level of funding from CFS has been fixed at $10,000 per proceedings for the next two meetings, down from the previous amount of $17,000.

Motion: That the Editor's report be accepted as read.

Moved by B. Wang, seconded by G. Caron. Carried.

243. BUSINESS ARISING FROM THE MINUTES

a) **Ad hoc** committee on incorporation: Tim Mullin presented the report on behalf of Jim Coles. There appears to be no particular advantage, at this time, for the CTIA to become incorporated. Therefore the recommendation from the committee was that the CTIA/ACAA name be registered as a society. Action was taken on this matter and the CTIA/ACAA is now registered as a Society in the province of Ontario.

b) Standing Advisory Committee: Don Fowler reported that the only request for advice from this committee occurred from Doug Pollard regarding seed certification. He noted that the committee will continue to provide input at a technical level on matters related to tree improvement.

c) **Ad hoc** committee on publishing: Tim Boyle reported on the work of the committee in investigating means whereby the costs of publishing the CTIA/ACAA proceedings could be reduced. He provided the three options considered by the committee:

1. Reduce the quantity of material produced.
2. Reduce unit costs.
3. Reduce costs specific to CFS.

Tim read the six recommendations from the committee:

1. That only one report per "group" be allowed, the interpretation of "group" to be the responsibility of the editor.
2. That the size of these group reports be limited in relation to the size of the group.
3. That the level of funding should only cover the printing of abstracts of voluntary papers for Part 2, and that if an organizing committee wish to publish the papers in full, they obtain the required extra funding.
4. That members' reports be photo-reduced and that both Parts be xerox-printed if required.
5. That the editor examine the distribution list for Part 1 and remove those addresses which are unlikely to require Part 1.
6. That a charge to partially cover costs be built into the registration fee and charged directly to non-registrants for Part 2 only.

This topic was discussed at length by the membership. Kit Yeatman reiterated the need to regularly purge mailing lists and that it is the responsibility of the membership to ensure that duplicate or redundant copies of proceedings are not being sent to each organization or individual. Steen Magnussen suggested that a RSVP return label be included in the proceedings from this meeting as a means of determining which names could be purged.

Motion: That the report of the publishing committee be adopted, and that the new executive have the mandate to continue to investigate means of reducing costs associated with publishing of the Minutes.

Moved by J. Klein, seconded by F. Yeh. Carried.

d) Education committee: Francis Yeh noted that the main activity of this committee was related to the student travel scholarships. Discussion followed related to whether or not these scholarships should be exclusively for use by undergraduate students. The general consensus was that the choice of a recipient must be left up to the discretion of the supervisors, however, undergraduates should be given preference whenever possible.

244. OTHER BUSINESS ARISING FROM THE MINUTES

a) Kit Yeatman gave a brief outline of a report he prepared regarding the Conservation of Forest Gene Resources (see attachment #2). Discussions regarding this report took place.

b) Mike Meagher asked what level of support for students would be available for the 1989 CTIA/ACAA meeting in Edmonton? Tim Mullin replied that it will be up to the incoming executive to solicit funds.

c) Mr. John Murphy, from the United States Forest Service, Milwaukee, Wisconsin thanked the CTIA/ACAA for the opportunity to participate in the 21st meeting.

245. NEW BUSINESS

Motion: That the Constitution/Bylaw amendments as read be accepted (see attachment #3).

Moved by T. Boyle, seconded by C. Yeatman. Carried.

246. FUTURE MEETINGS

a) Location of the 1989 meeting: Motion passed at the 20th meeting (item 234b) accepting offer from the Alberta Forest Service to hold the meeting in Edmonton. Confirmed.

b) Location of the 1991 meeting:

Motion: That the 1991 CTIA/ACAA meeting be held at the Petawawa National Forestry Institute.

Moved by D. Lester, seconded by G. Powell. Carried.

c) Location of the 1993 meeting: Robert Bettle, on behalf of the New Brunswick Department of Natural Resources and Energy, offered to host the 1993 CTIA/ACAA meeting in Fredericton, New Brunswick.

d) Francis Yeh solicited themes for the 1989 meeting. Several topics were suggested. The incoming executive will choose the topic.

247. ELECTION OF OFFICERS

The nominating committee chairman E.K. Morgenstern proposed the following slate of officers for election:

Chairman: J. Klein
Vice-Chairman - Symposium: F. Yeh
Vice-Chairman - Arrangements: N. Dhir
Executive Secretary: J. Coles
Treasurer: C. Yeatman
Editor: T. Boyle

No additional nominations forwarded.

Motion: That the slate of officers proposed be elected.

Moved by C. Yeatman, seconded by C. Heaman. Carried.

248. ADJOURNMENT

a) Motion: That the members of the CTIA/ACAA thank the executive committee for their hospitality and their efforts over the past two years.

Moved by C. Yeatman, seconded by C. Heaman. Carried.

b) Motion: That the 21st business meeting of the CTIA/ACAA be adjourned.

moved by T. Thorpe, seconded by M. Rauter. Carried.

ATTACHMENT #1

Financial Statement
12th August 1987

The accounts of the CTIA/ACAA were duly audited for the calendar years 1984 and 1985 by Geo. Welch and Co. of Pembroke, Ontario by signature dated April 7, 1986. The balance at the end of 1985 stood at $11,686, which represented an excess of revenue over expenditure for 1985 of $277. The current cash balance stands at $481.08, plus a Bank of Montreal Guaranteed Investment Certificate of $8500.00 to mature on June 11, 1988, with interest at 8% per annum. This represents a net loss of $293.40 over the two year period, August 16, 1985 to August 12, 1987. Thus the combined revenues from the 20th meeting in Quebec and interest earned on investments and savings almost covered major expenses of printing the membership list, printing Seed Working Group newsletter, travelling expenses for students to attend the 20th meeting in Quebec, auditors fee, and printing of letterhead stationary.

A detailed cash flow from August 1985 to August 1986 is attached.

Respectfully submitted

C.W. Yeatman
Treasurer
CTIA/ACAA

CTIA/ACAA

Cash Flow
August 1985 - August 1987

		Balance, August 1985		$ 9,274.48
		Credit		
Year	Date	Item	Amount	
1985	Oct. 31	Interest	265.35	
	Dec. 16	Proceeds, 20th Mtg.	3,771.36	
		Return of advance	1,000.00	
1986	April 30	Interest	354.34	
	Oct. 31	Interest	108.01	
1987	March 31	Interest	29.96	
	June 11	G.I.C. principal	8,000.00	
		G.I.C. interest	680.00	
		Total Credit	14,209.02	14,209.02
		Credit plus Balance		23,483.50
		Debit		
Year	Date	Item	Amount	
1985	Aug. 31 - Oct. 29	Travel - 3 students	1,899.09	
1986	Feb. 28	Travel - 1 student	559.00	
	March 25	Stationary	801.33	
	May 12	Bank charge	10.00	
	June 12	G.I. Certificate	8,000.00	
	July 23	Audit	540.00	
	Aug. 22	Advance, 21st Mtg.	1,000.00	
	Sept. 18	Seed Newsletter	319.00	
1987	March 5	Membership list	1,362.00	
	March 31, May 29	Bank charges	1.00	
	May 13	Partnership registr.	11.00	
	June 11	G.I. Certificate	8,500.00	
		Total Debit	23,002.42	23,002.42
		Balance, August 1987		481.08

ATTACHMENT #2

CONSERVATION OF FOREST GENETIC RESOURCES

Report to the 21st Meeting
CTIA/ACAA
August 1987
C.W. Yeatman

No action programmes for the sole purpose of forest genetic conservation have been initiated or promoted in Canada during the past two years, or previously. This is appropriate because the long-term maintenance and evolution of representative gene pools of forest species can only be effective in the context of forest management, whether the primary objective of management is wood production, park land, ecological conservation, protection of rare species, wildlife management, or multipurpose. Within each or any of these contexts, management and maintenance of genetic resources should be a recognized component and addressed specifically in management policies and plans.

Greatly increased planting programmes of recent years place heavy demands for tree seed. It is generally recognized by Canadian forest services and industry that serious losses may be incurred by using an improper seed source or by moving seed beyond the limits of recognized ecological zones or seed zones, or by exceeding rules for seed transfer. These losses will be perpetuated in future generations derived from sub-optimal plant or seed stock. The first step in genetic management is to identify good natural stands within defined regions for collection and production of seed on the basis of forecasted requirements and contingencies, e.g. forest fire.

Selected stands cut for seed collection may be regenerated naturally or with seed or seedlings of the same origin. These designated stands will remain identifiable genetic resources (gene pools) with very close to original gene frequencies responding to environmental influences climate, soil, cultural practices) within the original setting. As such they will remain standards against which genetic gain can be measured. They will also remain consistent sources for seed collection and for future selection of trees required for breeding.

F.A.O. Panel of Experts on Forest Gene Resources

I attended the sixth session of the Panel held in Rome, Italy, in December 1985. As North American member I represented the interests and concerns of Canada and U.S.A. Much of the attention of the Panel is directed to the warm-temperate and tropical forests of the world. In both humid and arid climates, social and economic pressures are rapidly eroding genetic resources through large scale transformation and/or eradication of existing forest ecosystems. The panel reviews the current status of depletion of forest genetic resources, makes recommendations for means of conservation, and establishes priorities for action and international support.

Attempts to generate global lists of species in danger are of doubtful value in view of the scale and complexity of the problem. The Panel performs a useful function by drawing the attention of policy makers and practitioners to the need for perpetuation of genetic resources and by publicizing principles, methods and examples for sampling and sustaining selected tree populations.

The Forestry Department of F.A.O. sponsors and contracts projects in education and consultation that frequently result in substantial publications of direct use to foresters in less developed countries. Two recent examples are:

F.A.O. 1985. Forest Tree Improvement. Report on the FAO/DANIDA Training Course on Forest Tree Improvement, Merida, Venezuela, January-February, 1980. FAO Forestry Paper 20. 271 pp.

F.A.O. 1985. Tropical Forestry Action Plan. Committee on Forest Development in the Tropics. 159 pp.

Each of these publications includes discussions of genetic resource management.

Expert Committee on Plant Genetic Resources in Canada (ECPGR)

The ECPGR is the scientific advisory group to the Plant Gene Resources of Canada Office (PGRC), Research Branch, Department of Agriculture, Ottawa. The PGRC maintains the national seed repository for conservation of agricultural plant genetic resources. It participates in international gene resource programmes and international exchange of genetic stocks. It also provides documentation and information services to breeders and plant scientists and regularly publishes a newsletter.

Interests and activities of ECPGR and PGRC are understandably focussed on agricultural and horticultural crop species of Canada. Members are drawn from agricultural research stations, faculties, seed and nursery trade associations, the Genetics Society of Canada, the Canadian Society of Horticultural Science, and the Canadian Forestry Service (myself). Annual reports by members are presented at each November meeting and printed in the Minutes, together with discussions of current concerns, projects and initiatives. Further information may be obtained from me or from Dr. Brad Fraleigh, Plant Gene Resources of Canada, Plant Research Centre, Research Branch, Agriculture Canada, Ottawa, Ontario K1A 0C6.

Canada-USSR Working Group on Forestry - Forest Tree Seed

Following the initial visit to the USSR in 1983 by Drs. D.P. Fowler and C.W. Yeatman, three Canadian forest scientists travelled to southern Siberia in October, 1985, to collect seed of Scots pine (*Pinus silvestris* L.) and to identify superior stands of Siberian larch (*Larix sibirica* Ledeb.) for future collection. Only small quantities of Scots pine were acquired on this occasion. The objective is that seed of

selected origin will be distributed to interested agencies in Canada for growth and yield trials and subsequent selection of trees to add to base breeding populations of these species of potential value in Canadian forest production. The team included a representative of the Canadian Forestry Service (Dr. T.J.B. Boyle, P.N.F.I., Chalk River, team leader), a representative of Agriculture Canada, Prairie Region (Mr. W.R. Schroeder, P.F.R.A. Nursery, Indian Head, specializing in shelterbelt species) and a supporting Forest Officer of the Canadian Forestry Service to aid in interpretation (Mr. J. Holowacz). Their reports and recommendations were forwarded to Mr. J. Cayford, Director, Great Lakes Forestry Centre, Sault Ste. Marie and Co-Chairman, Canada/USSR Working Group for Forestry.

The collection trip planned for Southern Siberia in the autumn of 1986 to collect seed of Scots pine was cancelled in September. The Russian authorities advised the Canadian Forestry Service that the crop forecasts were poor. Tim Boyle hopes to proceed with this trip in 1987, but arrangements have not yet been confirmed. In the meantime, a party led by Bill Schroeder had a highly successful visit to Russia this summer in relation to arboreal shelterbelt management and selection of species.

Canadian Plant Conservation Programme (CPCP)

With the initiative from plant scientists from Canadian Botanical Gardens, a first meeting attended by 19 people was held on November 20 and 21, 1986, at the University of Guelph Arboretum. The goal of the programme is: "The conservation of genetic diversity of species and populations of rare native plants and heritage ornamentals in Canada".

The following announcement was sent to Botanic Gardens and related institutions immediately following the meeting.

PROGRAMME ESTABLISHED FOR THE CONSERVATION OF CANADA'S RARE PLANT RESOURCES

John Ambrose
University of Guelph Arboretum
Guelph, Ontario
Canada. N1G 2W1

Canada has an estimated 1,200 species of native plants that are rare or endangered. Botanical gardens and arboreta have an enormous potential to contribute toward the lessening of the threat under which these species precariously exist.

At the founding meeting of the Canadian Plant Conservation Programme hosted by the University of Guelph Arboretum, representatives from Canada's botanical gardens, related institutions, and various agencies concerned with the conservation of plant gene resources, convened to consider appropriate objectives and action.

The objectives of this national program have a special emphasis on the roles living collections can play in a comprehensive conservation effort. With a goal of conserving genetic diversity of species and populations of rare native plants as well as heritage ornamentals, detailed objectives were defined.

The enhancement of communication and cooperation between Institutions with living collections is a primary objective. In addition, such institutions are encouraged to carry out research into the conservation biology of rare plants, which will provide the information needed for the management of significant natural habitats. Garden-propagated collections of rare plants can serve in a crucial aspect of conservation, namely, the promotion of public awareness of conservation issues and philosophies through interpretive programs.

A paramount concern of conservation is the protection of the habitats of rare species. This group intends to maintain communications with agencies directly concerned with habitat conservation, and direct efforts toward that overall goal. The establishment of garden collections of rare plants is seen as a complement to, not a substitute for, habitat conservation. These collections, sampled from wild populations in such a manner as not to further endanger them, provide material for research as well as a source of appropriate genotypes for re-introductions into restored habitats or enhancement of depleted populations.

A parallel program will be established for the preservation of heritage garden plants, both those that have been in cultivation since the time of settlement and old cultivars developed in Canada. In addition to preserving some of our cultural heritage, many have potential for further garden selections suitable to Canada's climatic conditions.

The botanical garden community has recognized the important role it can play in the World Conservation Strategy, to which Canada is a party. This program will facilitate and coordinate efforts at our various botanical gardens, arboreta, and related institutions.

The initial groundwork for this program was done by Patrick Seymour and staff of the Devonian Botanic Garden (Edmonton). The members of the elected executive are: John Ambrose (chairman, University of Guelph Arboretum), Randy Currah (Devonian Botanic Garden) and Peter Rice (Royal Botanical Gardens, Hamilton); and committee chairman Bernard Jackson (Memorial University of Botanical Garden, St. John's) and Ann Smreciu (Devonian Botanic Garden).

ATTACHMENT #3

PROPOSED AMENDMENTS:

To Article III, Section c, para. 1:

"A member may resign by notifying the Executive Secretary or by instructing the Editor to remove his name from the mailing list. In the case of an Active Member, the Editor will then notify the Executive Secretary."

To Article IV, Section a:

"The Executive of the Association shall consist of ..., an Editor and a Treasurer."

PROPOSED ADDITIONS:

To Article V, Section a:

"The Chairman shall be responsible for managing the financial accounts of the current meeting. Following the Meeting, and within the same calendar year, the Chairman shall provide the Treasurer with an audited, detailed statement of receipts, expenditures, and balance of the Meeting accounts. A surplus will be transferred to the CTIA account. A request for funds to cover a deficit must be made to the Treasurer."

To Article V:

"g. Treasurer

The Treasurer shall take office upon completion of the meeting which elected the new Executive, and shall be responsible for maintaining the accounts of the Association between meetings, providing a financial report to members at each business meeting and ensuring the accounts are audited at regular intervals. The Treasurer shall provide funds to the Chairman in advance of each meeting to establish an operating account and receive surplus funds, if any, following each meeting for deposit in the Association account."

SYMPOSIUM AND FIELD TOURS - PHOTOS

SYMPOSIUM, ET TOURS DES LIEUX - PHOTOS

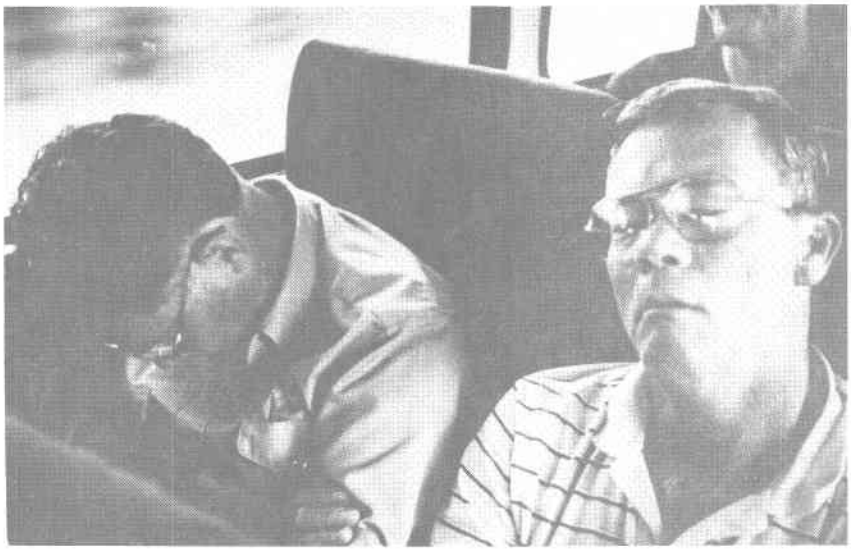
1987-88 Executive: Howard Frame (Vice-Chairman, Local Arrangements), Tim Mullin (Chairman), Tim Boyle (Editor), Kit Yeatman (Treasurer). Missing: Kris Morgenstern (Vice-Chairman, Symposium), Jim Coles (Executive Secretary), Armand Corriveau (Past Chairman).

Tim Mullin and Frances Yeh (Chairman, Education Committee, extreme right), with scholarship-winning students.

A happy group of tourists: Dale Simpson, Marie Rauter, Bruce Dancik, Gilles Vallee, Joan Wild, Yves Lamontagne, Cheng Ying, Mike Meagher and Mrs Meagher.

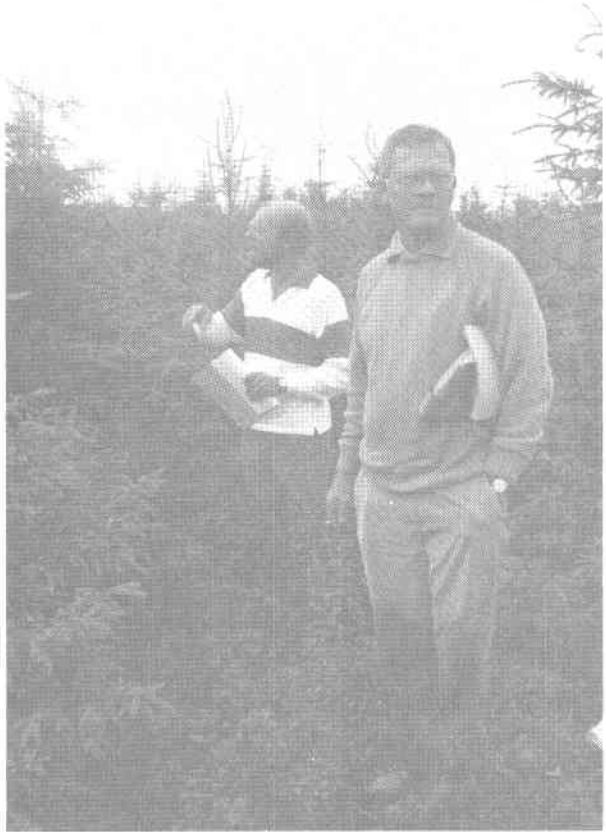
As Gordon Murray, Mrs. Powell, Graham Powell and Chung Suk Kim (Korea) look on, Kit Yeatman grabs the last lobster and Jerry Klein expresses his frustration at missing out.

A triple-Ying: Cheng Ying, Mrs. Ying and Lin Ying come to grips with Nova Scotian lobster.



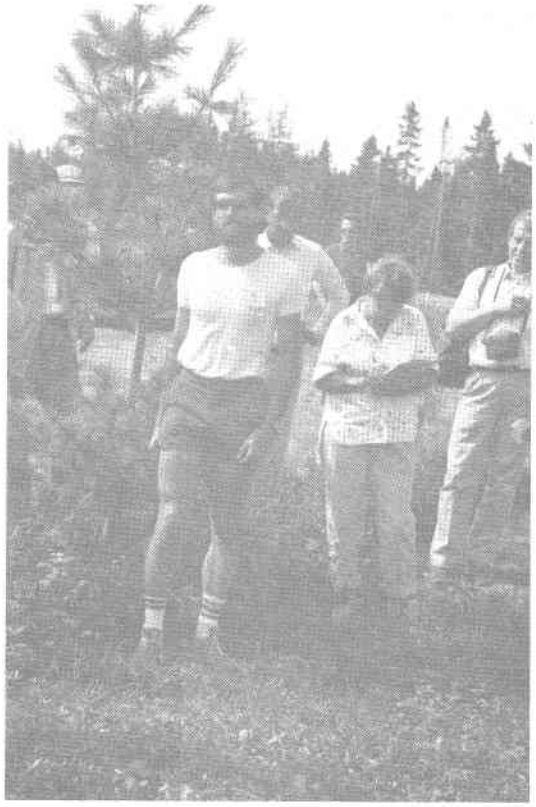
While Don Fowler dreams up new tree improvement strategies, Kit Yeatman checks that his boot-laces are done up.

Bruce Dancik and Ron Wasser help to hold up spruce grafts.



Where has everybody gone? Tim Mullin and Don Fowler have lots to talk about, but no-one to listen.

Who wants to look at black spruce when there's free food available? Ken Eng, Jerry Klein, Graham Powell, Ben Wang and Mike Meagher hunt for berries.



Ron Smith models the latest fashions for tree improvement specialists. Narinder Dhir isn't impressed.

George Edwards, about to perform.

MEMBERS' REPORTS

RAPPORTS DES MEMBRES

A LONG-TERM TREE-IMPROVEMENT STRATEGY FOR NEWFOUNDLAND AND LABRADOR

C.M. Harrison

Department of Forest Resources and Lands
P.O. Box 2006, Herald Building
Corner Brook, NF
A2H 6J8

Keywords: Plus trees, seed orchards, controlled crosses, exotics

A comprehensive programme for tree improvement in Newfoundland and Labrador was developed and published in 1986. Copies of the publication are available from the above address.

After an initial review of current and past activities in the area of tree improvement in the Province, future strategy is discussed under the headings of Selection and Breeding of Native Species, The Exotic Testing Programme, and Miscellaneous Projects. Under the first heading, a long-term breeding strategy is presented for black spruce, white spruce, and eastern larch or tamarack. Step-by-step plans are presented in the form of flowcharts, and each step is discussed in the text. Techniques that play a part in the strategies include plus-tree selection, progeny tests, breeding gardens, polycross and partial diallel matings, selection of the best phenotypes within families, clonal and seedling seed orchards, and hedges for vegetative propagation. Seed production areas have been and are being established to provide above average seed until the seed orchards begin to produce improved seed. The possibility of future breeding programmes in other species is also discussed.

Under the exotic testing programme, a flowchart is also presented to represent a general case. The course of events from preliminary consideration of an exotic species for introduction to genetic improvement of that species is presented in the same step-by-step manner. Along the way, of course, are several junctures at which the species may be eliminated from the programme.

A few exotic species, such as Japanese larch and jack pine, have already proven themselves sufficiently to justify production planting. Many others have either not survived or have done so poorly that they can be eliminated from further consideration. Quite a few others are still in the "grey area". They have not done well enough to justify a full-scale introduction and improvement programme, but neither have they done so poorly as to be written off as failures. Further trials are indicated for them.

The broad range of species not yet tried includes many that can be eliminated because they would not survive Newfoundland winters or because they are of little or no commercial value anyway. Most of the remainder will be subjected to pilot trials, usually as arboretum specimens. Then, if they show promise, they will later be subjected to larger species trials. A few, which seem to be especially good prospects, will be subjected to species trials without going through the pilot trial stage.

The major project discussed under the Miscellaneous heading is The Provincial Arboretum. It will consist of an exotic division and a genetic division, and will be centered at Wooddale Nursery, with branches at Pynn's Brook, Mt. Pearl, Goose Bay, and possibly other locations. One of its major functions will be to serve as a place for pilot trials of numerous exotics, but will also be valuable for educational and scientific purposes, for preservation of genotypes, for public relations, and for reference. A few specimens have already been planted in situ, and many others are in the greenhouse or in special transplant beds. Most of them will be placed in the arboretum this year.

Biotechnology and the impact developments in that area may have on our strategy are briefly discussed. A work plan for 1987 and a five-year plan for 1987 through 1991 are presented. Copies of the publication have been distributed to appropriate Provincial, Federal, and industry personnel. An annual meeting will be held in January of each year to keep everybody concerned up to date on progress in implementing the strategy.

TREE IMPROVEMENT AT THE NEWFOUNDLAND FORESTRY CENTRE 1985-1987

J. Peter Hall

Newfoundland Forestry Service
Canadian Forestry Service
Box 6028
St. John's, Nfld.
A1C 5X8

Keywords: Provenance trials, afforestation trials, flower induction

Tree improvement activities at the NeFC centred on a series of provenance trials. A study on flower induction in black spruce was published and a study on optimal dates of cone collection for central Newfoundland was begun. An evaluation was begun of a series of afforestation trials which had been established in eastern Newfoundland between 1937 and 1970.

PROVENANCE TRIALS

The results of the twenty-five year old White spruce (Picea glauca (Moench) Voss) provenance trial was published and showed the superiority of certain Ottawa Valley and western Quebec sources (Hall 1986b). Results from a twenty-five year old trial of red spruce (P. rubens Sarg.) indicated no clinal or geographic trends (Hall 1986a). Height growth was related to the amount of introgression with black spruce (P. mariana (Mill) B.S.P.). A test of coastal and inland balsam fir (Abies balsamea (L.) Mill) sources indicated that growth of the coastal sources declined around age thirty (Hall 1987d). Twelve provenances of Sitka spruce (P. sitchensis (Bong.) Carr.) were assessed at twenty years. On average the Sitka were outgrown by local black spruce but some individual Sitka spruce grew much faster than black spruce. This suggested the development of a land race in Sitka spruce (Hall 1987b). The regional provenance trials of black spruce indicated a mixed clinal and ecotypic pattern of variation. Use of local seed sources for reforestation is suggested (Hall 1987c).

A trial of twelve seed sources of European larch (Larix decidua Mill.) was established in 1986. Seed for an all range trial of tamarack (L. laricina (Du Roi) K. Koch) was sown in the greenhouse n 1986.

FLOWER INDUCTION

A study on flower induction in black spruce showed that $GA_{4/7}$ was effective in promoting flowering in twenty-year old trees (Hall 1986c). Another study showed that it was practical to collect black and white spruce and tamarack cones several weeks earlier than usual to reduce losses by squirrels and insects (Curran et al. 1987).

AFFORESTATION STUDIES

A survey of afforestation trials showed that it was possible to afforest exposed barranlands with a variety of species of Larches, Spruces and Pines (Pinus spp.) (Hall 1987a). The crop for the first rotation (40 years) is likely to be firewood. The plantations regenerated naturally and the second crop is superior in growth and form because of the amelioration of the microclimate.

PUBLICATIONS AND REFERENCES

Curran, W.J., P. Tricco, and J.Peter Hall. 1987. Optimal dates for collection of conifer seed in central Newfoundland. Can. For. Serv., Nfld. Forestry Centre, Inf. Rep. N-X-248 (in press).

J. Peter Hall. 1986(a). A provenance trial of red spruce i the boreal forest. Can. For. Serv., Nfld. Forestry Centre, Inf. Rep. N-X-246. 18 p.

J. Peter Hall. 1986(b). A provenance trial of white spruce in Newfoundland: twenty-five years from seed. Can. For. Serv., Nfld. Forestry Centre Inf. Rep. N-X-247. 33 p.

J. Peter Hall. 1986(c). Flower promotion in black spruce seedlings using gibberellins. Can. For. Serv., Nfld. Forestry Centre, Inf. Rep. N-X-252. 23 p.

J. Peter Hall. 1987(a). Afforestation of heathands in eastern Newfoundland. Can. For. Serv., Nfld. Forestry Centre, Inf. Rep. N-X-253. 25 p.

J. Peter Hall. 1987(b). A provenance trial of Sitka spruce in the boreal forest. Can. For. Serv., Nfld. Forestry Centre, Inf. Rep. N-X-254 (in press).

J. Peter Hall. 1987(c). Regional provenance trials of black spruce in Newfoundland: fifteen years from seed. Can. For. Serv., Nfld. Forestry Centre, Inf. Rep. N-X-255. 23 p.

J. Peter Hall. 1987(c). Growth of inland and coastal provenances of balsam fir. Can. For. Serv., Nfld. Forestry Centre, Inf. Rep. N-X-256 (in press).

TREE IMPROVEMENT AT NEW BRUNSWICK DEPARTMENT OF NATURAL RESOURCES & ENERGY

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Keywords: Family tests, plus tree selection, seed orchards, stand tests

The New Brunswick Department of Natural Resources and Energy's tree improvement program has continued to be very active over the last two years. Most of our effort has concentrated on the four main reforestation species, black spruce (Picea mariana (Mill.) B.S.P.), jack pine (Pinus banksiana Lamb.), white spruce (Picea glauca (Moench) Voss) and tamarack (Larix laricina (Du Roi) K. Koch.). In addition, tree improvement programs have been initiated for balsam fir (Abies balsamea (L.) Karst.). Active participation and cooperation has continued with the New Brunswick Tree Improvement Council.

A summary of the Department of Natural Resources & Energy's tree improvement effort is outlined as follows.

STAND TESTING

A number of black spruce and jack pine stands have been reserved and tested throughout New Brunswick. Ten-year measurements were assessed for jack pine stand tests in 1985 and 5 black spruce stand tests in 1986. To date, 337 kilograms of black spruce seed and 257 kilograms of jack pine seed has come from reserve stands.

PLUS TREE SELECTION AND BREEDING

First generation selection has finished, with a total of 632 black spruce, 539 jack pine, 102 tamarack and 78 white spruce plus trees selected by DNRE. For white spruce and tamarack, controlled pollinations began in 1986 with 5 crosses carried out for tamarack and 11 white spruce crosses. It will be several years before there are enough crosses for progeny testing.

ORCHARD ESTABLISHMENT AND FAMILY TESTS

To date, 40 hectares of black spruce, 25 hectares of jack pine and 8 hectares of Ottawa Valley white spruce seedling seed orchard have been outplanted. It is anticipated that the total area now planted will meet all of our present seed requirements. In the fall of 1986, the first major cone collection was made at our Otter Brook 1979 jack pine orchard. A total of 1644 litres of cones were collected, which yielded approximately 5 million seed (Tosh 1987). Roguing operations were completed in this orchard in the fall of 1986, with a final first roguing of 53%.

Grafting of white spruce and tamarack for clonal orchards and breeding gardens has continued. Approximately 2361 white spruce and 1560 tamarack scions were grafted. The total clonal orchard area is 8 hectares of white spruce and 9 hectares of tamarack and, with the exception of fill-ins, all of the clonal orchards have been planted.

PUBLICATIONS AND REFERENCES

Powell, G.R. and K.J. Tosh. 1987. Tamarack. In: Reproduction of conifers: a handbook for cone crop assessment. Can. For. Ser., For. Tech. Rep. 31. 2 pp. In press.

Tosh, K.J. 1986. Development and distribution of cones, pollination and yield of seeds in young plantations of tamarack. M.Sc.F. thesis, University of New Brunswick, Fredericton, NB, 144 pp.

Tosh, K.J. 1987. Cone and seed yield from a jack pine seedling orchard. Tree Seed Working Group Bull., No. 7.

Tosh, K.J. and G.R. Powell. 1986. Proliferated, bisporangiated, and other atypical cones occurring on young, plantation-grown Larix laricina. Can. J. Bot. 64: 469-475.

TREE BREEDING AT THE CANADIAN FORESTRY SERVICE - MARITIMES 1985 and 1986

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Keywords: Population studies, provenance tests, species hybridization, applied tree improvement, tissue and organic culture, Picea, Larix, and Pinus

An opportunity exists to substantially increase forest growth by developing and utilizing genetically superior trees for the expanding reforestation programmes of the Maritimes Region. The objectives of the tree breeding work at the Canadian Forestry Service - Maritimes (CFS-M) are to determine the amount of genetic improvement attainable within promising tree genera and to provide resource managers of the Region with the information and, in some cases, breeding materials required to obtain realistic levels of genetic improvement.

HYBRIDIZATION IN PICEA AND LARIX

The almost complete absence of flowers on Picea and Larix in central New Brunswick in 1985 precluded work on species hybridization. In 1986, pollen of Picea engelmannii, P. glauca, P. glehnii, P. jezoensis, P. koyamai, P. meyeri, and P. orientalis were tested on P. glauca. The cross P. glauca X P. jezoensis was the only one that consistently produced viable seeds. No full seeds were obtained from other crosses of P. mariana (female) with P. glauca from both eastern and western sources. A paper on species crossability of P. glauca and P. sitchensis has been accepted for publication.

Selected Larix leptolepis clones were crossed with phenotypically good L. decidua in 26 tree X tree combinations. Seed yields from these crosses were below expectation. One seedling from each of 25 different L. leptolepis X L. decidua crosses was vegetatively propagated to provide materials for tests designed to determine the number of ramets/clone and number of planting sites required to identify superior hybrid clones. Seeds germinated in February produced over 50 cuttings each in November. With serial propagation (14 cuttings taken in June and three sets of cuttings struck at monthly intervals starting in November) it is possible to obtain 500 ramets/clone in one year. Using this system, 1,000-2,000 plants could provide 1 million cuttings or more per year.

SPECIES AND PROVENANCE TRIALS

Starting in 1953-54, field trials of important native species and potentially important non-native species have been established in the Maritimes. The species trials include: Abies (5 trials), Larix (7), Pinus (5), Picea (1). This aspect of the study has been largely completed. During this same period, provenance trials were established with the following species: Abies balsamea (3 trials), Larix leptolepis (1), L. laricina (1), Picea abies (11), P. mariana (1), P. rubens (2), Pinus banksiana (1), P. resinosa (2), Pseudotsuga menziesii (3), and Betula alleghaniensis (1). With the exception of the most recently established trials with Picea mariana and Larix laricina and the few trials established using large plots, most of the useful information on geographic variation has been extracted from this study. No new provenance trials are anticipated. During the report period survival data were obtained from the L. laricina trial which is planted in 10 locations in the Region. The L. leptolepis trial which was planted in 49-tree plots was measured and thinned to 25 trees per plot. Data from a Picea rubens trial (age 23 years) and the range-wide P. mariana trial (10 years) have been prepared for publication.

POPULATION STUDIES

In 1979, the population genetic studies of important reforestation species were reorganized and consolidated to include experiments on population structure, inbreeding, progeny testing, and quantitative estimates of genetic parameters. There is a total of eight major experiments involving black spruce, white spruce, and tamarack. The studies concerning effects of inbreeding on seed set, relatedness among neighboring trees, embryonic lethals, and early survival and growth of the three species have been completed. The field plots of these experiments will be maintained and evaluated at regular intervals.

A new study concerning genetic structure of upland and lowland populations of black spruce was initiated in 1985. The prime purpose of this experiment was to examine family relationships among the trees growing under different ecological conditions. It is hypothesized that the lowland populations consist of overlapping generations of trees, and, thus, are expected to have stronger family relationships than found in upland populations. Five subpopulations at Acadia Forest Experiment Station (AFES) were used. For each subpopulation, a series of controlled pollinations were performed using self-pollen, a pollen mix of neighboring trees and a pollen mix from an unrelated population, plus an open-pollination. This resulted in a total of 150 families. The seed set and greenhouse growth data have been analyzed. A field test has been established at AFES using 10 randomized blocks of 4-tree row plots.

Population studies of tamarack received attention during the review period. An open-pollinated progeny test was established at four test sites in the Maritimes using families from three natural populations in New Brunswick (AFES, CANAAN, and NORTON) and has been analyzed for five year height and survival. Narrow sense heritability for height for the AFES population was moderate ($h^2 = 0.12$), but for the CANAAN and NORTON populations it was low, 0.05 and 0.04, respectively. This result implies that the conventional selective breeding techniques may be ineffective for populations such as CANAAN and NORTON.

Another tamarack experiment, "clonal progeny test" at two test sites, was also analyzed for five year height and survival. The same three populations were included in this experiment, but the plant materials were derived by mass clonal propagation, i.e., rooted cuttings. The main objectives of this experiment were (1) to determine amount of genetic variability for each population and partition into additive and non-additive components and (2) to explore feasibility of clonal propagation and selection as a tree improvement-reforestation option. The results indicated that about 85% of clonal variation in height was additive for the AFES and CANAAN populations but only 18% for the NORTON population. It also indicated that clonal forestry with tamarack is a viable alternative, and selection based on clone means and mass vegetative propagation will achieve substantial genetic gain even if the proportion of additive variance is small.

COOPERATIVE TREE IMPROVEMENT

The CFS-M continues to provide technical coordination and direction to the cooperative tree improvement programme in New Brunswick. The New Brunswick Tree Improvement Council completed its 10th year of operation in 1986. The programme is at a crossroad between the completion of plus tree selection, family testing, and seed orchard establishment and the initiation of a breeding and progeny testing programme and the harvesting of cones from seed orchards.

Plus tree selection has been completed with over 2500 trees selected representing over 90% of the goal. Seedling seed orchard establishment and family testing of jack pine and black spruce will be completed in 1987. Presently there are about 44 and 84 ha of jack pine and black spruce seedling orchards, respectively. About 44 ha of clonal seed orchards have been established, primarily of tamarack and white spruce. Two jack pine seedling orchards, planted in 1979, were rogued in 1986. About 8.5 million seed were collected in 1986 from three jack pine seedling orchards. Some seed was also collected, for the first time, from two black spruce seedling orchards.

The breeding programme for white spruce and tamarack was initiated in 1986. Two types of mating are being conducted: polycross, to test clones for general combining ability and pair-mating, to generate material for second generation selections.

An immediate benefit of the tree improvement programme can be through a reduction in planting efforts required to achieve specific future wood supply targets as a direct result of shorter rotations and higher yields. However since there are only small amounts of improved seed available, this is considered a potential benefit. The extent to which this potential benefit will be realized will be determined by following or even accelerating the schedule for rogueing orchards and maximizing seed production within them.

CONE AND SEED RESEARCH/SEED ORCHARD MANAGEMENT

There are currently over 200 ha of seed orchards in the Maritime Provinces. Numerous problems have arisen associated with both the establishment and management of these orchards. The CFS-M staff from both Tree Improvement and the Forest Insect and Disease Survey continue to provide assistance to orchard managers in the Region through technology transfer, and conducting operational, problem-oriented research trials.

An operational fertilizer trial for cone induction was established in a New Brunswick Department of Natural Resources and Energy jack pine seedling seed orchard. This trial will be assessed in 1987. Similar trials are scheduled for black spruce and white spruce seedling orchards in 1987.

TISSUE CULTURE OF CONIFERS

Dr. Patrick von Aderkas joined J.M. Bonga to work in the area of tissue culture of conifers. The tissue culture programme has two main components, 1) regeneration of plants from haploid tissues, and 2) clonal propagation of mature trees. Over the last 6-7 years almost all our work has been carried out with Larix decidua, a species that appears to be easier to culture than most other conifer species that we have available.

Three years ago we established a highly embryogenic callus from megagametophytes. This callus by now has passed through about 50 subcultures and is still producing haploid embryos at an undiminished rate. These embryos germinate readily and form small, green plantlets that can be grown in soil for about 6 months. Then growth stops and the plantlets die. The plantlets are much smaller than their diploid counterparts at the same stage of development. Presumably, lethal recessives, freely expressed in the haploid state, prevent continued growth of the plantlets. This experiment was repeated during each of the following two summers, i.e., we have a reproducible system. The two key factors in the initiation of embryogenic callus are the proper collection date (within 2-3 weeks after fertilization), and 2,4-D.

Clonal propagation of mature trees is still difficult. We are routinely producing large numbers of adventitious shoots from trees that are about 30 years old. However, only about 1% of these shoots will form roots. Unfortunately, most of these rooted shoots fail to elongate. So far we have produced only one plantlet that is behaving like a normal seedling. Formation of this normal plantlet is encouraging because it indicates that the explants at least have the potential to produce normal propagules.

PUBLICATIONS

Bonga, J.M. 1986. In vitro propagation of mature conifers. In Biotechnology and Renewable Energy. Edited by M. Moo Young, S. Hasnain, and J. Lamptey. Elsevier Applied Sciences Publications Ltd., 20 p.

Carter, K.K., and J.D. Simpson. 1985. Status and outlook for tree improvement programs in the Northeast. North. J. Appl. For. 2: 127-131.

Fowler, D.P. 1985. Past, present, and future of Canadian tree improvement programs. 66th Annual Meet., Woodlands Sect. CPPA. Montreal, P.Q., Jan. 29, 1985. Can. For. Ind. 105(10): 141-142.

Fowler, D.P. 1985. Tree improvement. Chapter 6. In Reforestation in the Maritimes 1984 Symposium. Edited by R.D. Hallett, M.D. Cameron, and T.S. Murray, Apr. 3-4, 1984. Moncton, N.B.

Fowler, D.P. 1986. Strategies for the genetic improvement of important tree species in the Maritimes. Can. For. Serv.-Maritimes. Inf. Rep. M-X-156.

Fowler, D.P. 1986. Strategies for the genetic improvement of Larix species and hybrids in the Maritimes. Proc. 1986 Larch Workshop. Fredericton, N.B., Oct. 14, 1986.

Fowler, D.P. 1986. Strategy for the genetic improvement of Norway spruce. Proc. 30th NEFTIC, Orono, Maine. July 22-24, 1986.

Fowler, D.P., J.M. Bonga, Y.S. Park, J.D. Simpson, and R.F. Smith. 1986. Tree breeding at the Maritimes Forest Research Centre 1983 and 1984. Proc. 20th CTIA. Part 1. Edited by C.W. Yeatman and T.J.B. Boyle. Quebec City, P.Q., Aug. 19-22, 1985: 58-63.

Gerhold, H.D., and Y.S. Park. 1986. Population hybridization in Scotch pine (Pinus sylvestris L.): II. combining ability comparisons. Silvae Genet. 35: 195-201.

Nagmani, R., and J.M. Bonga. 1985. Embryogenesis in subcultured callus of Larix decidua. Can. J. For. Res. 15: 1088-1091.

Park, Y.S., and H.D. Gerhold. 1986. Population hybridization in Scotch pine (Pinus sylvestris L.): I. genetic variance components and heterosis. Silvae Genet. 35: 159-165.

Simpson, J.D. 1985. Third annual report. N.B. Tree Improvement Council, Marit. For. Res. Cent. 15 p.

Simpson, J.D. 1986. Fourth annual report. N.B. Tree Improvement Council, Marit. For. Res. Cent. 20 p.

Simpson, J.D. 1986. Developing the superior balsam. Pages 57-61 in Balsam Fir Update: A Review of the Latest Research Findings Pertinent to Christmas Tree Culture, University of New Brunswick, Faculty of Forestry, 76 p.

Smith, R.F. 1985. Grafting experiments with white spruce. Can. For. Serv., Marit. For. Res. Cent. Tech. Note No. 134.

Smith, R.F., L.P. Magasi, and K. Harrison. 1986. Cone rust - A potential problem in white spruce seed orchards. Can. For. Serv., Maritimes For. Res. Cent. Tech. Note No. 161.

Smith, R.F. 1985. Seed collection and handling. Chapter 7. In Reforestation in the Maritimes 1984 Symposium. Edited by R.D. Hallett, M.D. Cameron, and T.S. Murray. Apr. 3-4, 1984. Moncton, N.B.

Smith, R.F. 1986. Managing black spruce seedling seed orchards for cone and seed production. Pages 187-190 in Proc. Conifer Tree Seed in the Inland Mountain West Symposium. Compiled by R.C. Shearer, Missoula, MT, 5-6 August, 1985.

J.D. IRVING LTD. - TREE IMPROVEMENT PROGRESS

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Keywords: Picea mariana, P. glauca, P. abies, Pinus banksiana, Larix laricina, clonal seed orchard, family test, seedling seed orchard, controlled pollination, flower induction

This report summarizes tree improvement progress of J.D. Irving Ltd. for the past two years. The program was initiated in 1980 and activities have mainly involved plus tree selection, open pollinated family test establishment as well as clonal and seedling seed orchard establishment. The establishment of family tests and seedling seed orchards has been in conjunction with the New Brunswick Tree Improvement Council. New projects will also be discussed.

PARENT TREE SELECTION

Field selection of plus trees for first generation seed orchards was completed in October, 1986. A total of 487 selections have been made since 1980 for black spruce (Picea mariana (Mill.) B.S.P.), white spruce (Picea glauca (Moench) Voss), Norway spruce (Picea abies (L.) Karst.), jack pine (Pinus banksiana Lamb.), and eastern larch (tamarack) (Larix laricina (Du Roi) K. Koch). These selections, combined with other selections shared with the New Brunswick Tree Improvement Council (NBTIC), provide the initial genetic base of 588 select trees for J.D. Irving Ltd.

All future selections for advanced generation seed orchards will be made in replicated field plots, using only tested material.

PROPAGATION AND CLONAL ORCHARDS

Grafting for clonal orchard and clone bank establishment has been done at the Sussex Tree Nursery since 1981. Rootstock and seedlings for field test establishment are also grown at this facility. Work on methodology for operational vegetative propagation has also begun for several species. Multiplication techniques and rooting procedures are being investigated now to assess the economic feasibility of propagating specific crosses based on progeny test information in years to come.

Progress has been steady in the establishment of first generation clonal orchards. The areas currently completed are as follows, by species:

Species	Area planted (ha)	Total planned (ha)
Black spruce	10.1	20.2
White spruce	14.2	24.3
Norway spruce	1.6	3.2
Jack pine	8.1	8.1
Eastern larch	9.7	9.7

The oldest areas of the orchards are beginning to produce cones and in 1987 the first 50,000 seedlings were grown.

SEEDLING SEED ORCHARDS

Since 1979, a total of 13 open pollinated seedling seed orchards of jack pine and black spruce have been established by J.D. Irving Ltd. on 37.2 hectares of land. These orchards originated from seeds collected from plus tree selections within the New Brunswick Tree Improvement Council. The first genetic roguing of the oldest jack pine orchard has been completed and operational seed crops have already been harvested and crops grown in the company nurseries. Supplemental mass pollination activities were conducted in 1987 in the oldest black spruce seedling orchard, with the first cone crop to be harvested in September 1987.

FAMILY TEST ESTABLISHMENT

Since 1978, a total of 88 research plantations of various types have been established by J.D. Irving. Of this total, 30 open-pollinated family tests of jack pine and black spruce are planted on 50.9 hectares of land. These tests are established in co-operation with NBTIC and are providing the genetic information to rogue the seedling seed orchards and for the selection of improved parents for future generation orchards.

TREE BREEDING

The first major efforts in tree breeding began in 1986. Controlled pollination is being done on the clones from the seed orchard in order to determine those to be rogued and also to provide some of the material for the next generation of improvement. This process is anticipated to require a number of years for completion. Work is currently underway to

look at practical ways of accelerating this process through growth acceleration of grafts in the greenhouse and flower induction techniques. In the current generation, this is especially important for clones which came into the program in later years. This will reduce the time span over which first generation progeny tests are established. Work has also been initiated in retrospective family tests in the nursery, using some of the families from the first series of tests established by NBTIC in 1979. This will give us an idea of the potential uses of accelerated progeny testing.

RESEARCH IN TREE SEED AND POLLINATION, 1985-1987

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Keywords: Picea mariana, seed-cone, pollen-cone, seed production, distribution patterns, pollen monitoring

During the period covered by this report, my Ph.D. program at the University of New Brunswick was finalized. This report includes the abstract of my thesis and a brief summary of research initiated with Fraser Inc.

Ph.D. THESIS ABSTRACT

The objective of this investigation was to describe morphological and developmental changes associated with tree-maturation, branch-maturation, and seed-production phenomena as crown structure developed in young black spruce (Picea mariana (Mill.) B.S.P.). The information was gathered from 6- to 18-year-old, plantation-grown trees in northwestern New Brunswick from 1980 to 1983. This information was used to show how developmental patterning is related to production of seed cones and pollen cones and, hence, to initiation and continuation of seed production.

The amount, duration, and complexity of branch development followed patterns related to the initial position of the branch on the main stem. Seed cones and pollen cones were first recorded on 7- and 10-year-old trees, respectively. Quantities of seed cones and pollen cones increased with tree age but with biennial fluctuations. The seed-cone and pollen-cone zones fluctuated in size as production of strobili fluctuated. Placement of strobili on shoots was associated with shoot length and shoot location within individual strobilus zones. Seed-cone and pollen-cone production were each associated with concomitant, and subsequent, reduction of shoot production, which reduced the potential number of sites for cone production in the subsequent year. Large quantities of cones were negatively associated with numbers of buds initiated, time of shoot-bud flushing, amount of sexual differentiation, lengths of shoots, and numbers of ovuliferous scales per seed cone during the seed-bearing year, and with lengths of seed cones the following season. Therefore, the large quantities of cones were themselves involved in maintenance of biennially

fluctuating levels of production. Full seed yield per cone increased with increases in numbers of both kinds of reproductive structures. Seed potential was generally high for seed cones on the young trees but full seed yield per cone was at times low and was associated with relatively small numbers of pollen cones and small quantities of pollen.

This investigation demonstrated the existence of distinct structural patterns associated with fluctuating seed production. The information provided should be of value in managing seed orchards, in developing procedures to enhance or otherwise control strobilus production, in explaining resource production and allocation within the crown, and in elucidating the physiological bases for cone differentiation.

SEEDLING SEED ORCHARD POLLEN MONITORING

Pollen monitoring was initiated in 1987 in two Fraser Inc. black spruce seedling seed orchards in northwestern New Brunswick. The 2.8 ha Second Falls (S.F.) orchard was established in 1978. Parts of the 13.5 ha Plaster Rock (P.R.) orchard were sequentially established in 1979, 1980, 1981, and 1984. Pollen traps (10 and 16 in the S.F. and P.R. orchards, respectively) were installed within and surrounding the orchards. Traps were installed at the level of the female zone of the trees and were collected and replaced daily for 18 days starting on May 17th.

The pollination period began on May 18 in P.R. and one day later in S.F., and lasted until early June. Pollen grains were still being trapped by early June, but quantities were low and insignificant. Most seed cones had closed by May 30th. Seed-cone receptivity lasted for about 15 days. Peak pollen shedding was recorded on traps collected on May 28th in both orchards.

The quantity of pollen grains of within orchard sources trapped during the entire pollination period was low. This was expected, as production averaged 1.0 and 3.2 pollen cones per tree in the S.F. and P.R. (1979 section only), respectively. Evaluation of the quantity of pollen grains of contamination sources indicated that 35.5 and 68.6 % of pollen grains trapped in the S.F. and P.R. orchards, respectively, were contaminants.

PUBLICATIONS

Caron, G.E. 1987. Development of branch and seed production in young black spruce (Picea mariana (Mill.) B.S.P.). Ph.D. theis, University of New Brunswick, Fredericton, N.B., 330 pp.

Owens, J.N., S.J. Simpson, and G.E. Caron. 1987. The pollination mechanism of Engelmann spruce (Picea engelmannii Parry). Can. J. Bot. 65:1439-1450.

TREE IMPROVEMENT AND RELATED STUDIES AT THE UNIVERSITY OF NEW BRUNSWICK 1985-1987

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The program of education and research at the University of New Brunswick (UNB) is expanding and good progress is being made. This report highlights activities since the last review (Powell and Morgenstern 1986).

Provenance

By means of a contract with the Canadian Forestry Service, a synthesis of results was prepared from the range-wide study of black spruce (Picea mariana (Mill.) B.S.P.) at age 15 years from seed. Height was well differentiated but not survival; opposite trends appeared in some experiments. Results from the northeastern experiments have been discussed by Kolotelo (1987) and Morgenstern et al. (1987). In experiments with jack pine (Pinus banksiana Lamb.) at five locations there are good correlations between height at ages 5 and 10 years from seed (Crain 1986). In three experiments of white spruce (Picea glauca (Moench) Voss) in Nova Scotia, both Prince Edward Island and Ottawa Valley, Ontario provenances were in top rank at 5 years (Bailey 1987).

Progeny tests

Several series of open-pollinated family tests of jack pine and black spruce again confirmed that at age 5 years, narrow-sense heritability of height growth based on individual trees ranges from 0.12 to 0.17 and family heritability from 0.75 to 0.85 (Colpitts 1987, Johnstone 1987, Maxwell 1987). The family heritability of multiple-leader incidence is much lower (0.12) (Mason 1987).

Family-nutrient interaction

Family tests of black spruce at two locations demonstrated significant family differences in foliar concentrations of nitrogen (N), potassium and magnesium (Opio 1987). In greenhouse experiments with open-pollinated tamarack (Larix laricina (Du Roi) K. Koch) families, there were significant differences among families in N utilization efficiency and dry weight and significant N-family interactions for N accumulation and dry weight, and large differences in phenotypic stability. Differentiation with respect to soil types and phosphorus was less pronounced (Wanyancha 1986).

Breeding strategy

Efforts have continued to develop more basic information on wood

quality with the objective of using it in breeding strategies. Age-to-age correlations of relative density were determined for jack pine and black spruce and heritability of jack pine density was estimated. A Pilodyn wood tester was found to be suitable for family selection in jack pine and an appropriate sampling method was devised (Villeneuve 1986a, 1986b).

Mr. Greg Adams, an M.Sc.F. candidate, developed a selection index for jack pine based on height, crown form, stem straightness, branch angle, and branch diameter. Negative genetic correlations between height and crown and stem and branch traits indicate that selection for height alone results in deterioration of quality traits. The thesis is in its final stages.

Cone and seed production and crown development

Distinct within-crown patterns of buildup and annual variation of cone production were evident in young tamarack and black spruce and lag in production of pollen cones adversely affected seed set in early years (Tosh 1986, Caron 1987). Continued cone production was intimately related to developmental patterns of branches of black spruce (Caron 1987). Simulation of tamarack crown development was extended to higher branch orders (Remphrey and Powell 1987) and will facilitate simulation of foliage and cone deployment. Composition of bisporangiate cones varied in relation to position in tamarack crowns (Tosh and Powell 1986). Evidence of microclimatic patterning was observed in white spruce crowns (Phelps and Powell 1987). The seed-production process was briefly described for tamarack (Powell and Tosh 1987), eastern hemlock (Tsuga canadensis (L.) Carr.), eastern white cedar (Thuja occidentalis L.) (Powell 1987b,c), and three tropical leguminous trees (Kariuki 1986). Seeds of one of the latter, Brachystegia spiciformis Benth., appeared not to be seed-coat dormant, whereas those of the other two legumes were (Kariuki and Powell 1987).

Studies of syllepsis, a feature of many young tamarack trees, were continued. Syllepsis was associated with greater diameter and height growth (McCurdy 1986, Powell and Vescio 1986), was evident in both long-shoot and short-shoot forms and did not affect leader crookedness (Stairs 1986, Powell 1987a). Even under favourable growth conditions, some trees remain non-long-shoot sylleptic. Narrow-sense, individual-tree heritability estimates for numbers of sylleptic long shoots produced per year ranged from 0.25 to 0.75 in groups of tamarack families (Young 1987).

Tree physiology

Dr. R.A. Savidge has received substantial NSERC funding in support of his research dealing with the regulation of wood formation. A state-of-the-art facility for screening trees for hormone levels in relation to wood quality/quantity should be fully operational by 1988-89. Studies of regulation of lignification in Larix eurolepis Henry have been initiated.

PUBLICATIONS AND REFERENCES

Bailey, T.A. 1987. Five year results of a white spruce provenance experiment at three locations in Nova Scotia. BScF thesis, UNB, 39 p.

Boyle, T.J.B. and E.K. Morgenstern. 1986. Estimates of outcrossing rates in six populations of black spruce in central New Brunswick. Silvae Genet. 35: 102-106.

Caron, G.E. 1987. Development of branch patterns and seed production in young black spruce (Picea mariana (Mill.) B.S.P.). PhD thesis, UNB, 330 p.

Colpitts, M.C. 1987. Five-year height and survival of eighty-one open-pollinated black spruce families. BScF thesis, UNB, 35 p.

Cornelius, J.P. and E.K. Morgenstern. 1986. An economic analysis of black spruce breeding in New Brunswick. Can. J. For. Res. 16: 476-483.

Crain, D.S. 1986. Analysis of the ten year results from a jack pine (Pinus banksiana Lamb.) provenance experiment in New Brunswick. BScF thesis, UNB, 34 p.

Johnstone, S.B. 1987. Five year height and survival of black spruce in four family tests in New Brunswick. BScF thesis, UNB, 31 p.

Kariuki, E.M. and G.R. Powell. 1987. Pretreatment and germination of seeds of three leguminous tree species indigenous to Kenya. Seed Sci. & Technol. 15: in press.

Kariuki, E.M. 1986. Production and handling of seeds of Acacia xanthophloea, Brachystegia spiciformis and Trachylobium verrucosum. MF rep., UNB, 68 p.

Kolotelo, D.A. 1987. Performance of black spruce provenances in Quebec experiments at 15 years of age. BScF thesis, UNB, 44 p.

Krahn, R.A. 1986. Isolation of a black spruce seedling orchard from external pollen. BScF thesis, UNB, 32 p.

Marr, S. 1986. Analysis of a hybrid poplar plantation in southern New Brunswick. BScF thesis, UNB, 24 p.

Mason, S.C. 1987. Roguing of a seedling seed orchard based on 7 year height results. BScF thesis, UNB, 57 p.

Maxwell, R.R. 1987. Five-year height and survival of four black spruce family tests in New Brunswick. BScF thesis, UNB, 44 p.

McCurdy, W.D. 1986. The effect of sylleptic branching on stem growth of Larix laricina (Du Roi) K. Koch saplings. BScF thesis, UNB, 70 p.

Morgenstern, E.K. 1987. Methods for rooting of larch cuttings and application in clonal selection. For. Chron. 63: 174-178.

Morgenstern, E.K. 1986a. Status and future of seed orchards in Canada. Proc. Twentieth Mtg. Can. Tree Improv. Assoc., Pt. 1: 248.

Morgenstern, E.K. 1986b. Mark Holst -- pioneer tree breeder. Proc. Twentieth Mtg. Can. Tree Improv. Assoc., Pt. 2: vi-x.

Morgenstern, E.K. 1986c. Genetic variability and potential for gain. 1986 Larch Workshop, organized by N. B. For. Res. Advis. Comm. p. 65-72.

Morgenstern, E.K. and G. Valleé. 1986. Genetic improvement of species in the genus Larix Mill. In Research in forestry for energy. Edited by C.P. Mitchell, P.O. Nilsson, and L. Zsuffa. Swedish Univ. Agric. Sci., Uppsater och Resultat Nr. 49/1986. Vol. I: 188-201.

Opio, C. 1987. Genetic variation in mineral nutrition in black spruce, Picea mariana (Mill.) B.S.P. BScF thesis, UNB, 63 p.

Phelps, M.G. and G.R. Powell. 1987. Bud, cone and shoot development of Picea glauca: within-crown patterns and microclimate. Poster at Forest Climate '86, Symp., Environ. Can. etc., Orillia, Ont. Nov. 1986. Summary in Proc. in press.

Powell, G.R. and K.J. Tosh. 1987. Tamarack or eastern larch. In Reproduction of conifers: a handbook for cone crop assessment. Can. For. Serv., For. Tech. Rep. 31: addition in press.

Powell, G.R. 1987a. Syllepsis in Larix laricina: analysis of tree leaders with and without sylleptic long shoots. Can. J. For. Res. 17: 490-498.

Powell, G.R. 1987b,c. Eastern hemlock, Eastern white cedar. In Reproduction of conifers: a handbook for cone crop assessment. Can. For. Serv., For. Tech. Rep. 31: additions in press.

Powell, G.R. and E.K. Morgenstern. 1986. Tree seed and forest-genetic studies at the University of New Brunswick, 1983-1985. Proc. Twentieth Mtg. Can. Tree Improv. Assoc., Pt. 1: 66-74.

Powell, G.R. and S.A. Vescio. 1986. Syllepsis in Larix laricina: occurrence and distribution of sylleptic long shoots and their relationships with age and vigour in young plantation-grown trees. Can. J. For. Res. 16: 597-607.

Remphrey, W.R. and G.R. Powell. 1987. Crown architecture in Larix laricina saplings: an analysis of higher order branching. Can. J. Bot. 65: 268-279.

Savidge, R.A. 1985. Prospects for manipulating vascular-cambium productivity and xylem-cell differentiation. In Attributes of trees as crop plants. Edited by M.G.R. Cannell and J.E. Jackson, ITE, Abbots Ripton, England. p. 208-227.

Savidge, R.A. and Colvin, J.R. 1985. Production of cellulose and soluble polysaccharides by Acetobacter xylinum. Can. J. Microbiol. 31: 1019-1025.

Savidge, R.A. 1986. Prospects for genetic manipulation of wood quality. Proc. Twentieth Mtg. Can. Tree Improv. Assoc., Pt. 2: 159-165.

Savidge, R.A. 1987. Dihydroconiferyl alcohol in developing xylem of Pinus contorta. Phytochemistry 26: 93-94.

Sternberg, L., DeNiro, M.J. and Savidge, R.A. 1986. Oxygen isotope exchange between metabolites and water during biochemical reactions leading to cellulose synthesis. Plant Physiol. 82: 421-427.

Stairs, N.D. 1986. An investigation of overwintering buds associated with leaders of Larix laricina. BScF thesis, UNB, 64 p.

Tosh, K.J. 1986. Development and distribution of cones, pollination, and yield of seeds in young plantations of tamarack. MScF thesis, UNB, 143 p.

Tosh, K.J. and G.R. Powell. 1986. Proliferated, bisporangiate, and other atypical cones occurring on young, plantation-grown Larix laricina. Can. J. Bot. 64: 469-475.

Villeneuve, M. 1986a. Rapid estimates of wood density in family tests. MScF thesis, UNB, 88 p.

Villeneuve, M. 1986b. Estimating wood density in family tests using a Pilodyn. Tech. Rep. No. 3, N. B. Tree Improv. Counc. 32 p.

Wanyancha, J.M. 1986. Genetic variation in nutrient uptake and utilization in open-pollinated families of Larix laricina (Du Roi) K. Koch. PhD thesis, UNB, 137 p.

Young, D.W. 1987. Heritability and dimensional relationships of sylleptic branching and associated features in nine-year-old families of Larix laricina (Du Roi) K. Koch. BScF thesis, UNB, 54 p.

AMÉLIORATION DES ARBRES FORESTIERS À LA DIRECTION DE LA RECHERCHE ET DU DÉVELOPPEMENT DU MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES DU QUÉBEC

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Mots-clés: Populus L., tests de provenances, tests de descendances, test clonal, sélection de clones, croisements dirigés, variétés multiclonales, vergers à graines, sélection d'arbres, résineux, greffes, densité du bois

SÉLECTION DE CLONES ET AMÉLIORATION DU PEUPLIER (POPULUS L.)

G. Vallée

En résumé, à ce jour, un total de 2032 clones ont été sous observation au service, dont 650 ont été sélectionnés dans les peuplements naturels au Québec et 928 dans des plantations comparatives; les 454 autres clones ont été introduits surtout d'Europe et d'Ontario. De plus 39 dispositifs de tests clonaux, cinq plantations de collections de clones, et 20 dispositifs de tests de provenances et de descendances ont été mis en place. Un total de 2184 croisements ont été faits dont 282 ont donné des semis. Ajoutons l'obtention de pays étrangers de 243 lots de semences et de la récolte au Québec de 299 lots de semences représentant 23 espèces ou hybrides.

Durant 1985 et 1986, un total de 734 croisements artificiels ayant produit 10 752 semis ont été faits à partir d'arbres de clones sélectionnés dans nos plantations et de pollen de P. nigra L. et P. maximowiczii Henry obtenu d'Italie et du Japon respectivement. Toutes les familles hybrides avec P. maximowiczii montrent une croissance exceptionnelle et une très bonne résistance aux maladies foliaires Melampsora medusea Thum et Marssonnina brunnea (Ell. et Ev.) Magn.

Un test de 30 descendances de P. maximowiczii comprenant 12 137 plants est en cours de réalisation. Les graines de ces descendances ont été fournies par le Dr. Chiba du Japon et proviennent de l'île d'Hokkaido. Le Dr. Steenackers de Belgique nous a fourni 19 lots de semences récoltées dans ses plantations et 165 clones de ses sélections récentes. Quelque 11 tests clonaux représentant divers hybrides et six tests de provenances avec P. trichocarpa Hook et P. nigra ont été installés durant les deux dernières années.

À cause des dégâts importants faits par Septoria musiva Peck dans les plantations de peupliers hybrides du sud du Québec, il a été décidé de sélectionner, au niveau de la pépinière, les clones résistants ou peu susceptibles à cette maladie. Avec l'aide de Guy Bussières (pathologiste au M.E.R.), et en collaboration avec le Dr. Hubbes de l'Université de Toronto, des méthodes de production d'inoculum et d'inoculation de rejets de souches en pépinière ont été développées. Une inoculation a été faite en juillet 1986 sur 1071 clones avec une souche de Septoria musiva connue pour sa virulence. Un total de 742 clones ont montré une susceptibilité élevée et seront éliminés. En 1987 les 329 clones ayant montré une résistance ou une faible susceptibilité seront réinoculés avec 3 souches provenant de diverses régions du Québec et une de l'Ontario afin de vérifier l'aptitude générale à la résistance ou une faible susceptibilité vis-à-vis Septoria musiva.

AMÉLIORATION DES MÉLÈZES (LARIX SP.), DE L'ÉPINETTE NOIRE (PICEA MARIANA (MILL.) B.S.P.) ET DE L'ÉPINETTE DE NORVÈGE (P. ABIES KARST.),

A. Stipanicic et A. Rainville

Dans le cadre de notre projet d'amélioration des mélèzes, deux nouveaux tests de descendances ont été établis en 1986 avec le matériel récolté sur les arbres sélectionnés dans nos plantations expérimentales. Ces tests permettront d'évaluer la valeur génétique des arbres sélectionnés et la possibilité d'utiliser nos plantations expérimentales comme sources de graines améliorées. Trois autres tests de descendances mis en marche au printemps de 1987 et composés de 60 descendances ont pour but d'étudier l'héritabilité de deux caractères morphologiques du mélèze laricin: la flexuosité de la tige et l'angle d'insertion des branches. Un test de 102 descendances est aussi mis en marche au printemps 1987 dans le cadre du programme d'implantation des vergers à graines de mélèze laricin. Les informations obtenus à partir de ce test serviront à l'aménagement d'un verger à graines de semis installé simultanément dans la région de Québec. Les travaux de sélection d'arbres se sont poursuivis dans les plantations de mélèzes d'Europe et du Japon; 115 nouveaux arbres ont ainsi été sélectionnés et greffés. Un verger à graines expérimental de mélèze du Japon a été installé dans l'arboretum de Verchère. Les 136 clones qui le composent proviennent d'arbres sélectionnés dans deux plantations de la compagnie C.I.P. inc., et qui furent reproduits par greffage ou par bouturage. Aux printemps de 1986 et de 1987, nous avons mis l'accent sur les croisements dirigés des clones des mélèzes sélectionnés dans nos plantations ou à l'intérieur du parc à clones. Ces croisements avaient pour but de favoriser principalement l'hybridation interspécifique entre les mélèzes d'Europe, du Japon et laricin. Les travaux de 1986 nous ont permis d'obtenir 60 petits lots de graines d'hybrides inter- et intraspécifiques. Nous évaluons présentement la viabilité de ces graines, et les semis obtenus seront installés dans un test de descendances le plus tôt possible. Au printemps de 1987, nous avons effectué au-delà de 300 croisements. Malhureusement selon les dernières observations, les gelées tardives ont détruit plusieurs fleurs femelles. Soixante-deux lots de pollen récoltés ce printemps sont actuellement entreposés dans notre banque de pollen et serviront pour les travaux futurs.

Concernant les travaux d'amélioration de l'épinette noire, il faut surtout noter les neuf tests de descendances établis en 1986 et les six autres établis en 1987 dans le cadre du programme d'implantation des vergers à graines. Ces tests, composés chacun d'environ 300 familles, permettront d'évaluer dans différentes zones de récolte de cônes au Québec, le comportement des descendances qui constituent les vergers à graines. Les informations obtenues serviront à effectuer les éclaircies sélectives et l'aménagement à l'intérieur de ces vergers à graines. Nous avons aussi poursuivi les travaux de croisements dirigés chez l'épinette noire dans le but d'obtenir des hybrides interprovenances. Un total de 68 croisements ont été effectués sur les arbres sélectionnées dans un test de provenances-descendances et dans le parc à clones. Dix-huit lots de pollen ont été entreposés pour les croisements ultérieurs.

Les travaux d'amélioration de l'épinette de Norvège étaient surtout concentrés sur le greffage des arbres sélectionnés et sur la compilation des données recueillies dans nos plantations les plus âgées. Ainsi 218 arbres ont été greffés et seront installés dans notre parc à clones. Ce matériel servira pour les travaux de croisements dirigés et pour la production des greffons et des boutures. L'analyse des données de mesurages nous a permis de confirmer la variabilité de production entre les différentes provenances de cette espèce. Par exemple, un gain de 32 % pour l'accroissement en volume a été noté dans le cas de la provenance québécoise de Proulx en le comparant avec 21 autres provenances européennes. Ces renseignements serviront de guide pour l'établissement des futurs vergers à grains clonaux.

AMÉLIORATION DU PIN GRIS (PINUS BANKSIANA LAMB.), DU PIN DE MURRAY (P. CONTORTA DOUGL. VAR. LATIFOLIA ENGELM.) ET DU PIN SYLVESTRE (P. SYLVESTRIS L.)

R. Beaudoin et A. Rainville

Afin d'exploiter au maximum les résultats des plantations comparatives réalisées à travers le Québec avec les pins gris et de Murray, le Service de l'amélioration des arbres s'oriente de plus en plus vers la création de variétés multiclonales qui vont fournir des gains génétiques maximums tant pour la production en volume que pour la qualité des tiges.

À ce jour, un total de 17 tests de descendances ont été réalisés sur le pin gris dont six en 1986 et 1987. Le test le plus âgé, celui du canton de Briand, a été implanté en 1977. Notre choix d'améliorer cette provenance découle de la performance démontrée par celle-ci dans le test de 64 provenances installées dans le canton de Fontbrune en 1966. Les résultats de ce test de descendances nous montrent que des gains en hauteur et en volume de 10 et 32 % respectivement après 10 ans de croissance en plantation sont attribuables à la sélection d'arbres-plus dans le peuplement par rapport aux mêmes variables de la provenance sans amélioration. La sélection des 70 meilleures descendances (25 % du total) correspond au nombre de descendances qui seront conservées dans les

vergers à graines après les éclaircies sélectives. Parmi ces meilleures descendances, 75 arbres ont été sélectionnés et greffés; les greffes seront conservées dans le parc à clones à la station forestière de Duchesnay et serviront éventuellement de matériel pour les croisements dirigés et les vergers à graines en serre.

Un total de 57 croisements dirigés ont été réalisés en 1986 et 1987 dans le parc à clones de pin gris établis en 1980 à l'arboretum de Lotbinière. Les 174 clones compris dans ce parc proviennent des arbres sélectionnés du canton de Briand. En général, ces clones produisent très peu d'inflorescences mâles comparativement au nombre de fleurs femelles étant donné que les greffons ont été récoltés dans le tiers supérieur de la cime d'arbres âgés de 50 ans. Une pollinisation des meilleurs clones est prévue pour 1988, et à cet effet 25 lots de pollen de pin gris provenant d'une plantation à Cabano de descendances d'arbres sélectionnés de la provenance Mattawin ont été récoltés. Trente-neuf croisements ont été effectués en 1986 dans cette plantation sur les plus beaux arbres de sept descendances.

Une sélection d'arbres a été effectuée en 1986 et 1987 dans un test de 125 provenances (IUFRO) de pin de Murray établi en 1980 à l'arboretum de Lotbinière. La sélection des descendances les plus intéressantes a été faite parmi les meilleures provenances pour la croissance en hauteur. En général, ces provenances sont de la zone intérieure, la plupart (80 %) de la Colombie-Britannique et à une altitude ne dépassant pas 1200 m. Au total, 178 croisements interprovenances ont été réalisés en 1986 et 1987 de même que quelques croisements interspécifiques avec la provenance de pin gris du canton de Briand. Vingt-deux lots de pollen sont conservés dans la banque de pollen.

Plusieurs arbres des trois provenances de la zone intérieure de la Colombie-Britannique introduits en 1972 ont été sélectionnés en 1986 dans le canton Ross et aux arboretums de Matapédia et Bonaventure. Ces arbres seront éventuellement greffés et placés dans un parc à clones à Duchesnay pour être utilisés dans de futurs croisements.

Dans le but de constituer un parc à clones et un verger à graines clonal de pins sylvestres dans la région de l'Estrie, 76 arbres ont été sélectionnés dans une plantation âgée de 75 ans située à la pépinière de Grandes-Piles, ainsi que 36 arbres d'âges variables dans les régions de la Beauce et de Drummondville. De nouvelles sélections auront lieu dans les tests les plus âgés et dans d'autres plantations à l'automne 1987.

SÉLECTION D'ARBRES ET ÉTABLISSEMENT DE VERGERS À GRAINES,

Y. Lamontagne

Cette activité a pour objectif l'établissement d'un réseau de vergers à graines pour les résineux qui fournira éventuellement toutes les semences améliorées génétiquement nécessaire pour le programme de reboisement du ministère.

À cette fin, les travaux de sélection d'arbres se sont poursuivis depuis 1985, et près de 2000 nouveaux candidats ont été identifiés, ce qui porte à plus de 18 000 le nombre total d'arbres-plus. De ces nouvelles sélections, 1000 lots de cônes ont été cueillis et traités. Au Centre de greffage de Duchesnay, 46 060 greffes ont été réalisées.

Les travaux de détermination de la densité du bois se sont poursuivis sur 1431 échantillons d'épinettes blanche et rouge portant ainsi à 4731 le nombre total d'arbres-plus dont la densité est connue.

Des travaux de préparation de terrain ont été effectués sur 654 ha, tandis que des travaux d'entretien ont eu lieu sur 192 ha de vergers déjà établis. De plus, la plantation de 24 nouveaux vergers au printemps de 1986 et de 1987 (comprenant 54 ha de type clonal et 385 ha du type de semis) porte à 42 le nombre total de vergers établis et à 703 ha, la superficie plantée.

TREE GENETICS AND IMPROVEMENT AT CFS QUEBEC: 1985-1987

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Keywords: Pinus strobus, Picea glauca, Picea abies, floral induction, wood quality, blister rust, white pine weevil

During the review period, emphasis was placed on white spruce, Norway spruce, and eastern white pine genetic research and improvement. Early genetic tests were completed in controlled environments and genecological testing was undertaken in forest conditions. Selected clones were potted and floral induction was conducted in a polyhouse. Control crosses were made in a breeding orchard, while scions were produced in propagation hedges and genetic material was transferred to forest organizations for seed orchard establishment. White spruce wood quality variation was investigated in natural populations and provenance trials. Research was begun on Norway spruce tolerance to white pine weevil. Also, variation of productivity and phenotypic stability of black and red spruces were studied in provenance trials.

EASTERN WHITE PINE GENETICS RESEARCH AND BREEDING

Following genetic sampling in the natural range of eastern white pine (Pinus strobus L.), early testing was begun in a controlled environment and nursery. Some 450 progenies from 170 populations were grown and assessed for phenological and growth performance. Population differences were found but no clonal variation in growth was detected. Under artificial freezing conditions, hardiness increased with greater continentality of the climate at the source of the populations. No north-south gradient was shown and cold hardiness of sources appeared to be related to local climatic conditions.

In the spring of 1986, four genecological tests were established under aspen and birch cover in the moderate rust incidence zone of southern Quebec. The objective was to increase the reliability of genetic information by reducing tree damage caused by the white pine weevil

(Pissodes strobi (Peck.)). Shading is an effective way to control weevil populations. The undergrowth and wildlife had to be controlled. Wildlife severely damaged the Gaspé test.

An experimental seed orchard was completed by grafting superior trees on pre-established rootstocks. Field grafting has the advantage of reducing losses due to snow damage. However, delay caused by weevil oviposition and feeding greatly extended the establishment period. We used the interactive computer program MIMOSOL to set up the orchard layout.

Plus-trees were selected in target populations, bench grafted, and established in the Cap Tourmente breeding orchard for use in genetic studies. To assess weevil tolerance of the hybrid, Pinus strobus and Pinus monticola were crossed with pollen provided by Dr. M.D. Meagher of the Pacific Forestry Centre.

Haploxilon exotic pine species, resistant or partially resistant to fusiform rust (Cronartium ribicola J.C. Fisch), were tested for hardiness in a nursery in southwestern Quebec. No severe frost damage was recorded. However, most of the Himalayan pine (Pinus griffithii McLelland) populations showed high susceptibility to scleroderris canker (Gremmeniella abietina (Lagerb). Morelet). Korean pine (Pinus koraiensis Sieb. and Zucc.) and Macedonian pine (P. peuce Griseb) were affected to a lesser extent while no infection was recorded on Siberian pine (Pinus sibirica Mayr).

WHITE SPRUCE GENETICS RESEARCH AND BREEDING

Following genetic studies in a greenhouse and nursery, white spruce (Picea glauca (Moench) Voss) families and populations from its natural range in Canada, mainly Quebec and Ontario, were established in eleven genecological tests representative of reforestation sites. Some 400 progenies from 100 populations were planted and a survey indicates that survival is excellent on most sites. A first field growth measurement survey is planned for this summer.

A study on dry mass productivity and wood density variation has been completed in a 25-year-old provenance trial and results have been published. Highly significant differences between provenances were observed for both characteristics. Twenty percent of the total wood density variation could be explained by the origin of the populations, while 80% was due to tree to tree variation within sources and to experimental error. These results were confirmed by a second study conducted in natural forests. No geographic trend in wood density was observed within the sampled portion of the natural range of white spruce in Quebec. However it appeared that provenances of some regions produce a wood of higher density than the average. Several fast growing populations with high wood density were recorded. For breeding, our results suggest that substantial gain in dry mass production could be obtained by selecting rapid growing populations and then by choosing, within these populations, trees which produce wood of above average density. A third study, initiated this year, will provide accurate information on additive

genetic variance and heritability estimates of white spruce wood density and dry mass productivity.

The first genetic base of our improvement program is now complete. Selected clones were established in a breeding orchard at Cap Tourmente Wildlife Reserve. Control crosses were initiated in 1984 and additional ones made each year since. However, because of the small portion of clones producing female and male strobili each year, only a part of the planned crosses were made. Following information from Dr. S.D. Ross, flower induction through $GA_{4/7}$ spray and water and heat stresses was initiated on potted grafts in a polyhouse. One hundred and twenty clones were induced. Induction will be made on ramets of the same clones next year and we hope to be able to cross clones of the first group.

NORWAY SPRUCE IMPROVEMENT AND NATIVE SPRUCES PROVENANCE RESEARCH

Norway spruce genetic improvement in relation to pedoclimatic conditions of the Great Lakes-St. Lawrence forest region and Gaspé is based on selections made in provenance trials that are over 15-years-old and in outstanding commercial plantations. During the last few years, about three hundred trees were selected for superior growth, stem quality and wood density. They were multiplied by grafting and potted for flower induction or breeding orchard establishment. They constitute the genetic base of our improvement program.

The genic sampling of introduced stock for provenance research or commercial planting, initiated in 1984, was pursued in 1985-1986. Several hundred seed lots were collected, treated and stored, awaiting testing with 150 Polish progenies obtained from the Warsaw Forest Institute.

Through growth measurements in a 25-year-old red spruce (Picea rubens Sarg.) provenance experiment, planted in three different locations, we have obtained estimates of population genotype-environment interaction and phenotypic stabilities. Interaction of red spruce provenances with growing conditions are important, and careful selection of seed sources are necessary for acceptable growth performance. Fortunately, under the testing conditions, it appears that the provenances with good stability are among the most productive.

Fifteen-year growth measurements were made in black spruce (Picea mariana (Mill.) B.S.P.) population trials and served as base for a U.N.B. bachelor thesis. Clinal variation was found for height growth but not for survival. Superior growth was observed at the southern-most test site and introduction of southern provenances increased yield. Site was the major source of variation in height growth, but the provenance component was large enough to warrant selection. Replicates were more important than site for survival, indicating that microsite is important.

Extensive site characterization and soil classification of established genecological tests were begun in collaboration with the forest site classification section of Agriculture Canada. These will increase the level of confidence that could be placed in the results of our tests.

MATERIAL AND TECHNOLOGY TRANSFER

Superior genetic material is made available to reforestation agencies and companies through the establishment and maintenance of propagation hedges and bushes on which cuttings and scions are collected when needed.

In order to facilitate the layout of seed orchards in which inbreeding is minimized and outcrossing favored, an interactive computer program has been developed. MIMOSOL, written in FORTRAN language, is easy to use and available on request from the authors.

Technical communications were presented to different interest groups and short courses on grafting and rooting of cuttings were offered each year to nurserymen.

An eastern white pine experimental seed orchard was established in collaboration with the Quebec Ministère de l'Énergie et des Ressources on pre-established rootstocks. White pine weevil attacks and rootstock quality appear to be the main difficulties with this approach.

PUBLICATIONS AND CONFERENCES

Beaulieu, J. and A. Corriveau. 1985. Variabilité de la densité du bois et de la production des provenances d'épinette blanche, 20 ans après plantation. J. Can. Res. For. 15: 833-838.

Beaulieu, J., A. Corriveau and G. Daoust. 1985. MIMOSOL: Programme informatique interactif pour la réalisation de plans de vergers à graines réduisant la consanguinité et favorisant l'hétérofécondation. Serv. can. forêts, Cent. for Laurentides, Sainte-Foy, Québec. Rapp. inf. LAU-X-69.

Beaulieu, J., A. Corriveau and G. Daoust. 1985. MIMOSOL: Interactive computer program for minimum inbreeding and maximum outcrossing seed orchard layouts. Can. For. Serv., Laurentian For. Cent., Sainte-Foy, Quebec. Inf. Rep. LAU-X-69E.

Beaulieu, J. 1986. Registre des données phénotypiques et phénologiques relatives à la génétique forestière, (restructuration 1985). SCF-Québec, Sec. Gén. Amél. Arbres, Rapp. int. GA-86-08, 180 pages.

Beaulieu, J., A. Corriveau and G. Daoust. 1987. Productivité et stabilité phénotypique de l'épinette rouge au Québec. Page 344 in 55ième Congrès de l'ACFAS Univ. Ottawa, Ottawa, 19-22 mai 1987. Ann. ACFAS (Assoc. can. fr. av. sci.) Vol. 55.

Beaulieu, J., A. Corriveau and G. Daoust. 1987. Rusticité et productivité de l'épinette rouge: Variabilité vs reboisement. Carrefour 87 de la recherche forestière, Sainte-Foy, Québec. 26 mars 1987.

Caron, F., A. Corriveau and T.J.B. Boyle, editors. 1986. New Ways in Forest Genetics/Voies nouvelles en génétique forestière. Proceedings 20th Meeting Part 2 Canadian Tree Improvement Association. Quebec City, Quebec. Aug. 19-22, 1985.

Corriveau, A., J. Beaulieu and G. Daoust. 1986. Activités de recherche du S.C.F. en génétique et amélioration des arbres forestiers au Québec. Pages 87-93 in C.W. Yeatman and T.J.B. Boyle eds. Comptes rendus de la vingtième de l'Association canadienne pour l'amélioration des arbres. Partie 1. Québec. Qué. 19-22 août.

Corriveau, A., J. Beaulieu and G. Daoust. 1986. Génétique et amélioration des résineux au SCF Québec: Progrès et perspective. Pages 36-47 in Colloque sur l'amélioration génétique des essences forestières, F. Sauvageau, R. Bergevin éditeurs. 54ième congrès ACFAS, Univ. Montréal, 12-19 mai, 1986. Ann. ACFAS (Assoc. can. fr. av. sci.) Vol. 54.

Corriveau, A., J. Beaulieu and F. Mothe. 1987. Wood density of white spruce in natural populations in Quebec. Can. For. Res. 17:.

Corriveau, A. and R. Keable. 1985. Étude génétique du pin blanc. I. Tests précoces sous culture intensive. Rapp. int. GA-85-02, Sec. Gén. Amél. Arbres. Serv. can. forêts. Cent. for. Laurentides. Sainte-Foy, Québec. 60 p.

Daoust, G., J. Beaulieu and A. Corriveau. 1987. Aptitudes au racinement des boutures de phénotypes supérieurs d'épicea commun âgés de 19 ans. Rapp. inf. LAU-X-. (Sous presse).

Daoust, G., J. Beaulieu and A. Corriveau. 1987. Les vergers à graines d'épinette de Norvège: bouturage ou greffage. Carrefour 87 de la recherche forestière, Sainte-Foy, Québec. 26 mars 1987.

Daoust, G., J. Beaulieu and A. Corriveau. 1987. Aptitudes au bouturages d'épiceas communs (Picea abies (L.) Karst) d'origines différentes et âgés de 19 ans. Page 345 in 55ième congrès de l'ACFAS. Univ. d'Ottawa, Ottawa, Ont. 19-22 mai 1987. Ann. ACFAS (Assoc. can. fr. av. sci.). Vol. 55.

Keable, R. and A. Corriveau. 1987. Étude génétique du pin blanc, II. Établissement des tests génécologiques. Rap. int. GA-87-03. Sec. Gén. Amél. Arbres. Serv. can. forêts, Cent. for Laurentides. 90 p.

Kolotelo, D.A. 1987. Performance of black spruce provenances in Quebec experiments at 15 years of age. B.Sc. Thesis, U.N.B. 44 p.

CIP'S TREE IMPROVEMENT ACTIVITIES

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Keywords: Jack pine, black spruce, white spruce, Norway spruce, larch, seedling seed orchard, clonal seed orchard

In 1979, a tree improvement program was initiated by CIP Inc. in Quebec, following two years' involvement in the New Brunswick Tree Improvement Council. The program's objective in Quebec is to produce genetically superior seed for the Company's reforestation program on its Upper St-Maurice freehold in central Quebec.

The selection and testing of plus trees takes place in the Gouin (8-3) boreal region (Rowe, J.S. Forest Regions of Canada. Can. For. Serv. Publ. 1300, 1972). The principal seed orchard complex is located at CIP's Harrington Nature Centre in southwestern Quebec, and a small orchard is at Batiscan, near Three-Rivers, Québec.

CIP's tree improvement program concentrates on black spruce (Picea mariana [Mill.] B.S.P.) and jack pine (Pinus banksiana Lamb.), with some work being done on Japanese larch (Larix leptolepis [Sieb. and Zucc.] Endl.), European larch (L. decidua Mill.) and Norway spruce (Picea abies [L.] Karst).

NBIP Forest Products Inc. in Dalhousie, N.B., a CIP Inc. subsidiary, participates in the NBTIC cooperative, working on black spruce and white spruce (Picea glauca [Moench] Voss). Testing of both species is done in New Brunswick, and a black spruce seedling seed orchard is located near Dalhousie. A white spruce clonal seed orchard is located at Harrington.

Black and White Spruce and Jack Pine

During the period under review, the principal objective attained was the completion of the black spruce seedling seed orchard and family tests in 1986. Approximately 21,000 seedlings were planted in the orchard and 16,000 in the family tests. In the fall of 1986, the 5 year measurement was initiated in the family tests established in 1982 for both jack pine and black spruce (117 and 40 families respectively). Data collected were total height, latest annual increment and tree condition. In 1987, family test measurements will continue for the families established in 1983, representing 94 jack pine and 49 black spruce families.

In 1986 and 1987, the clonal archives located at the Harrington Seed Orchard were completed with the establishment of approximately 2,800

ramets of jack pine and black spruce. This facility will be used to carry out controlled crosses for the development of future orchard generations.

The propagation phase of the white spruce program was completed with the grafting of 2,400 scions in 1986 (95% survival) and 370 in 1987. In 1987, orchard establishment began with the first 100 ramets being moved to the orchard. Establishment will be completed in 1988 with the transplanting of another 2,140 ramets.

Japanese and European Larch

At Harrington, the hybrid larch clonal orchard was filled with the planting of 180 ramets of Japanese and European larch in 1987. These were replacements for mortality which had occurred since 1981 when the orchard was established.

At Batiscan, the Japanese larch seedling seed orchard was thinned in 1986. About 1,200 rodent killed or damaged trees were removed. In 1987, the Company provided 200 cuttings to the Maritimes Forestry Centre for propagation.

Norway Spruce

The Norway spruce clonal orchard at Harrington was completed in 1986 with the establishment of 700 ramets. Scions for this program were donated by the C.F.S. through the Laurentian Research Centre and the Petawawa National Forestry Institute.

NBIP FOREST PRODUCTS INC.

In 1986, two 1.76 ha black spruce family tests were established on the Company's license in northern New Brunswick. In 1987 the family test program was completed with the establishment of a black spruce test on the license, and a jack pine test on the CIP Miramichi freehold in central New Brunswick.

Table 1. Harrington Seed Orchard Information Summary

Species	Type[1]	Area[2] (ha)	Number of Families (F)/ Clones (C)	Establishment	Clone Bank	Clone Bank Area (ha)
Black spruce	S	16,6	440 F	1985/86	yes	2,3
Jack pine	S	12,0	480 F	1984/85	yes	2,5
White spruce	C	6,0	65 C	1987/88	no	-
Norway spruce	C	1,6	120 C	1984 & 86	yes	0,2

[1] S: Seedling seed orchard C: Clonal seed orchard
[2] Area in production

FOREST GENETICS RESEARCH AT THE ONTARIO TREE IMPROVEMENT AND FOREST BIOMASS INSTITUTE

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GENECOLOGICAL AND GENETIC STUDIES IN SPRUCE

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Keywords: Picea, interspecific hybridization, crossability, variation, clonal propagation of hybrids.

The objectives of these studies are: (1) to investigate genotype x environment interaction with regard to variation in efficiency, growth and nutrition as related to site regions and productivity systems; (2) to create long-term genetic banks for gene pool and population studies, breeding, and assessment of genetic parameters to elucidate the breeding system and structure of the genus Picea; (3) to produce, test and select the best hybrids for propagation; and (4) to develop genetic and physiological techniques for breeding juvenile trees.

Hybridization

Following the massive spruce flowering year in Ontario in 1984, flowering in 1985 was light. Two breeding areas were used, one each in Sault Ste. Marie, and Simcoe Districts. Eighty-five tree x pollen parent crosses were made with 115 ramets. There were 24 interspecific crosses involving 16 species; 12 tri-hybrid crosses; and one hybrid backcross, involving 14 species. Some of these were repeat crosses to gain repeatability estimates and to increase stocks of particular hybrids.

Emphasis continues to be placed on the search for fast-growing hybrids for use in the boreal forest. To this end, selections of high-latitude Picea sitchensis were crossed with an array of P. glauca from Moosonee, Black Sturgeon, Pays Plat, Pembroke, and Lindsay. These crosses were, of course, all successful, and the seed banked until all combinations were completed.

Similarly, high-latitude P. sitchensis were crossed with an array of P. mariana from Black Sturgeon, Geraldton, and Thunder Bay, Ontario, and Green River, New Brunswick. Most of these were unsuccessful (cf Gordon 1984), failing to produce any seedlings, despite, in a few crosses, low numbers of filled seed per cone.

Most interspecific crosses were unsuccessful; however, P. engelmannii was crossed successfully for the first time with P. farreri, a high-elevation Burmese species, and P. omorika with P. jezoensis, both with crossabilities of 1%. The hybrid seedlings will be cloned. P. sitchensis was crossed successfully with P. jezoensis with a high crossability of 14%. This is not a new cross, but the crossability was not expected to be quite so high. This confirms the close relationship of these species as suggested by several British workers (Fletcher, A., 1985, pers. comm.).

Tri-hybrid crosses involving P. lutzii (P. sitchensis x P. glauca) were successful with P. glehnii (2%); P. likiangensis (1%); P. omorika (6%); P. rubens (.04%); and P. mariana (.04%). Interestingly, P. lutzii failed to backcross with P. sitchensis, providing further credence to comments (Gordon 1984) that backcrossing with several spruce hybrids is proving much less successful than expected. This has important implications for arguments concerning casual introgression.

Flowering in 1986 was even lighter than 1985. Two breeding areas in Sault Ste. Marie and Simcoe Districts were again used. There were 63 tree x pollen parent crosses, of which 55 were interspecific crosses involving 11 species, three tri-hybrid crosses and five hybrid backcrosses with a total of four species. Further combinations of high-latitude P. sitchensis selections were made with P. glauca from Pagwa and Lake Superior selections. This seed was also banked until all combinations are complete.

With the same aim, excellent selections of P. omorika and P. sitchensis were used with P. mariana from Black Sturgeon, Geraldton, and Thunder Bay. This seed too was banked until all combinations are made. Unfortunately, results were somewhat limited by the low amount of flowering. Losses were also incurred due to depredations of red squirrel, particularly on the P. omorika x P. mariana crosses, and several combinations must be repeated. Success in other interspecific crossing was additionally low because of the poor flowering year and animal depredations. P. omorika was crossed successfully with P. pungens (0.1% crossability). This was a repeatability cross and is very difficult to make. There are only one or two other possible records.

Progeny of the Rosendahl spruce (P. glauca x P. mariana) crossed successfully with P. rubens (1%), and depending on parent, backcrossed poorly with P. glauca (.08%) and well with P. mariana (10%). P. x lutzii (P. sitchensis x P. glauca) crossed successfully with one P. mariana selection (.08%), failing in another. P. lutzii, confirming earlier attempts, failed with P. glauca, and with one female parent, failed with P. sitchensis backcross and was successful (2%) with another.

Outplanting of clonal hybrids is under way in trial and archive areas. Other work of this unit concerns studies of productivity and nutrient cycling dynamics in spruce forest ecosystems, spruce-fir stand dynamics in relation to budworm events (Gordon 1985), and measurements of biomass, specific gravity, productivity, and nutrient uptake in genotype x environment interaction studies in our Piceta.

PHYSIOLOGICAL GENETICS STUDIES

G.P. Buchert

Growth Analysis of Jack Pine Container Stock

Two genetic test plantations were established in 1984 to determine whether or not population substructuring was discernable in terms of differential growth of jack pine population collections from a portion of Northern Ontario. Due to size limitations of production facilities, two types of stock were produced. Half the stock were grown in Ray Leach Super Cells in a greenhouse in 1983, overwintered in a shadehouse, and outplanted in June 1984. The remainder were sown in the same container type in winter 1984 and hardened off for planting in June 1984. Concern for performance of stock types and how they affect expression of heritable differences led to a continuing analysis of growth comparisons between stock types, between plantation sites, and among seed sources. At the more southern, Blind River site, over-wintered stock from Blind River District sources were about 50% taller than current-year stock after the first growing season. By the end of the second growing season, this difference had dropped to 13%. The average height differential between stock types remained at about 4 cm over both growing seasons. Over-wintered stock of Chapleau District origin was about 66% taller than current-year stock of the same origin after the first growing season; after the second season, this differential dropped to 17%. The average height differential between current-year and overwintered stock was 5 cm after both growing seasons.

Stock type performance at the Chapleau site was identical to that at Blind River at the end of the first growing season. However, at the end of the second season, the change in relative height between stock types was more pronounced at this northern site than in Blind River District. Overwintered stock was 28% to 30% taller than current-year stock, resulting in a 6 cm to 7 cm height differential. The expected source x plantation x stock type interaction will be examined in the future to help explain phenotypic variation present in the tests.

Wide Testing of Selected White Pine Clones

Numerous white pine genetic tests have been established over the last four decades. Differing in experimental design, replication over different sites, and origin of material, these plantations are valuable for selection and further testing. The very best individual trees are currently being selected, grafted and outplanted into long-term test areas across Southern Ontario in standard replicated designs. In 1986, 30 clonal selections from Pakistan sources of Pinus griffithii included in a

1979 IUFRO trial were established at the wide-testing experimental sites. These selections exhibited winter hardiness and blister rust resistance. In addition, six selections from a 1975 weevil resistance experiment were grafted in 1986 for addition to the wide testing program. Three of these clones exhibited from 12% to 25% weeviling, while the remaining three showed no signs of weevil damage over the 10-year period in 1987. Selections for the 1987 grafting program include clones of P. albicaulis, P. flexilis, P. peuce, P. strobus, P. strobus x peuce, P. peuce x strobus, P. strobus x parviflora, P. parviflora x strobus, P. holfordiana x parviflora, P. monticola x parviflora, P. peuce x parviflora and P. flexilis x griffithii.

Testing White Pine for Blister Rust Resistance

Resistance to white pine blister rust by open-pollinated P. strobus families from the Orono rust-resistant seed orchard was initiated in 1986. Previous isozyme phenotyping of the orchard had permitted the identification and ramet-to-clone mapping of the orchard, so in December 1985, open-pollinated seed from 16 ramets representing seven orchard clones was sown in the greenhouse. Two bulk general collections were also included for comparison. One hundred seedlings from each source were inoculated with blister rust in September 1986 by placing an infected blackcurrant cutting in each seedling container, making sure that maximum contact was made between the leaves of the currant and the needles of the pine. Beds were then covered with burlap and kept moist. After one week the currant cuttings were removed and the seedlings were moved to overwintering facilities. Analysis of needle-spotting data indicates quite different patterns of rate of disease development among the different clones and the bulk collections. Mortality is being monitored to determine the diagnostic value of levels of apparent infection within one year of inoculation.

Black Spruce Clonal Identification

A COFRDA-supported project is under way to develop electrophoretic standards of isozyme variability in black spruce for identification of black spruce clones. Furthermore, staff working on this project have developed a portable, standardized electrophoretic system; along with a comprehensive manual of procedures now in preparation, this will allow personnel without extensive specialized training the specialized laboratory facilities to catalogue, identify and eventually certify black spruce clonal stocks. Isozyme analysis by electrophoresis enables one to discriminate accurately and consistently between materials of different clones by comparing samples with standardized isozyme patterns of specific clones. The equipment development phase has been completed, and procedures have been standardized to use a small inventory of inexpensive equipment. Chemical procedures have been optimized for useful information at relatively low cost. The manual of procedures will cover all aspects of the electrophoretic technique in sufficient detail that routine tests for identification, certification and quality control will become as commonplace in black spruce clonal production as they are for many agricultural crops.

FLOWER INDUCTION AND TISSUE CULTURE STUDIES

R.H. Ho

Cone Induction

Seed-cone production was enhanced by spraying $GA_{4/7}$ onto foliage of black spruce (Picea mariana). Eighty trees, representing 10 clones, were selected from a seed orchard and 44 trees, representing 11 clones and families, from two arboreta. The trees from the orchard were sprayed with different concentrations of $GA_{4/7}$ and those from the arboreta with $GA_{4/7}$, vitamin E, and a combination of $GA_{4/7}$ and vitamin E. The period of spraying was from a week after vegetative bud burst in May to the end of June. Applications were made to each tree a total of six times. Spraying $GA_{4/7}$ at 0, 400, 800 and 1200 mg/L produced 130, 246, 235 and 283 cones per tree respectively. The results indicate that 400 mg/L $GA_{4/7}$ appears to be optimal for bud differentiation in field-grown black spruce. Vitamin E at the concentration (1,000 mg/L) used was not effective and had no synergistic effect when applied with $GA_{4/7}$.

Anther Culture

Embryoids were produced through anther culture in white poplar (Populus alba). Five clones were selected from an arboretum, and catkin buds were collected when pollen in the anthers had reached the mononucleate stage. Anthers were sterilized and incubated on Murashige and Skoog (MS) medium, supplemented with kinetin and/or proline. Embryoids emerged from the anther cavity through the abscission layer after a two-month culture on MS medium with kinetin in darkness at 25°C. They were produced from two clones at a frequency of 0.3% per clone.

Tissue Culture in Black Spruce and Jack Pine

Adventitious roots and shoots have been produced from embryonic shoots in black spruce while no organogenesis, but only callus formation, occurred in the explants of jack pine (Pinus banksiana). In black spruce, adventitious roots were either generated from the axillary area of the leaf primordia or redifferentiated from the leaf primordia after embryonic shoots had been incubated on Gresshoff and Doy (GD) medium supplemented with 2,4-D and NAA. Adventitious shoots were differentiated from the axillary area of the leaf primordia or redifferentiated from the leaf primordia on embryonic shoots which had been cultured on GD or Quoirin and Lepoivre (LP) medium supplemented with BAP and NAA. Many elongated adventitious shoots have been excised for rooting to produce plantlets. In jack pine, calli were formed from young leaves and bud cross sections after the explants were cultured on GD medium supplemented with BAP and NAA.

PUBLICATIONS

Gordon, Alan G. 1984. Genetics, genecology and tree improvement of spruce in 1981 and 1982, Sault Ste. Marie, Ontario. Proc. 19th Meet. Can. Tree Impr. Assoc., Pt. 1: 94-97.

Gordon, Alan G. 1985. "Budworm! What about the forest?" In: Schmitt, D (ed.) Spruce-fir Management and Spruce Budworm. Proc. 2nd SAF Region VI Tech. Conf., Burlington, VT, 24-26 Apr. 1984, 29 p.

Ho, R.H. 1985. Production of haploid plantlets from poplar anther culture. In Forest Energy and Fuelwood Crisis. Proc. IUFRO P1.09.00. Meeting in Uppsala, Sweden, June 8-9, 1984. (eds.) G. Siren and C.P. Mitchell. Swed. Univ. Agr. Sci. Energy For. Proj. Rep. 41: 79-80.

Ho, R.H. 1985. Effect of pollination technique and repeated pollination upon filled seed in black and white spruce. Can. J. For. Res. 15: 1195-1197.

Ho, R.H. and Y. Raj. 1985. Haploid plant production through anther culture in poplars. For. Ecol. Manag. 13: 133-142.

Ho, R.H. 1987. Embryo culture. In Cell and Tissue Culture in Forestry. (eds.) J.M. Bonga and D.J. Durzan. Martinus Nijhoff Pub., Dordrecht, Vol. II. P. 137-167.

PROGRESS IN ONTARIO'S PROVINCIAL TREE IMPROVEMENT PROGRAM

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Keywords: Black spruce, jack pine, white spruce, white pine, seed orchards, breeding halls, clonal forestry

Ontario's operational tree improvement programs continued to show steady and significant growth during the period 1985-1987. Conifer tree improvement programs are now under way in all eight regions of the province. The Ontario Tree Improvement Council (OTIC) was formed, and began programs during this period. The additional efforts of members have added considerably to the progress of programs in northern Ontario. The OTIC programs are reported elsewhere in these proceedings (q.v.). This report will summarize tree improvement activities of the various regional programs and of the Tree Seed and Forest Genetics Unit.

NORTHWESTERN REGION

The Northwestern Region now has programs under way for three species, black spruce (Picea mariana (Mill.) B.S.P.), jack pine (Pinus banksiana Lamb.) and white spruce (Picea glauca (Moench) Voss). The newly-formed OTIC is also playing an active role in the region, particularly in jack pine improvement.

Black Spruce

As of 1985, 11 seedling seed orchards and 22 open-pollinated family tests had been planted. Selections have been completed for one additional orchard, the Red Lake 3300, and the stock is currently being grown at the Dryden nursery. This orchard, and the two companion family tests, will be planted in 1989. The family tests planted in 1983 are scheduled for 5th year measurements in the fall of 1987.

The fertilization and irrigation trials at the Goodie Lake North seed orchard in Sioux Lookout district have essentially been completed. The results have been partially analyzed and models for formulating both irrigation and fertilization regimes have been produced.

White Spruce

The white spruce clonal orchard program is showing steady progress with five orchards now under way and the Kenora district orchard completely planted. Most of the selections and grafting have been completed for all other orchards, and it is anticipated that the remainder will be fully stocked by 1989.

Jack Pine

The jack pine tree improvement program will be based initially on seven seedling seed orchards. Two of these orchards will be established in conjunction with OTIC. Selections began in some districts in 1985, and currently all other districts are working on collecting their plus trees. Location and preparation of seed orchard and genetic test sites are under way, anticipating initial planting in 1989 and the remainder in 1990.

NORTHERN REGION

The tree improvement strategy of Ontario's Northern Region focuses first generation activity on traditional seedling seed orchard and testing programs for black spruce and jack pine. The direction, planning and development of the regional tree improvement program is carried out by the Northern Forest Development Group. Operational aspects of the program are managed by the respective district within which the activity occurs. Programs are also under way in conjunction with OTIC. A breeding hall is located at, and managed by, Swastika Nursery and a private clonal centre is operated at Moonbeam, Ontario.

Black Spruce

The region has been divided into five black spruce breeding zones. Of the targeted 2,200 plus tree selections, 2,000 have been completed. A lack of cones/seed in one breeding zone has prevented completion of this stage of the program. The remaining selections are scheduled for the coming year, conditional on the cone crop. The orchard program will see over one-half of the required 140 ha established this year. The balance will be completed by 1988/89. All orchard sites have been selected, cleared and readied for planting.

Open-pollinated family tests are being established as the orchards progress. There are three tests planned for each breeding zone. These are on a variety of sites with excellent site preparation being a requirement. All tests are established using randomized single-tree plots, replicated 32 times. Roguing from test results will be a reality in the orchards in approximately seven years.

Jack Pine

Plus tree selection is now complete for each of the four breeding zones. In total, over 1,600 natural forest selections were made. In addition to cones and scions, breast-height wood discs were collected from each selection. Wood quality measurements are complete for three-quarters of the discs collected and include percent moisture content, percent heartwood, juvenile specific gravity (<20 years), mature specific gravity (> 20 years), specific gravity at 1/2 cambium, specific gravity at 5, 15 and 25 years, tracheid length at 5, 15 and 25 years and 1/2 cambium.

Of the four jack pine seedling seed orchards planned, three and one half are now complete. Orchards exist for breeding zones 1 (15 ha) and 3, at the Island Lake Tree Improvement Area orchard complex near Chapleau, Ontario, and breeding zone 4 (10 ha) at Aidie Creek, near Englehart, Ontario. The final half of the breeding zone 2 orchard (16 ha total) will be completed in 1988 as part of the OTIC orchard complex near Ramore, Ontario. All orchards follow a standard provincial four-tree cluster design. Management techniques, including determination of the most effective fertilization regimes, vegetation control, cover crop and insect/disease protection, have become the major emphasis of the orchard program now that the establishment phase is nearly complete. Jack pine orchards are expected to be producing small amounts of collectable seed by 1995 and be the sole producer of seed for planting stock by 2005.

Of the ten open-pollinated family tests supporting the four orchards (minimum of two tests per orchard), seven have been established. Those established have utilized randomized five-tree row plots, replicated five times. The remaining 3 tests will be established in 1988, utilizing randomized single-tree plots, replicated 32 times.

Breeding Hall and Clonal Program

In 1985/86, a 1,144 square metre breeding hall was completed at Swastika Nursery, near Kirkland Lake, Ontario. The facility, operated by a specialist and technician, has concentrated, and will continue to concentrate over the next few years, on the development of effective techniques to promote early flowering and healthy rapid growth of jack pine and black spruce in large containers. A test breeding population, consisting of ramets from original plus tree selections, is currently being used for development work.

Also located at Swastika Nursery is a jack pine clonal archive, established in 1986 and 1987. Ramets resulting from scion collections for each jack pine plus tree will be held in the archive and maintained by breeding hall staff. The archive is closely associated with the breeding hall as a potential source of pollen and scion collections, for selective supplemental breeding for increased seed yield, or for the achievement of crosses difficult to carry out in the breeding hall.

Also under methods development at the breeding hall are appropriate techniques to vegetatively propagate jack pine. Emphasis to date has been on the use of newly developed auxins and the adaptation of techniques currently used operationally for black spruce. Tests will also be undertaken to determine the ability to increase lateral branching of jack pine in order to augment the number of cuttings per tree.

A private facility in the region is producing one million black spruce rooted cuttings annually. New clones from controlled crosses are added into the program each year, and extensive testing of each clone is done. A cooperative research project, involving scientists from the University of Toronto and O.M.N.R., is underway, to find a reliable method for early identification of poor black spruce clones. Clonal screening trials are planted on six different sites each year. These are measured annually and the results are used to ensure that only the top clones remain in production.

NORTHEASTERN REGION

Jack Pine

Most of the establishment phase of the jack pine program is complete. Over 2,100 plus trees have been selected in five breeding zones. Five seedling seed orchards, planted in a four-tree cluster design, and 14 half-sib family tests were established in the early 1980's. Two additional seed orchards and 5 family tests will be planted in 1989 and 1990. The first measurements on the family tests were done in 1986. Fall grafting is being attempted on both jack pine and black spruce, so that clonal breeding orchards can be established.

The North Shore Tree Improvement Cooperative was formed so that members could mutually advance towards common goals in tree improvement. Currently there are four members - Dubreuil Bros. Ltd., Domtar Forest Prod. Ltd., E.B. Eddy Forest Prod. Ltd., and Ontario Ministry of Natural Resources - Northeastern Region. Members are cooperating on the jack pine program, in which they participate in plus tree selection, seed orchard management, and family test establishment and maintenance.

Black Spruce

Two seedling seed orchards are planned and these, along with five family tests, will be established in 1989. Over 500 plus trees will be collected this fall to complete the 800 trees required. A clonal breeding orchard will also be established from these plus trees.

White Pine

Three clonal seed orchards of white pine (Pinus strobus L.), planted in a permutated neighbourhood design, are in various stages of development. To date, 265 plus trees have been selected. Field grafting has been very successful in these orchards; they are scheduled for completion in 1991. A breeding orchard has also been started.

White Spruce

Two clonal seed orchards are planned. One of these is partially completed and will be finished in 1992. The other was established in the early 1970's and will be expanded over the next five years.

EASTERN REGION

The Fast Growing Forests Group (FGF), Brockville, Ontario, initiated a conifer tree improvement program for the Eastern Region in 1985. The species included in the program are, in order of priority, white pine, Norway spruce (Picea abies (L.) Karst) and three species of larch (Larix laricina (Du Roi) K. Koch, L. leptolepis (Sieb. & Zucc.) Endl., and L. decidua Mill.).

Conifers

Tree improvement efforts over the past two years have focused on the following: establishment and maintenance of controlled seed collection areas (SCAs and SPAs); plus tree selection and grafting; white pine breeding; and development of indoor breeding facilities and treatment regimes.

Conifer plus tree selection throughout the region is continuing. To date, FGF has made over 300 conifer selections. Additionally, 74 white pine selections, previously made by district staff, are also available. Selections are made from native populations as well as genetic trials and plantations. Scions of selected trees are grafted onto potted rootstock; grafts are allocated to archives, production seed orchards, and the breeding hall. Over the past two years, FGF has grafted 150 plus trees.

Breeding work for all species is carried out in a breeding hall located at Kemptville Nursery; the hall serves as an indoor breeding orchard. This gutter-connect greenhouse measures 22 m x 33 m, for a total floor area of approximately 722 sq. m., and has 3.05 m straight sidewalls. To date, breeding work in the hall has focused primarily on white pine. Controlled crosses are carried out on the basis of 5-parent disconnected half dialleles. A total of 60 controlled crosses have been made to date. Ensuing progeny trials will provide the basis for rouging two 8-ha white pine production seed orchards that are to be established over the next several years. These progeny trials will also provide the source of next-generation selections.

Much development work is being conducted in the breeding hall, aimed at accelerating the breeding cycle by reducing the time required for grafts to flower. Studies have been initiated to define treatment regimes that 1) enhance vegetative growth and crown development, and 2) promote precocious enhanced flowering. Treatments now under study include the application of gibberellin, root pruning, moisture stress, and forcing early bud break.

Poplar tree improvement work is in progress. To date, 1850 plus tree selections have been made of native poplar species (Populus deltoides, P. tremuloides, P. grandidentata, and P. balsamifera). Emphasis on breeding of P. deltoides has been increasing, with aims of exploring and enhancing the native gene pool. Additionally, interspecific crosses are being made to produce first generation hybrid populations from which to select individuals for systematic testing in clonal screening trials.

ALGONQUIN REGION

The primary focus of tree improvement in the Algonquin Region is on white pine. Additional programs are underway for tamarack and Ottawa Valley white spruce. A small program for red spruce (Picea rubens Sarg.) is in the formative stages. Hardwood management also plays an important role in the overall strategy for forest renewal.

White Pine

The white pine program (Petawawa source) will be based on three 8-ha clonal seed orchards. All plus trees have been selected, and the initial graftings have been completed. Some clones will need to be re-grafted in order to meet the numbers required for planting. A combined production-breeding orchard for the Georgian Bay source of white pine will also be established.

White Spruce

The white spruce program in the Algonquin region is concerned primarily with developing a genetically improved source of seed from the Douglas-Beachburg provenance. An Upper Ottawa Valley White Spruce Cooperative program was established jointly by OMNR (regional, district and head offices) and the Petawawa National Forestry Institute (PNFI) of the Canadian Forestry Service. To date 198 plus trees have been selected and grafted by PNFI, and a few blocks of orchard have been established. Future plans call for additional inter-agency cooperation on breeding and testing.

Tamarack

A combined production/breeding orchard complex has been established with grafts of 134 different tamarack plus trees. The seven ha orchard will be used to produce seed via open-pollination and controlled breeding for both production and test plantings. Seed may also be used in a clonal forestry program.

Red Spruce

Although red spruce has a limited distribution in the area, and will account for only five per cent of the planting target, the region feels that red spruce's unique role in the ecology of the region's mixed-conifer forests warrants a special program. A clonal forestry approach is anticipated, with seeds supplied from a breeding orchard. To date 92 selections have been made and an additional 42 are scheduled. Five ramets of each selection will be established in the breeding orchard.

CENTRAL AND SOUTHWESTERN REGIONS

Sixty per cent of the Southwest Region's and forty-six per cent of the Central Region's annual planting is with white pine, and it is therefore the most important species in the tree improvement program. Other species in the program are white spruce, Norway spruce, larches (European, Japanese), black walnut (Juglans nigra L.) and white ash (Fraxinus americana L.).

White Pine

Only white pine warrants a seed orchard program, though seed production areas have been established for most other species. The 6E white pine orchard will be 24 ha when completely established and the 7E orchard will be 8 ha. All selections have been made; grafting and planting are scheduled to be completed by 1991.

White Spruce and Norway Spruce

Based on a survey of Southern Ontario, completed in 1981-84, breeding orchards consisting of 375 white spruce selections and approximately 200 Norway spruce selections are being established at the Orono nursery. Planting and testing stock will be produced through controlled breeding and vegetative propagation.

Black Walnut

A small black walnut production/breeding orchard has been established at the St. Williams Nursery in the Southwestern Region to meet the needs of both regions. Sixty-two clones have been selected and grafted to date, with an additional 100 grafts per year scheduled over the next two years.

W.R. Bunting Tree Improvement Centre

Activities have concentrated on breeding hall and clonal forestry projects in support of the southern Ontario programs. The 300 sq. metre breeding hall is being utilized to accelerate breeding for the clonal seed orchard programs of white pine and the clonal forestry programs of white and Norway spruce and the larches. These are in their early stages and have concentrated on determining the most appropriate treatments. Initial results using various combinations of $GA_{4/7}$, heat and root pruning have been encouraging.

Rooted cuttings are being produced for both extensive testing of clones and mass propagation for production plantations. Approximately 120,000 rooted cuttings from juvenile, potted donor plants are being produced annually. Developmental work has concentrated on optimizing conditions for donor plant production and successful rooting of Norway spruce, larches, and red spruce.

TREE SEED AND FOREST GENETICS UNIT

The role of the Tree Seed and Forest Genetics Unit (TS&FGU) is one of both technical direction and support, as well as overall program coordination. This is accomplished through the development of policy and procedure directives, bulletins, and manuals. In addition, the unit also holds workshops and short courses in the field, and sponsors visiting scientists to provide additional expertise.

Over the past two years, TS&FGU strongly encouraged and supported the acquisition of breeding halls. As a result, three are now in place and operating, though they are still in initial development phases. To lend additional support, two experts in the field, Drs. Steve Ross and Mike Greenwood, were brought in for a workshop. The unit continues to facilitate interchange of information among the different programs through a working group.

In the spring of 1985, Tore Skroppa, a quantitative geneticist with the Norwegian Forest Research Institute, was sponsored to do a brief study of the efficiencies of various genetic testing designs. His investigations resulted in a report (unpublished) circulated to the regions, and his recommendations were followed in the provincial tree improvement strategy.

The computer data base system discussed in the last report (1983-85) was subjected to substantial and close scrutiny, and is undergoing major surgery. The regions are playing a very active role in both the design and writing of the new version.

Three notable documents were completed in 1986-87. The original "Guidelines for Tree Seed Crop Forecasting" was replaced with a new "Guidelines for Tree Seed Crop Forecasting and Collecting". The same pocket-size format was used. The "Tree Improvement Master Plan for Ontario" was published early in 1987, after substantial review and revision. A field manual titled "Operational Guidelines for Tree Improvement" is now in press, and is expected to be available for distribution in the very near future.

NATIONAL TREE SEED CENTRE 1985-1987

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Keywords: cone crop enhancement, insect control, maturation, germination, pretreatment, seed-borne fungi, storage, seed bank, testing and processing

Since October 1986 Ben Wang has become the Project Leader of both the Research & Development and Seed Bank & Services projects of the Centre due to the transfer of Peter Janas to the Silviculture project. Garry Scheer who was working with the Molecular Genetics and Tissue Culture Project, joined the Research & Development project as a seed technician in September 1986. Our NSERC Visiting Scientist, Dr. R.K. Mittal successfully completed his two-year term plus a six-month extension with us and returned to India in July 1987.

RESEARCH AND DEVELOPMENT

Cone and seed crop assessments

Studies of cone crops in a red pine (Pinus resinosa Ait.) seed production area (SPA) from 1979 to 1986 demonstrated the importance of frost as a major factor controlling seed production. SPAs should be located to avoid man-made as well as natural features that may create adverse environments (Schooley et al. 1986). Data on cone crops and cone damage by insects in three different white spruce (Picea glauca [Moench] Voss) habitats from 1979 to 1986 will be used to construct models for utilizing vegetation diversity as a means of reducing losses to major cone and seed insects. Periodic sampling of the 1981 white spruce cone crop showed that 39% of seed losses were unambiguously attributed to insects, 25% could not be attributed to any cause, 27% of seeds failed to develop endosperm and only 14% of potential seed developed to maturity. Losses begin very early in the season and reach a maximum by mid-July. Treatments to reduce insect damage should be made soon after or before the peak of flowering while damage assessments should not be made before mid-July. White spruce cones collected in 1982 and 1984 showed highly significant coefficients of determination (R^2 values) for seeds per cone with seeds per cone slice and cone length, but not with cone width. The relationships were specific for location and crop year. Thus, for particular

locations and years, counts of sound seed per cone slice can be used to estimate seed yield and, thereby, provide a means of assessing the efficacy of insecticide treatments. Potential sex-attractant lures for monitoring the spruce seed moth have been identified in cooperative studies with the Forest Pest Management Institute. In poor crop years the moth does not emerge from overwintering diapause. Climatic conditions that favor the mutualistic response of the insect and its host tree need to be identified.

Insect control

Foliar-applied systemic insecticides including lannate, dimethoate and acephate reduce cone damage by insects (Fogal and Lopushanski 1985). Injections of oxydemetonmethyl are effective in the year of treatment and persist to the second year. Implants of powdered acephate are more effective the year after treatment. Soil-incorporated carbofuran is more effective in a liquid formulation than a granular formulation. White and black spruce (Picea mariana [Mill.] B.S.P.) foliage is protected at all crown levels for at least 2 years, but cones are not protected until the year following treatment. More research is required to develop equipment for operational use. Seed yields are not always increased by treatments because other factors such as pollination success, embryo abortion, squirrel foraging and size of the cone crop influence seed yields and efficacy of treatments. Injections and implants do not impair wound closure and compartmentalization within the stem, so that there is little danger of fungal infection (Bowen 1987) and systemic insecticides do not cause serious reductions in seed germination.

Preliminary studies, have shown that Beauveria bassiana (Bals.) Vuill. applied to conelets can increase seed yields (Fogal et al. 1986a), and when applied to soil the fungus provides significant control of cone maggot (Fogal 1986). More extensive field trials are required. To facilitate this we have published a guide on the production and use of insect-pathogenic fungi (Fogal et al. 1986b).

Cone-crop enhancement

Fertilizing of white spruce seed orchard trees with NH_4NO_3 on sandy soils enhanced cone production and substantially increased seed yields. Similar treatments of white and black spruce trees growing on clay loam soils failed to enhance cone production in a budworm defoliated SPA. However, when fertilizer (NH_4NO_3) was combined with carbofuran treatments cone bud production was increased ten-fold.

Flower induction trials with gibberellin $GA_{4/7}$ and NH_4NH_3 have been initiated in jack pine (Pinus banksiana Lamb.) seed orchards established by PNFI and the Saskatchewan Division of Weyerhauser Canada. The interaction of gibberellin treatments with different levels and types of nitrogen are being investigated in potted jack pine trees under polythene shelters. Studies on apical control of growth and reproductive development in jack pine have been initiated.

Seed Maturation

White spruce seeds require 6-week post-harvest ripening period in the cones to obtain maximum germinability. Apparently, this period is necessary for the translocation of organic material to take place within the cone.

Seed Pretreatment and Germination

As a result of variation in the degree of seed maturation and dormancy of seed from different trees within a stand, and differences in collecting, handling and processing of cones, white spruce seeds require 3-week prechilling for maximum, uniform germination in laboratory and greenhouse sowing (Wang 1987b). Results of prolonged prechilling treatment of white spruce and eastern white pine seeds suggested that both species can be prechilled for 15 weeks at 2°C-4°C in the dark without germination. Rates of germination under standard conditions began to decline after 8 and 14 weeks of prechilling treatment for eastern white pine and white spruce seeds respectively. Contrary to the widely established hypothesis that prechilling treatment is detrimental to the germination of seeds that are physiologically "old" or damaged by processing, white spruce seeds artificially aged in an incubator at 40°C and 98% relative humidity for 10 days responded very favourably to a 3-week prechilling.

Progress was made on the ecology of germination of black spruce and red alder (Alnus rubra Bong.).

Seed-borne Fungi

Studies of the effects of seed-borne fungi on germination and early seedling development of white spruce and eastern white pine were completed. The study areas covered were: identification of fungus species isolated (Mittal and Wang 1986a, b), source of infestation (from cone collection to seed processing) (Mittal and Wang 1987c), pathogenicity of fungi to seed germination and early seedling development under laboratory and greenhouse conditions (Mittal and Wang 1987b, Mittal et al. 1987), effective control measures, and literature review (Mittal and Wang 1985, Mittal et al. 1987).

Seed Storage

Preliminary results showed that white spruce seeds, with moisture content from 2 to 11% (fresh weight basis), suffered no injury after 2 weeks of storage under cryogenic conditions at temperatures of -80°, -150° and -196°C. Germination of seeds with 14% or more moisture content was reduced. Further trials with black spruce seeds and other species are in progress.

Genetic changes that may occur as seed germinability declines in storage are being studied using accelerated aging techniques and electrophoretic analysis.

SEED BANK AND SERVICES

Seed Processing and Testing

The Centre's seed extraction plant has continued to provide seed processing services to maintain the Seed Bank holdings and to other clients. Seed lots of about 25 species were processed, including 267 lots for complete processing from cones to clean seeds and 1,109 lots for recleaning and reconditioning.

The demand for regulatory seed testing services has decreased but 3,000 in-house service tests were conducted in the last two years. In addition, 500 tests were performed for ongoing (or routine) monitoring of seed quality of the Seed Bank stock.

Seed Bank and Information Services

The Seed Bank has continued to procure seeds of various species to strengthen its holdings; 170 seedlots of 57 species were procured from 12 countries in 1986 including 25 lots collected by project staff. An updated list of seeds available from the Seed Bank was published and distributed to users. In response to 161 requests for seeds, 1,327 lots of 132 species were dispatched to clients in Canada and 17 other countries in 1986. Over 2,000 seed and cone samples were distributed to educational institutions, visitor centres and exhibitions through other project activities. In reply to inquiries, information in the form of letters, reprints, maps, and computer inventory listings were mailed to 55 clients in 9 Canadian provinces and 15 countries.

National Seed Statistics

Results of the 1982-83 national survey of conifer forest tree seed statistics was published. Preparation of a summary of results of the 1984-85 survey has been delayed by staff changes and by the lack of data from the Maritime Provinces. The available data will be published along with the results of the 1986-87 survey. Requests for data are being sent out, and returns from all areas of Canada are hoped for.

OTHER ACTIVITIES

The Centre has continued to provide programs and facilities for training in tree climbing skills, and seed science and technology to technical and professional personnel from CIDA's Project in Southeast Asia and other agencies.

In cooperation with Dr. George Edwards of Pacific Forestry Centre (PFC), and Ron Smith of Maritimes Forestry Centre, regional workshops on tree seed testing are scheduled to be held at: Petawawa National Forestry Institute on September 29 - October 1, 1987 and March 1988, Truro, Nova Scotia on November 24-26, 1987 and PFC, Victoria, B.C. on December 8-10, 1987. The first one will be co-sponsored by the Ontario Ministry of Natural Resources for their staff.

PUBLICATIONS

Bowen, R. 1987. Wound response to systemic insecticide injections in white spruce. B.Sc.F. Thesis. School of Forestry, Lakehead University, Thunder Bay, Ont.

Fogal, W.H. 1986. Applying Beauveria bassiana (Bals.) Vuill. to soil for control of the spruce cone maggot Lasiomma anthracina (Czerny). pp. 257-266. In: Proc. IUFRO Cone and Seed Insects Working Party Conference, Briançon, France.

Fogal, W.H. and S.M. Lopushanski. 1985. Foliar-applied insecticides for control of white spruce seed and cone insects. For. Chron. 61:499-502.

Fogal, W.H., R.K. Mittal and G.S. Thurston. 1986. Production and quality evaluation of Beauveria bassiana for control of white spruce cone and seed insects. Canadian Forestry Service Information Report PI-X-69.

Fogal, W.H., G.S. Thurston and G.D. Chant. 1986. Reducing seed losses to insects by treating white spruce conelets with conidiospores of Beauveria bassiana. Proc. Entomol. Soc. Ont. 117:95-98.

Janas, P.S. 1985. A list of seed in the Canadian Forestry Service Seed Bank. Can. For. Serv., Petawawa Nat. For. Inst. Inf. Rep. PI-X-58 E/F.

Janas, P.S. 1985. Canadian conifer forest tree seed statistics: 1982-83 survey results. Can. For. Serv., Petawawa Nat. For. Inst. Inf. Rep. PI-X-56.

Mittal, R.K., and B.S.P. Wang. 1985. Botrytis hazards in forest regeneration. Abstract. Can. J. Pl. Pathol. 7(4):447.

Mittal, R.K., and B.S.P. Wang. 1986a. Emergence failure and top decay in white spruce germinants due to three fungi. Can. Pl. Disease Survey 66(1):5-7.

Mittal, R.K., and B.S.P. Wang. 1986b. Pathogenicity of seed-borne fungi in Pinus strobus. Abstract. Phytopathology 76(10):1113.

Mittal, R.K.; and B.S.P. Wang. 1987a. Fungi associated with seeds of white spruce and eastern white pine during cone collection and seed extraction. Can. J. For. Res. (in press).

Mittal, R.K., and B.S.P. Wang. 1987b. Pathogenicity of seed-borne fungi in Picea glauca and Pinus strobus. Can. J. For. Res. (in press).

Mittal, R.K., Pritam Singh, and B.S.P. Wang. 1987. Botrytis - a hazard to reforestation. European J. For. Pathol. (in press).

Mittal, R.K.; B.S.P. Wang, and D. Harmsworth. 1987. Effects of extended prechilling on laboratory germination and fungal infection in seeds of white spruce and eastern white pine. Tree Planters' Notes (in press).

Pitel, J.A., and B.S.P. Wang. 1985. Physical and chemical treatments to improve laboratory germination of western white pine seeds. Can. J. For. Res. 15:1187-1190.

Pitel, J.A., and B.S.P. Wang. 1987. Improved germination of basswood (Tilia americana L.) seeds with gibberellic acid. Seed Sci. & Technol. (in press).

Schooley, H.O., D.A. Winston, R.L. MacNaughton and M.L. Anderson. 1986. Frost killing of red pine female flowers. For. Chron. 62:140-142.

Wang, B.S.P. 1987a. Review of new development in tree seeds. Seed Sci. & Technol. (in press).

Wang, B.S.P. 1987b. The beneficial effects of stratification on tree seed germination. Proc. Ont. Nurserymen's Meet., June 15-18, 1987, Dryden, Ont. (in press).

FOREST GENETICS, PETAWAWA NATIONAL FORESTRY INSTITUTE, 1985-87

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Keywords: Provenance, Progeny testing, Population genetics, Early testing, Electronic data collection

INTRODUCTION

The Tree Genetics and Breeding Project at PNFI was divided and expanded into three projects in May, 1985, with the creation of the Molecular Genetics and Tissue Culture project (Dr. W.M. Cheliak, project leader) and the Tree Propagation project (Mr. Z. Zdrazil, project leader). Dr. Steen Magnussen, post doctoral fellow from the Royal Veterinary and Agricultural University of Copehagen (Denmark), joined the project in 1985. In 1986, Dr. Gordon Murray was confirmed in his new position of Program Manager, Forest Genetics and Biotechnology.

PROVENANCE AND HYBRID TESTING

A study of biomass production and distribution in 12 jack pine (Pinus banksiana Lamb.) provenances was concluded in 1985 (Magnussen et al. 1985). Differences among provenances were greater for biomass than for height growth, and biomass production per unit leaf area was constant. The affect of competition was assessed in another jack pine provenance test (Magnussen and Yeatman 1987e). Only diameter growth was significantly affected by competition, and adjusting for competition lead to no changes of ranking. Growth and form characters were assessed for 26 jack pine provenance hybrids, growing on six sites. Hybrids generally exceeded mid-parental values, but were usually inferior to the better parent.

In a provenance-progeny test of Soviet and Chinese Scots pine (Pinus sylvestris L.), established in 1986, sources from southern Siberia were superior to Ukrainian and western Russian provenances in first- and second-year height growth. In a 30-year-old provenance test, diameters of central Siberian provenances from near Krasnojarsk were not significantly different from those of Hungarian and Czechoslovakian provenances that had been significantly larger at age 17.

Three range-wide tamarack (Larix laricina [Du Roi] K. Koch) trials were established in Ontario in 1986-87.

PROGENY TESTING

In a seven-tree, complete diallel cross of black spruce (Picea mariana [Mill.] B.S.P.), planted at three locations, genetic control of height growth at four ages between six and 14 was predominantly additive. However, location and location x cross interaction effects were large (Boyle 1987). From about age 10, though, specific combining ability effects began to increase in size, relative to general combining ability, on all three sites. The same material has been used for a study of wood properties. Specific gravity and tracheid characters have been demonstrated to be highly heritable and predominantly additive in their inheritance.

Analyses of an accelerated nursery trial and standard field trial of open-pollinated jack pine families demonstrated the potential for early selection for height growth (Magnussen and Yeatman 1987d). In another nursery trial, the effects of spacing on branch characters was studied. Repeatabilities were low, except for branch angle, indicating the potential for genetic improvement of this character, but although progenies of plus trees were superior to those from "average" trees in terms of height, this superiority declined with age (Magnussen and Yeatman 1987a, b).

A series of experiments was planted in nursery and field tests with control-pollinated jack pine. The objective is to quantify gains to be achieved by selection and breeding over a range of levels and in first and second generations. Surplus seed will provide plants for block planting of families and seedlots for subsequent selection. A ten-family x spacing progeny test was established for growth and yield studies in collaboration with U. of T. Forestry Faculty.

In a 22-year-old Norway spruce (Picea abies Karst) progeny test, white pine weevil tolerance was demonstrated to be highly heritable, but susceptibility to frost appeared to have little influence on future stem form (Coleman et al. 1987). Growth rates of the better families were outstanding.

POPULATION STUDIES

Analysis of isozyme genotypes of 180 individuals in a "lowland" black spruce population in northern Ontario indicated a random distribution pattern within the population. A comparative study on 350 individuals from a nearby "upland" site is currently underway.

BREEDING POPULATIONS

Clones of superior Norway spruce selected in plantations in eastern Canada were added to the 'land race' population at PNFI. Scions of Norway spruce and larch select trees were supplied to cooperators in eastern Canada. Clones of Upper Ottawa Valley white spruce selections were planted in breeding archives. The Spoor Lake research orchard was used for a workshop in orchard thinning. Budworm-tolerant jack pine were selected, grafted and used for epidemiological research by Taylor Scarr, U. of T. graduate student. Dr. Andy Hurley, Queens University, completed his graduate studies of squirrel activity in pine graft plantations at PNFI. He was awarded his Ph.D. in July, 1987.

DATA COLLECTION

Mr. T. Nieman is serving as the Canadian representative on a joint US-Canadian committee on Electronic Data Collection and Micro-computers under the Forest Assessment Technology Exchange programme. The purpose of the committee is to review existing users and applications and to facilitate the exchange of information and ideas. The current status of Electronic Data Collection in the US and Canada was reviewed by Nieman (1987).

PUBLICATIONS

Boyle, T.J.B. 1985. The mating system and population structure of black spruce in central New Brunswick and its influence on tree improvement strategy. Ph.D. dissertation, University of New Brunswick: 141 pp.

Boyle, T.J.B. 1985. Range-wide provenance tests of black spruce in Ontario. Can. For. Serv. Inf. Rep. PI-X-57.

Boyle, T.J.B. 1986. Ten-year height growth of open-pollinated black spruce families in Ontario. Can. For. Serv. Inf. Rep. PI-X-61.

Boyle, T.J.B. 1986. Accelerated testing in a black spruce improvement program. Pp. 65-72 In: Proc. 30th Northeast. For. Tree Improv. Conf., Orono, ME, 1986.

Boyle, T.J.B. 1986. Black spruce genetics, Petawawa National Forestry Institute, 1983-84. Pp. 133-135 In: Yeatman, C.W. and T.J.B. Boyle (eds.). Proc. Pt. 1, 20th Mtg. Can. Tree Improv. Assoc., Quebec City, 1985.

Boyle, T.J.B. 1987. A diallel cross in black spruce. Genome 27:180-186.

Boyle, T.J.B. and J.F. Coles. 1987. The importance of climate in the selection of genetic resources. Proc. Forest Climate '86.

Boyle, T.J.B., J.F. Coles and J. Hood. 1987. Accelerated progress in a boreal tree improvement programme. Submitted to For. Chron.

Boyle, T.J.B. and D.C. Malcolm. 1985. The reproductive potential and conservation value of a near-derelict Scots pine remnant in Glen Falloch. Scot. For. 39:288-302.

Boyle, T.J.B. and E.K. Morgenstern. 1985. Inheritance and linkage relationships of some isozymes of black spruce in new Brunswick. Can. J. For. Res. 15:992-996.

Boyle, T.J.B. and E.K. Morgenstern. 1985. Population structure of black spruce in central New Brunswick. Pp. 142-156 In: Proc. 29th Northeast. For. Tree Improv. Conf., Morgantown, West Virginia. 1984.

Boyle, T.J.B. and E.K. Morgenstern. 1986. Estimates of outcrossing rates in six populations of black spruce in central New Brunswick, Canada. Silv. Genet. 35:102-106.

Boyle, T.J.B. and E.K. Morgenstern. 1987. Some aspects of the population structure of black spruce in central New Brunswick. Silv. Genet. 36:53-60.

Cheliak, W.M., G. Murray and J.A. Pitel. 1987. Genetic effects of phenotypic selection in white spruce. [submitted For. Manage. Ecol. 35 p.].

Coleman, M.N., T.C. Nieman and T.J.B. Boyle. 1987. Growth, survival and stem form of a 22-year-old Norway spruce progeny test. Can. For. Serv. Inf. Rep. PI-X-73.

Hurley, T.A., C.W. Yeatman and R.J. Robertson. 1987. Maturity and viability of seed from squirrel-cut pine cones. For. Chron. 63:268-271.

Magnussen, S. 1985. Growth transpiration, unit leaf rate and water use efficiency of six poplar clones at different light and temperature regimes. For. Tree Improvement 18.

Magnussen, S. 1986. Diameter distributions in Picea abies described by the Weibull model. Scand. J. For. Res. 1:493-502.

Magnussen, S. and C.W. Yeatman. 1987a. Early testing of jack pine. I. Phenotypic response to spacing. Can. J. For. Res. 17:453-459.

Magnussen, S. and C.W. Yeatman. 1987b. Early testing of jack pine. II. Variance and repeatability of stem and branch characters. Can. J. For. Res. 17:460-465.

Magnussen, S. and C.W. Yeatman. 1987c. Four years' height growth of 25 jack pine (Pinus banksiana Lamb.) families in an accelerated nursery trial. Pp. 47-64 In: Proc. 30th Northeast. For. Tree Improv. Conf., Orono, ME.

Magnussen, S. and C.W. Yeatman. 1987d. Accelerated testing of jack pine progenies: a case study. Pp. 107-121 In: Proc. IUFRO Conf., Working Parties on Breeding Theory, Progeny Testing and Seed Orchards, Williamsburg, VA.

Magnussen, S. and C.W. Yeatman. 1987e. Adjusting for inter-row competition in a jack pine provenance trial. Silv. Genet. (in press).

Magnussen, S., V.G. Smith, and C.W. Yeatman. 1985. Tree size, biomass and volume growth of twelve 34-year-old Ontario jack pine provenances. Can. J. For. Res. 15:1129-1136.

Magnussen, S., C.W. Yeatman and V.G. Smith. 1986. Foliage and canopy characteristics in relation to aboveground dry-matter increment of seven jack pine provenances. Can. J. For. Res. 16:464-470.

Murray, G. and W.M. Cheliak. 1985. Genetics of white spruce, larches and hardwoods, Petawawa 1983-1985. Pp. 136-138 In: Yeatman, C.W. and T.J.B. Boyle (eds.). Proc. 20th Meeting CTIA, Part 1, Quebec City.

Nieman, T.C. 1987. Electronic Data Collection in Canada and the U.S. Proc. Fast Growing Forests Technology Workshop, Ottawa, Ont. Aug. 17-20, 1987.

Yeatman, C.W. 1986. PNFI genetics and breeding, genetics of jack pine pine. Pp. 130-132 In: Yeatman, C.W. and T.J.B. Boyle (eds.). Proc. Pt. 1, 20th Mtg. Can. Tree Impov. Assoc., Quebec City, 1985.

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Keywords: Cooperative, tree improvement program.

The desirability of industrial/government cooperation in tree improvement in Ontario became apparent when the responsibility for forest management was transferred to industry through the Forest Management Agreements and with the realization that a possible wood supply shortfall may exist in the future.

The Ontario Tree Improvement Council (OTIC) - an incorporated industrial/government cooperative - began operation in January 1985. The structure and modus operandi are described. Operational black spruce (Picea mariana (Mill.) B.S.P.) and jack pine (Pinus banksiana Lamb.) tree improvement projects have been established in the three northern Regions of the Province in those breeding zones not previously addressed by the Ontario Ministry of Natural Resources (OMNR). To date, approximately 2000 plus trees have been selected, 20 hectares of seedling seed orchard established and four family tests outplanted. Progress and cooperation has been excellent and has every prospect of continuing.

STRUCTURE

The Ontario Tree Improvement Council (OTIC) is an incorporated cooperative composed of Abitibi-Price Inc., Boise Cascade Canada Ltd., Great Lakes Forest Products Ltd., Ontario Paper Co., Waferboard Corp. Ltd. and the Eastern, Northeastern, Northern, North Central and Northwestern Regions of the Ontario Ministry of Natural Resources, and employs a fulltime director headquartered at the University of Guelph. The objective of OTIC is "to increase the supply of industrial roundwood for the forest industries of Ontario by fostering the cooperative approach to an accelerated tree improvement program that will shorten rotations, increase yields and improve wood quality". The objective will be accomplished by (i) ensuring all seed used in reforestation are well adapted and source identified and (ii) providing genetically improved seed through a program of plus tree selection, testing and propagation.

OTIC is structured into three levels of committees. The parent committee of OTIC is composed of a senior management representative from each of the ten agencies as voting members and three non-voting members - the Provincial Forester, the Provincial Tree Improvement Specialist and the Director of OTIC. The parent committee meets twice a year to review progress, to set policy, to provide guidance to the Director and to establish a yearly budget for OTIC and is chaired by an elected voting member. Each of the ten agencies is assessed a standard membership fee to cover office, travel and salary expenses of the Director.

The Technical Committee is composed of a voting tree improvement representative from each of the ten agencies along with non-voting scientific advisors from the universities and federal and provincial governments. The Technical Committee's function is to review progress, recommend improvements, solve short term problems and recommend approaches to such long term opportunities as improvement of wood quality. The Technical Committee meets when required and is chaired by the Director of OTIC.

Regional Working Committees are in place for each project and are composed of the tree improvement specialists from the industrial woodlands and district and regional OMNR offices involved. The working committees plan and distribute the workload and coordinate a budget for each project. The committee and its members are responsible for the day-to-day operation and implementation of the project and meet as required - usually informally, several times a year.

MODUS OPERANDI

Cooperation between industry, OMNR and the research agencies is the key to a successful and efficient program and is facilitated by a framework of clearly defined and accepted groundrules.

i Program Design - the strategy for implementing a program will follow that prescribed by the OMNR (1987) document "Tree Improvement Master Plan For Ontario". These strategies are sufficiently flexible to incorporate new knowledge and meet individual agency's objectives.

ii Species - joint projects between industry and OMNR may be established in those species which are commercially important and commonly planted and in any area of the province where OTIC members determine there is a need.

iii Criteria For Selection - selection of criteria are determined by long-term industrial requirements.

iv Seed Orchards - orchards may be established either individually or jointly.

v Distribution of Improved Genetic Material - the guiding principal is that distribution of improved material will reflect the level of contribution of members to any of the selection, testing or orchard establishment phases of the project.

vi Funding - project plans, devised by the Regional Working Committees, will distribute the workload. Costs incurred to complete the designated workload will be born by the agency involved but may be offset should government funding (Canada-Ontario Forest Resources Development Agreement, COFRDA) be available.

PROJECTS

After a thorough review of OMNR's ongoing tree improvement program, OTIC members determined the need for three operational projects (Figure 1).

i In the Northern Region, Abitibi-Price, Ontario Paper, Waferboard and OMNR (Cochrane, Kirkland Lake, Timmins Districts) are cooperating to improve black spruce in two breeding zones and jack pine in one breeding zone.

ii In the North Central Region, Abitibi-Price, Great Lakes Forest Products and OMNR (Thunder Bay District) are cooperating to improve both black spruce and jack pine in the Lake Nipigon West breeding zone.

iii In the Northwestern Region, Boise Cascade, Great Lakes Forest Products and OMNR (Dryden and Fort Frances Districts) are cooperating to improve jack pine in two breeding zones.

In addition, Boise Cascade, Lakehead University in Thunder Bay and OMNR Regional Office in Kenora developed a research project "Development Of Short Rotation Silvicultural Systems For Selected Populus And Larix In Northwestern Ontario" (Lakehead University, 1986). The research project is in response to a desire by Boise Cascade to reforest the large areas of marginal farmland in the Fort Frances area.

For each of the four projects, work plans and budgets were devised and accepted by all parties and proposals were submitted to COFRDA. COFRDA funding was approved for four years which, in conjunction with industrial and OMNR financial commitments to the projects, will provide an adequate level of funding to complete the projects.

PROGRESS

Operational Tree Improvement Projects

The strategy to be employed for the first generation of improvement of both black spruce and jack pine in the Province is extensive selection of plus trees from natural stands followed by the establishment of family tests (single-tree plots, 32 replications) and seedling seed orchards. The seedling orchards will be rogued of their poorest families as required to maintain good espacement, based on growth and form measurements in the family tests.

Northern Region

Black Spruce, Cochrane Breeding Zone. A target of 450 plus trees exhibiting superior volume growth and good form was set and to date has been only partially met. Poor cone crops have reduced the number of sound seed available per tree. A 36 ha seed orchard site has been prepared.

Black Spruce, Kirkland Lake/Timmins Breeding Zone. A target of 450 plus trees of superior volume growth and form has been met by industrial and OMNR cooperators. A 12 ha seed orchard site has been prepared and seedlings for the orchard and family tests are currently being produced.

Jack Pine, Kirkland Lake/Timmins Breeding Zone. The target of 450 plus trees of superior form and volume growth has been met. Seven hectares of a proposed 14 ha orchard has been planted and seedlings are being produced to establish family tests and the remaining 7 ha of orchard in 1988.

North Central Region

Black Spruce, Lake Nipigon West. The target of 450 plus trees exhibiting superior volume growth has been met although seed yields have not been as high as required. A 16 ha orchard site has been prepared for outplanting in 1988 however an additional 16 ha will be required.

Jack Pine, Lake Nipigon West. All 450 plus trees of excellent form and volume growth have been selected. Four family tests and a 14 ha seedling orchard were established in the spring of 1987.

Northwestern Region

Jack Pine. The criteria for selection of plus trees is superior volume growth and excellent form. Approximately 3/4 of the 450 plus trees required for each breeding zone have been selected. Two orchard sites have been prepared.

Boise Cascade, Lakehead University, OMNR Research Project

"Development of Short Rotation Silvicultural Systems For Select Populus And Larix In Northwestern Ontario." A research associate at the School of Forestry has reviewed the literature, surveyed existing Northern Ontario trials, selected clones of Populus and species and provenances of Larix for testing, procured the material and, with assistance from Boise Cascade, established nursery trials of the selected materials at both Fort Frances and Thunder Bay.

SUMMARY

The Ontario Tree Improvement Council has made significant strides during the first two and a half years of operation. With funding secured, on-the-ground progress in the operational and research projects has been excellent and cooperation between industry, government and research agencies is improving. There is every indication that OTIC will prosper and grow to play a significant role in tree improvement in Ontario.

PUBLICATIONS AND REFERENCES

Coles, J.F. 1985. Interaction, Or Lack Thereof, Between Forest Managers From Industry And Government And Forest Researchers From Government And Universities. Proc. COJFRC Symposium "Forest Research - Who Needs It". Geneva Park, Ontario. 13 p.

Coles, J.F. 1985. An Introduction To Tree Improvement For Executives. O.T.I.C. 15 p.

Coles, J.F. and L.E. Parnell. 1986. Economics Of Tree Improvement In Eastern Canada. Paper Presented at 1986 Annual C.I.F. Meeting, Victoria, B.C. 11 p.

Lakehead University, School of Forestry. 1986. Problem Analysis For Development Of Short Rotation Silvicultural Systems For Selected Populus and Larix In Northwestern Ontario. 139 p.

Ontario Ministry of Natural Resources. 1987. Tree Improvement Master Plan for Ontario. 81 p.

FOREST GENETICS RESEARCH ACTIVITIES AT THE UNIVERSITY OF TORONTO 1985-1987

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The forest genetics laboratory has become well established since its inception in 1984. Undergraduate courses are offered in forest genetics and tree breeding to the second year and to the fourth year. A graduate course in forest genetics is offered as well.

Five Ph.D. students were enrolled in 1985-87 (O.M. Rajora, A. Mosseler, M. Stoehr, E. Chagala and A. Kenny). The first two students completed their Ph.D. studies in June, 1986 and June, 1987, respectively. A description of Rajora's thesis work appeared in the Proceedings of the 20th Meeting CTIA, 1985. A. Mosseler has since accepted a position as Research Associate with the Forest Genetics Laboratory, starting June, 1987. In addition, 4 new Masters students have commenced work (M. Roderick, T. Scarr, M. Simon and E. Viquez).

Graduate studies initiated since 1985, and the research projects conducted by the Forest Genetics Laboratory at the University of Toronto, are described as follows:

Hybridization studies in some North American Salix species

Dr. A. Mosseler has performed these studies as part of his Ph.D. thesis, and is continuing with the same now as a Research Associate.

The reproductive barriers restricting natural hybridization between S. amygdaloides Anderss., S. bebbiana Sarg., S. discolor Muhl., S. eriocephala Michx., S. exigua Nutt., S. lucida Muhl., S. pellita Anderss., and S. petiolaris Smith have been studied. Premating reproductive isolation mechanisms such as different habitat preferences or flowering times could not preclude natural cross pollination and suggested that stronger internal (post-mating) barriers must play an important role in minimizing natural hybridization. Microscopic observations indicated that pollen-pistil incongruity (incompatibility) represented a major internal barrier to interspecific fertilization. Among interspecific

hybrid families, postzygotic inviability barriers such as seed incompatibility, seedling inviability and inferior growth performance in hybrid progeny were also observed. Viable interspecific hybrids generally suffered reduced levels of fertility, but most female plants produced open-pollinated seed, indicating enough residual fertility to proceed with backcross breeding. Preliminary observations on biomass yield obtained from F_1 hybrids indicated that interspecific hybridization results in lower mean family biomass production and a much higher within-family variability in yields when compared with intraspecific families.

Induction and evaluation of haploid and dihaploid lines in Salix and Populus species (M. Stoehr)

Anthers with pollen grains at different stages of microsporogenesis are cultured on a range of media supplemented with various growth hormones. Plantlets are induced from callus tissue or embryoidal structures. Currently, a total of 145 plants have been obtained from one poplar clone. Ploidy levels of these plants have not yet been confirmed. Some of the anther-derived plants produced primitive flowers. In willows, haploid plants were induced but did not survive in non-sterile conditions.

Genetic characteristics of Gliricidia spieum (Jacq.) Walp. based on isozyme studies (A. Kenny)

This species is native to Central America, but planted throughout the tropics for fuelwood, in live fences, and as a protein supplement in ruminant forage. Despite its widespread use, little information exists on the degree of genetic variation in the species and on its mating system. Isozymes will be used to estimate the rate of outcrossing and levels of heterozygosity and the average number of alleles per polymorphic loci from populations throughout the tropics. Seed from natural and introduced populations will be supplied from the Oxford Forestry Institute; the Nitrogen Fixing Tree Association, University of Hawaii; and from the International Livestock Centre for Africa.

The effect of genotype and nutritional status of ortet on rooting ability of stem cuttings of Erythrina poeppigiana (Walp.) O.F. Cook (M. Rodrick)

The goal of this study is to establish the effect of genotype and nutrient status of the ortet, as related to the nutrients in the soil, on rooting. The study is being accomplished in four related trials with the following goals: 1) to investigate the effect of genotype x site interaction on rooting using clones from 15 different sites in Costa Rica; 2) to test the effect of nutritional status of ortet on rooting as related to the soil mineral content; 3) to investigate the effect of genotype on rooting by examining differences in rooting between clones within an existing provenance trial; and 4) to test the consistency in rooting by re-examining some of the clones used in the first trial. Soil, foliar and carbohydrate/nitrogen analysis are an integral part of the investigations.

This study is performed at Central American Research and Training Centre (CATIE), Costa Rica.

Growth response of some North American willow species and their clones to fertilization (M. Simon)

This study was designed to establish species and clonal differences in nitrogen uptake and growth response. Salix eriocephala, S. lucida, and S. exigua with five clones per species, are being studied, with plants raised from cuttings, in pots. Fertilization treatments include 1) a chemical solution containing micro- and macro-nutrients; 2) industrial sludge; and 3) municipal sewage sludge. In addition, a field trial using North American and European willow species has been established at the Petawawa National Forestry Institute, and fertilizers with different levels of macro-nutrients are being applied at an exponentially increasing rate, during the summer of 1987.

Genetic variation in jack pine for resistance to jack pine budworm (Choristoneura pinus pinus) (T. Scarr)

Surveys were conducted to locate trees which continue to exhibit very little defoliation after several years of infestation, compared to their neighbours. Grafted clones of trees selected for apparent resistance or susceptibility are being used as bioassays to determine whether the undefoliated trees are rejected by budworm larvae, reduce larval survival, or are not preferred by ovipositing moths. Analyses of needle toughness, terpene content, and isozymes will attempt to characterize the green trees. Increment borings and wood disks will be used to measure vigour of the trees.

The establishment of isozyme gene markers for identification of important poplar hybrids and clonal varieties (E. Viquez)

The purpose of this study is: 1) to identify marker allozyme genes and alleles which will characterize selected interspecific hybrids and clonal varieties of poplar; 2) to produce keys for the reliable identification of the hybrids and clones of poplar used; 3) to study the heritability of some characteristic isozymes in poplar hybrids; and 4) to study linkages between established gene markers and clonal characteristics. Hybrids between P. deltoides and P. nigra will be assayed by electrophoretic techniques for approximately 20 different enzyme systems.

Selection and evaluation of Salix species for biomass production in short rotation plantations (B. Beatson, A. Mosseler, L. Zsuffa)

This study is financially supported by the Bioenergy Agreement, International Energy Agency, in cooperation with Belgium, Finland, Ireland, Sweden, U.K. and U.S.A. The objectives are to collect worldwide, propagate, evaluate and distribute clones of species and hybrids of genus Salix which are of importance for biomass production in energy plantations according to the needs of the project participants. A special focus of

the project is the selection and evaluation of North American Salix species, little studied up to now. Adaptability of the clones to local conditions and susceptibility to insect and disease damage is currently under study. Several hundred clones from across the North Central U.S.A., the Southeast U.S.A., Northwestern Canada and Ontario were shipped to Belgium, Ireland and Sweden during 1984 and 1985. Testing of these clones in local conditions is ongoing. Trials were established in the vicinity of Toronto, Kemptville, Petawawa (PNFI) and in Syracuse, N.Y. (U.S.A.), in 1986/87.

Coordination of international research and development projects

Forest genetics and tree breeding at the Faculty, with L. Zsuffa as operating agent, and R. Gambles as coordinator, is the secretariat of a cooperative task of the Bioenergy Agreement, International Energy Agency. The group's objective is the improvement of biomass growth and production technology in short rotation forestry. The participants in this task are Belgium, Canada, Finland, Ireland, Sweden, U.K. and U.S.A. The means are cooperative and coordinated R & D, transfer of technology and material, and exchange of information in the areas of genetic improvement, factors of growth, production technology and evaluation. The participating countries cooperate in planning and executing the task. The work is structured in activities, and activity leaders are from countries with the most expertise, strong support and funding. Results are in the form of reports and recommendations, handbooks and manuals, standardized procedures and evaluations, superior stock, and disease-free plant material. The participants contribute to the work in-cash and in-kind.

An evaluation and genetic enhancement of Populus deltoides Bartr. native to Ontario (B. Beatson, O.P. Rajora, L. Zsuffa)

This project started with a survey of P. deltoides occurrence in Ontario, from which 10 groupings were delineated, including a total of 120 trees. The genetic structure of the trees and populations was studied by isozyme analysis. Root tips were collected from vegetatively propagated trees, and 13 enzyme systems were resolved by starch gel electrophoresis. The allelic constitution was determined at 38 loci coding for these enzymes. The results of this study were tested using Nei' statistic, showing much of the variability (88%) resided within populations. Discriminant analysis of allele frequencies determined that the Southwest, Long Point and Perth populations were moderately well separated from the other populations. Differences among populations were also evaluated on the basis of leaf morphology using seven leaf characters and four ratios. Duncan's multiple range test and discriminant analysis showed the Long Point population was significantly different. Mahalanobis distances were highly significant among all populations, showing a high amount of morphological divergence of leaf characters in P. deltoides in Ontario.

Vegetative propagation of Pinus banksiana Lamb. and Pinus strobus L. (B. Beatson, L. Zsuffa)

Studies on vegetative propagation of P. banksiana began in the winter of 1985/86. Two types of plant material were used: 1) 1.5-year-old, half sib stock from selected plus trees (cuttings were taken from actively-growing seedlings) and 2) seven to 9-year-old plantation stock (dormant cuttings were collected). For both juvenile and adolescent stock, 4 trials were conducted to evaluate clonal differences in rooting, and reaction to rooting media, hormonal application, and environmental conditions. The results were 1) 25-50% of the cuttings from the best clones rooted; 2) 19 of the 40 older ortets rooted; and 3) half concentration Hare's powder was the best hormonal treatment, and the rooting box was the best environment for rooting.

In trials with P. strobus, two types of plant material were used: 1) nine to 12-year-old hedges established from rooted cuttings of seven to 25-year old trees, and 2) two-year old seedlings. These trials were established in rooting boxes (plastic boxes, 36 cm x 112 cm x 46 cm, with grow-lux light, kept in a room at approx. 25-30°C). Cuttings were taken from hedges while dormant in April, and during candle elongation, in July. Some of the dormant cuttings rooted by September, and those taken in July failed. Cuttings taken from seedlings in April were evaluated for rooting in August. Rooting for each family was 29-57%. Seedlings of the same families as used in the spring trials were decapitated in June to encourage lateral shoot development, and cuttings were taken for rooting in late September. Rooting was up to 100% for some clones by March.

PUBLICATIONS DURING THE PERIOD 1985-87

Banoun, F., D. Morgan, M. Viart and L. Zsuffa. 1984. The poplar: a multi-purpose tree for forestry development. Unasylva 36: 23-33.

Grossnickle, S., R. Evers and L. Zsuffa. 1985. Perspectives on forestry plantation practices in the temperate zone. In: IX World Forestry Congress, Mexico, July 1-10, 1985. pp. 1-20.

Hyun, J.O., O.P. Rajora and L. Zsuffa. 1986. Inheritance and linkage of isozymes in Populus tremuloides (Michx). Genome 29: 384-388.

Mitchell, C.P., P.O. Nilsson and L. Zsuffa. (eds.) 1986. Research in Forestry for Energy. Proc. Joint Mtg. IEA Forestry Energy Program and FAO Coop. Network for Rural Energy. Oct. 28-30, 1985. Swedish Univ. of Agr. Sciences. Publ. Vol. I-II, 452 pp.

Mitchell, C.P., L. Sennerby-Forsse and L. Zsuffa. 1986. Perspectives for the technical application of alternative grown ligno-cellulosics. In: Proc. Agricultural surpluses, European Economic Community Workshop, Stockholm, June, 1986. pp. 23-40.

Morgan, D.J., R.L. Gambles, L. Zsuffa and C.P. Mitchell. 1984. Proceedings Joint Workshop of IEA/FE Programme Groups B, C and D. Uppsala, Sweden, June 11, 1984. 103 pp.

Mosseler, A. 1987. Interspecific hybridization and reproductive barriers between some North American willow species. Ph.D. thesis, University of Toronto, Toronto.

Mosseler, A. 1985. An overview of Salix breeding in Ontario. In: Proceedings of the 20th Meeting of the Canadian Tree Improvement Association, Part 2: Symposium on New Ways in Forest Genetics. Quebec City, Quebec. August 19-22, 1985. F. Caron, A.G. Corriveau & T.J.B. Boyle Eds. pp. 142-150.

Mosseler, A. and L. Zsuffa. 1986. Genetic barriers to artificial interspecific hybridization in Salix. Poster Abstract IUFRO Ljubljana, September, 1986.

Nilsson, P.O., R.L. Gambles, C.P. Mitchell, D. Stevens and L. Zsuffa. 1984. Programme group activities - present status, collaboration and future directions. In: Proceedings Joint Workshop of IEA/FE Programme Groups B, C and D. Uppsala, Sweden, June 11, 1984. p. 1-18.

Papadopol, C.S. and L. Zsuffa. 1986. A simple model of growth and yield of poplar mini-rotations for fuel. Voluntary paper 18th IUFRO Congress, P.1.09.00. Abstract In: Proc. 18th IUFRO Congress. Ljubljana, September 9, 1986.

Rajora, O.P. 1986. Studies on genetics and relationships of Populus deltoides Marsh., P. nigra L. and P. maximowiczii Henry using isozymes, pollen competition and leaf morphology. Ph.D. thesis, University of Toronto, Toronto.

Rajora, O.P. 1986. Associations of allozymes with growth parameters and Melampsora rust resistance in full-sib families of Populus deltoides Marsh. crossed with P. deltoides, P. nigra L. and P. maximowiczii Henry. (Abstract) In: Ninth North American Forest Biology Workshop (Program & Abstracts). Oklahoma State University Stillwater, Oklahoma, June 15-18, 1986. p. 36.

Rajora, O.P. and L. Zsuffa. 1985. Atypical seedlings of Populus L.: their genetic significance and value in breeding. Silvae Genetica. 35: 122-124.

Rajora, O.P. and L. Zsuffa. 1986. On genetic improvement of trees for social forestry in India. Indian Forester 112.

Rajora, O.P. and L. Zsuffa. 1986. Sporophytic and gametophytic gene expression in Populus deltoides Marsh., P. nigra L. and P. maximowiczii Henry. Can. J. Genet. Cytol. 28: 476-482.

Rajora, O.P. and L. Zsuffa. 1986. Pollen viability of some Populus species, as indicated by in vitro pollen germination and tetrazolium chloride staining. Can. J. Bot. 64: 1086-1088.

Siren, G., C.P. Mitchell, L. Sennerby-Forsse and L. Zsuffa. 1986. Forest biomass energy production - a discussion of research and development needs. Position paper, Project Group P.1.09.00 Workshop on Integrated Research in Biomass for Energy, IUFRO Congress, Sept. 9, 1986. In: 18th IUFRO World Congress, Division 1, Forest Environment and Silviculture, Vol. 1. Ljubljana, Sept. 7-21, 1986. pp. 152-164.

Siren, G. and L. Zsuffa. 1986. Biomass production in semi-arid and arid zones. Invited Paper Interdivisional Meeting, Sept. 10, 1986. In: 18th IUFRO World Congress, Division 3, Forest Operations and Techniques. Ljubljana, Sept. 7-21, 1986. pp. 114-226.

Zsuffa, L. 1984. IEA cooperative research in biomass growth and production FAO/CNRE, Bulletin No. 5 pp. 19-23. June 25-27, 1984, Garpenberg, Sweden, 6 p., 3 pp.

Zsuffa, L. 1985. The genetic improvement of eastern white pine. Proc. Eastern White Pine: Today and Tomorrow, A Symposium. University of New Hampshire, June 12-14, 1985. U.S.D.A. Forest Service - General Technical Report WO-51:32-40.

Zsuffa, L. 1985. Perspectives on tree improvement and clonal forestry in eastern Ontario. In: Proc. East Growing Hardwoods Workshop, Ivy Lea, Ont. Sept. 10-13, 1985, 64. pp. 22-29.

Zsuffa, L. and A. Mosseler. 1986. The collection and distribution of clones of Salix spp. and hybrids which are of importance for biomass production in energy plantations. In: Proc. Joint Mtg. IEA Forestry Energy Program and FAO Coop. Network for Rural Energy. Oct. 28-30, 1985. Swedish Univ. Agr. Sciences. Publ. Vol. 1: 54-73.

Zsuffa, L. and O.P. Rajora. 1986. An evaluation and genetic enhancement of Populus deltoides, Bartr. native to Ontario. In: Renewable Resources Research Seminar Abstracts, Jan. 30-31, 1986. Ontario Ministry of Natural Resources. p. 11 (abstract).

Zsuffa, L., R. Salazar and B.P. Dancik. 1986. Biomass genetics and breeding. Position Paper. Post Congress Workshop on the Latest Achievements and Prospects in Forest Genetics and Tree Improvement. 18th IUFRO Congress, Dubrovnik, Sept. 20, 1986. 12 pp.

TREE IMPROVEMENT RESEARCH IN SASKATCHEWAN 1982-1987

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The tree improvement program of the Forestry Branch of Saskatchewan Parks, Recreation and Culture has been in place since 1978. Program activities have concentrated on plus tree selection, provenance tests, mass selection in nursery beds, thinning trials, seed collection stands and setting up a seed orchard. This report describes the progress of the work for the period 1982-1987.

PLUS TREE SELECTION

Since the beginning of the program, 100 plus trees of white spruce (Picea glauca (Moench) Voss) have been arbitrarily selected in the Provincial Forest. Only 36 parent trees have been confirmed. Criteria for selection emphasized height, diameter, growth, stem form and branching habit. Seeds will be collected from these trees for future work. For superior seed collection, five (5) seed production areas (SPA) have been established throughout the provincial forest.

SEED ORCHARD

In 1984, a 10 ha site close to the South Saskatchewan River and bordering the northeast portion of the South Branch Forest Nursery was cleared and fenced for the development of a seed orchard. The following stock have so far been planted in the seed orchard.

White spruce mass selected - 1405 trees
Grafted Jack pine clones from Canadian Forestry Service - 269 trees (Klein, 1982)
Provenance Test Plots
- Scots pine (Pinus sylvestris L.) - 2056 trees
- Red pine (Pinus resinosa Ait.) - 684 trees
- Lodgepole pine (Pinus contorta Dougl.) - 540 trees

Additional space is available for future expansion of the seed orchard.

PROVENANCE TESTS

Three (3) provenance tests have been established since 1982 in various locations in the Provincial Forest. Red pine provenance test-plots have been established near Greig Lake and Shoal Lake and at the South Branch Nursery. Nineteen (19) different provenances were used in this test. Lodgepole pine provenance test-plots have been located near Greig Lake and Man River and at the South Branch Nursery. Each test contains 27 different provenances to determine the most suitable one for Saskatchewan. Twenty five (25) provenances of jack pine (Pinus banksiana Lamb.) from within Saskatchewan have been planted at Greig Lake and Big River Nursery. All provenance test plots are measured every year for the first five years and then every fifth year there after.

REFERENCES

Halland, C. 1987. Provenance tests for tree improvement program. Internal report. Saskatchewan Parks, Recreation and Culture, Prince Albert, Sk.

MacKay, D. 1986. A tree improvement strategy for Saskatchewan. Internal report. Saskatchewan Parks, Recreation and Culture, Prince Alberta, Sk.

Klein, J.T. 1982. Establishment and first results for a Jack pine breeding program for Manitoba and Saskatchewan. Environment Canada, Canadian Forestry Service, Northern Forest Research Centre, Edmonton, Alta. NOR-X-247.

SHELTERBELT TREE IMPROVEMENT PFRA TREE NURSERY 1985-87

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Keywords: Provenance test, seed orchard, progeny test, shelterbelt, Populus, Pinus sylvestris, Pinus ponderosa, Larix sibirica, Fraxinus pennsylvanica.

The primary objective of the tree improvement program at the PFRA Tree Nursery is to develop genetically superior tree and shrub species for shelterbelt planting in the prairie provinces of Western Canada. This program has focused on poplar (Populus species), Scots pine (Pinus sylvestris L.), ponderosa pine (Pinus ponderosa var. scopulorium Laws.), Siberian larch (Larix sibirica Ledb.), and green ash (Fraxinus pennsylvanica Marsh. var. subintergerrima (Vahl) Fern.). Major activities in the past two years have been assembling a genetic base for breeding of Siberian larch, interprovenance breeding and progeny testing of Scots pine, establishment of a ponderosa pine progeny test, development of a superior poplar clone, and initiation of a green ash provenance test and clone bank.

POPLAR

Over the past 15 years, numerous poplar selections from open-pollinated populations of P. x deltoides 'Walker' have been evaluated. As a result of this program, a new poplar clone, 'Assiniboine', has been released for planting in prairie shelterbelts. This male poplar clone has superior hardiness and is relatively fast growing. Distribution of Assiniboine poplar was initiated in 1987.

SCOTS PINE

An interprovenance breeding program including twenty-four superior phenotypes is nearing completion. Initiated in 1983, the program has resulted in a total of 300 crosses. A progressive diallel mating system was incorporated, replacing the tester cross system used initially in the program. Concurrent with the breeding program has been the establishment of a clonal seed orchard. The seed orchard will contain five ramets each of 24 plus trees, selected from a 1962 provenance test.

PONDEROSA PINE

In 1986, an open-pollinated progeny test was established near Indian Head, in co-operation with the USDA-Forest Service. The test includes 62 families from 11 sources in Nebraska, South Dakota and Montana. In order that the progeny test be easily converted to a seed orchard, a three-tree noncontiguous plot design was used. First year survival ranged from 95 to 100 percent. There were no differences among families.

SIBERIAN LARCH

Investigations into the propagation of Siberian larch are underway. Current studies include vegetative propagation with softwood cuttings, and seed characteristics, including maturity and germination requirements. In 1986 seed obtained from the Petawawa National Forestry Institute, as well as collections from the native range of Siberian larch in the Soviet Union, were propagated. The seedlings, representing 11 seed sources, will be planted at various locations for future breeding programs. In 1987, investigations on controlled pollination and pollen handling techniques for Siberian larch were initiated.

GREEN ASH

In 1986, seed was collected from the northern range of green ash in North America. This included 36 sources from Nebraska, South Dakota, North Dakota, Manitoba and Saskatchewan. In total, 100 families will be represented in the provenance tests, which will be established at numerous locations in Manitoba and Saskatchewan during 1989. In addition to the provenance tests, a clone bank including 67 grafted plus trees (52 female and 15 male) is being established near Indian Head. The clone bank will be used for breeding programs, and ultimately transformed into a clonal seed orchard.

PUBLICATIONS

PFRA Tree Nursery. 1985. Propagation Projects. Annual Report, Tree Nursery Division, Agric. Can. Indian Head, Sask. p. 8-24.

PFRA Tree Nursery. 1986. Propagation Projects. Annual Report, Tree Nursery Division, Agric. Can. Indian Head, Sask. (In Press).

Schroeder, W.R. 1987. Planting and establishment of shelterbelts in humid severe winter climates. In: J.R. Brandle, D.L. Hintz and J.W. Sturrock (Editors), Windbreaks. Elsevier Scientific Publishing Co., Amsterdam/Oxford/New York. (In Press).

Schroeder, W.R. and Walker, D.S. 1987. Effects of moisture content and storage temperatures on germination of Quercus macrocarpa acorns. J. Environ. Hort. 5(1): 22-24.

JACK PINE AND WHITE SPRUCE TREE IMPROVEMENT

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Keywords: jack pine, white spruce, clonal orchard, family tests, flower induction, accelerated breeding

Tree improvement of jack pine (Pinus banksiana Lamb.) and white spruce (Picea glauca (Moench) Voss) is carried out to augment the Company's forest management activities. A short summary of the progress made to date in these programs is given below.

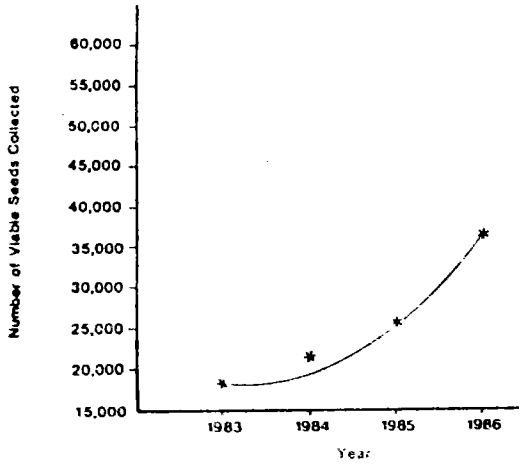
JACK PINE PROGRAM

Seed Orchard

Cone Production

A 7.2 hectare orchard, made up of 32 clones and established from 1979-1983, is now producing small amounts of seed. The seed harvested to date, shown below in Figure 1, is being grown and outplanted on prepared sites in the Company's operating area as it becomes available.

Figure 1: Seed Collected From Jack Pine Orchard



Flower Induction Trials

A trial to test the effects of gibberellins and ammonium nitrate fertilizer on the amount and type of flowering in the orchard is currently being carried out in cooperation with Canadian Forestry Service personnel from Petawawa National Forestry Institute.

Controlled Crosses

Controlled crosses are being carried out in the orchard to get information on the general and specific combining ability of the clones, and for future genetic material. Three, six-tree half-diallels have now been started, with the first seed being collected in the fall of 1986. The cones produced were very small, with the number of untested seed/cone ranging from 4 to 14.

Family Test Measurements

Five (5) year measurements on two sets of open pollinated family tests have been evaluated, and the best individuals from the best families chosen.

Future Direction of the Program

An accelerated breeding route is being taken with this program. Individual second generation trees, selected from the family tests on the basis of 5-year measurements, are being grafted into a breeding bank on the orchard site. They will be bred as quickly as possible to get the third generation, and the best results used to establish a third generation production orchard.

WHITE SPRUCE PROGRAM

Seed Orchard

An 8 hectare orchard, made up of 40 clones, is in the late stages of establishment. Some grafts are already producing cones.

Family Tests

Twenty-eight (28) open pollinated families were established in trials in 1986.

Seed will be collected from up to 172 more select trees in August of 1987, so that family tests can be established for a total of 200 selections.

Seed Production Area

An excellent stand of trees has been located and established as a seed production area, to give an interim supply of seed until the orchard comes into production. Unfortunately the anticipated 1987 cone crop did not develop, so no seeds will be collected this year.

GENETICS AND TREE IMPROVEMENT PROGRAM ALBERTA FOREST SERVICE, 1985-1987

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Keywords: Tree breeding, genetic improvement, provenance studies, species testing, seed orchards, white spruce, lodgepole pine

This report summarizes the progress of the Alberta Forest Service (A.F.S.) genetics and tree improvement program for the period 1985-1987.

PROGRAM DEVELOPMENT

The expanded genetics and tree improvement facilities at Pine Ridge were made fully operational. As a result, the plant propagation program could be substantially increased and wood quality analyses could be carried out.

A large part of the genetics and tree improvement program budget was provided by the "Maintaining Our Forests" project funded by the Alberta Heritage Savings and Trust Fund. This funding lapsed in 1986 and was partially replaced by funding provided by the Canada/Alberta Forest Resource Development Agreement.

Two new major projects were started during the report period. These are: (1) an arboretum and a set of demonstration plantings being established as part of the "Genetics and Future Reforestation" site at the new Demonstration Forest being developed in the Kananaskis Country near Calgary; (2) a systematic survey to locate, document and designate meritworthy stands as gene pool reserves.

GENETIC IMPROVEMENT

Assembly of Breeding Stock

Field selection of superior trees to provide base material for A.F.S., as well as A.F.S./industry cooperative genetic improvement projects, continued. As part of A.F.S. responsibility projects, a total

of 100 white spruce (Picea glauca [Moench] Voss), 16 black spruce (P. mariana [Mill.] B.S.P.) and 3 tamarack (Larix laricina [Du Roi] K. Koch) superior trees were selected. As part of A.F.S./industry cooperative projects, a total of 44 lodgepole pine (Pinus contorta Dougl.) superior trees were selected jointly with Blue Ridge Lumber, Canadian Forest Products and Procter and Gamble Cellulose.

All superior tree selections are being evaluated for wood density and fibre length. Based on the analyses completed so far, relative wood density of white spruce superior trees varied from 0.269 to 0.428 with overall mean of 0.350 (S.E. = 0.005). For lodgepole pine, relative wood density of superior trees varied from 0.366 to 0.501 with overall mean of 0.424 (S.E. = 0.006). Mean wood density of superior tree selections of both white spruce and lodgepole pine from different breeding regions was found to be smaller and differences were statistically non-significant.

Progeny Testing

As part of genetic improvement for breeding region D, four open pollinated half-sib family field trials were outplanted in spring 1986, using plug+2 transplant stock. The trials contained 144-150 families. Experimental design consisted of randomized complete blocks with 6 replications and 5- or 6-tree row-plots.

Site development was initiated for half-sib family testing, as part of genetic improvement of lodgepole pine for breeding region B2. Three sites are being developed jointly with Procter and Gamble Cellulose for this project.

Seed Orchards

Outplanting of a lodgepole pine seedling seed orchard (phase I) for breeding region B1 was completed at the Huallen seed orchard site, near Grande Prairie. It is 9.8 hectares in size and is the first A.F.S./industry cooperative seed orchard established in the province. It is managed jointly by Canadian Forest Products and Procter and Gamble Cellulose.

A 0.8 hectare expansion of the white spruce seedling seed orchard for breeding region D at Pine Ridge was completed in order to increase seed production capacity of the orchard, which was earlier 2.5 hectares in size. Stock production for three white spruce clonal seed orchards (breeding regions E, G and H) continued. Sites for regions E and G orchards are already finalized and fully developed for outplanting in 1988. Site development for the region H orchard is scheduled to commence in the fall of 1987. Stock production is also in progress for a small black spruce clonal seed orchard to be established at Pine Ridge.

GENETICS AND TREE IMPROVEMENT RESEARCH

Species Testing

Encouraged by good early performance of Siberian larch (Larix sibirica Ledeb.) in genetics and tree improvement research plantings, it was decided that operational testing of this species should commence on a variety of sites. A 3.2 hectare planting was established in 1985 near Whitecourt. The project was later transferred to a reforestation program.

A study was started to test the potential of green ash (Fraxinus pennsylvanica Marsh. var. subintergerrima [Vahl] Fern.) as a possible species for future reforestation in Alberta. Green ash, although not native to Alberta, is extensively grown as a street tree in many urban localities in the province. Seeds were collected from 20 desirable type trees selected in Edmonton and Smoky Lake areas. A nursery trial was established in 1986. It was assessed for winter damage in spring 1987. Damage among individual seedlots ranged from 69 to 92 per cent. Nursery testing will continue for another year, after which stock found to be hardy will be lifted and used for establishing several field trials.

Work was started on performance testing of Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) on drought-prone sites in the montane forest region of southwestern Alberta. Four test sites were selected and developed. Outplanting is planned for 1988-89. In addition, several small outplantings were established at Pine Ridge. These contained white birch (Betula papyrifera Marsh.), Norway spruce (Picea abies [L.] Karst) and Japanese larch (Larix leptolepis [Zieb. and Succ.] Endl.) (grown from a seedlot obtained from a plantation in the U.S.S.R.).

Provenance Studies

Field outplanting of two additional trials was completed in 1986, as part of a study to evaluate variability and comparative performance of the jack pine (Pinus banksiana Lamb.) - lodgepole pine seed source complex in Alberta. A total of six trials have been established so far, and three more are planned.

Three outplantings of tamarack provenance trials were established, which also included a set of Siberian larch seedlots. Nursery stock production is being carried out for 3 additional tamarack provenance trials for outplanting in 1988. Stock production for a series of black spruce provenance trials is also in progress. Province-wide outplanting of these will commence in 1988.

Eight year assessment of two Scots pine (Pinus sylvestris L.) seed source trials containing 25 seedlots of U.S.S.R. origin, and a local lodgepole pine seedlot was completed. One trial is located in northern Alberta, at Footner Lake, and the other is located in central Alberta, at Pine Ridge. Mean height at the two locations was 98.6 cm and 200.7 cm, respectively, and survival was 79 per cent and 85 per cent, respectively.

The best seed source at either location exceeded the plantation mean by about 25 per cent. Interestingly, the best-performing seed source at both test sites was found to have originated from a nearly identical latitudinal location in the U.S.S.R. Analysis of variance of the data showed that location, seed source and seed source x location effects were statistically significant. These results provided preliminary confirmation that Scots pine, with proper seed source selection, may prove to be a promising exotic for Alberta, and further testing is desired. In this regard, two additional Scots pine seed source trial outplantings were established, with 13 seedlots of Swedish origin.

Genetic Studies

Two small divergent selection trials (one in white spruce and one in lodgepole pine) were established at Pine Ridge. These contained a set each of the best-performing and worst-performing half-sib families. Families were selected based on their nursery or early field performance for height growth in other experiments, established earlier.

Controlled pollinations of lodgepole pine, to build a set of biparental inter-provenance crosses among selected Alberta and B.C. origins, were completed. A set of aspen (Populus L.) clones exhibiting very crooked and straight stem characteristics were selected and propagated for establishment in a demonstration clonal test, to illustrate the effectiveness of genetic selection.

Seed Production and Related Studies

Eight-year results on flowering and seed production monitoring of white spruce grafts of northern Alberta origin, outplanted at four climatically diverse locations (Vernon in B.C., Brooks in southern Alberta, Pine Ridge in central Alberta, and Grande Prairie in northern Alberta), were summarized. It was interesting to note that mean female strobilus production was better at the northern locations (i.e., Pine Ridge and Grande Prairie) than at the warmer southern locations (i.e., Brooks and Vernon). The study has provided valuable information for white spruce seed orchard planting in Alberta. It also alleviated earlier concerns with regard to the suitability of Pine Ridge and Grande Prairie locations for establishing seed orchards.

A study evaluating the effect of supplemental pollen application on seed yield and seed quality of lodgepole pine was concluded. It was found that supplemental pollination increased seed yield from 15.9 seeds/cone (in an open-pollinated control) to 24.7 seeds/cone. Germination capacity and 1000-seed weight of the supplementally pollinated seedlots did not differ significantly from the control seedlots.

Flowering and seed production monitoring of "accelerated growth" research seed orchards of lodgepole pine and white spruce was continued. A mini clonal seed orchard of Scots pine was established at Pine Ridge to develop information and experience on seed production management of this species. A new white spruce research orchard was established at Pine Ridge, for carrying out experiments on various cultural (irrigation, fertilization, root pruning, etc.) and protection procedures required for practical seed orchard management.

PLANT PROPAGATION AND SEED BANK

During the report period, stock production consisted of 50,972 seedlings, 4,969 grafts, 6,530 potted root stock trees and 425 stecklings.

A grafting date study was carried out on white spruce, in order to determine the earliest acceptable date for collection scions for grafting. It was concluded that scions could be collected as early as the end of September. Experimental grafting was carried out with tamarack and Siberian larch to develop local experience and procedures for grafting these species. Grafting success was 89 per cent for tamarack and 47 per cent for Siberian larch.

A total of 249 seedlots were added to the genetics seed bank. It presently contains 2,765 seedlots. Seed quality of the seed bank entries is monitored by annual testing of a set of reference seedlots, which consists of a stratified sample of about two per cent of all seedlots. Since the start of reference seedlot monitoring in 1981, mean seed germination has declined slightly from the original 80 per cent to 77 per cent in 1987.

FOREST GENETICS ACTIVITIES AT THE UNIVERSITY OF ALBERTA 1985-1987

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Keywords: Isozymes, electrophoresis, population genetics, differentiation, mating systems, heterozygosity, progeny tests, molecular genetics

Activities involving graduate students and associates have focused on population genetics, utilizing starch-gel electrophoresis and molecular genetics techniques, early evaluation of progeny performance, and quantitative inheritance.

MATING SYSTEMS OF CONIFERS

Mr. Albert Sproule expects to defend his Ph.D. dissertation on the mating system and population structure of black spruce (Picea mariana (Mill.) B.S.P.) shortly. Mr. Willi Fast completed his M.Sc. thesis on a study of the mating system and possible pollen contamination in a Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) seed orchard near Nanaimo, B.C. (in cooperation with Dr. Ralph Bower, Macmillan Bloedel). Ms. Nola Daintith completed her study on pollen and embryo competition in Douglas-fir. The mating system studies have been funded by NSERC operating and forestry development grants, the CFS, Macmillan Bloedel Ltd. and the Alberta Forest Service.

POPULATION STRUCTURE STUDIES

Ph.D. student Agnes Vanende continues her study of chemotaxonomy of the Populus balsamifera L. - P. trichocarpa Torr. & Gray complex, under the joint direction of Dancik and Keith Denford (Botany). Ph.D. student Chang Yi Xie continues his study of the population structure of Thuja orientalis L. Brad Johnson (joint with Don Pluth, Soil Science) completed his M.Sc. thesis on responses of white spruce provenances to soil chemical and biological factors. Ph.D. student Hong Zhu (joint with Ken Higginbotham) is investigating several aspects, including genetic variability, of ectomycorrhizal fungi. These projects were supported by the NSERC Forestry Development Grant and the CFS.

MOLECULAR GENETICS OF CONIFERS

Joyce Kenny completed her M.Sc. thesis on the nucleotide sequence of a portion of a lodgepole pine actin gene. Current Ph.D. student John Barrett is investigating the organization and structure of the light-harvesting chlorophyll a/b-binding protein genes in conifers. M.Sc. student Graydon Smith is studying chloroplast DNA variation and phylogenetic relationships in the Pinus contorta Dougl. complex. Jean Bousquet (Laval) has been studying genetics of Alnus. A comparative study of lodgepole pine and jack pine (P. banksiana Lamb.) cpDNA with Dave Wagner, University of Kentucky continues. Funds have been provided by NSERC.

EARLY EVALUATION OF PROGENY PERFORMANCE

Dancik, R.P. Pharis of the University of Calgary, and Yeh are pursuing studies of very early (90-180 day) progeny performance of several conifers. This work has been supported by a CFS/PRUF contract, an NSERC Strategic Grant, and an Alberta Forest Development Research Trust Fund grant.

QUANTITATIVE INHERITANCE

John King and Alvin Yanchuk completed their Ph.D. programs with studies of multiple trait selection on Douglas-fir and lodgepole pine. Ph.D. student Paul Jefferson is working on a study of advanced generation selection in French maritime pine (Pinus pinaster Ait.).

NEW PERSONNEL

Dr. Mei Sun joined us in November of 1987, after completing her Ph.D. at UBC under Dr. F. Ganders. Mei is investigating the compartmentalization of isozymes and the molecular population genetics of red pine. Dr. Om Rajora, NSERC PDF, recently joined us. Om completed his Ph.D. at Toronto under Dr. L. Zsuffa. He is investigating strategies of early selection and the molecular population genetics of several softwood and hardwood species.

PUBLICATIONS FROM THE GROUP

Barrett, J.W., P. Knowles, and W.M. Cheliak. 1987. The mating system in a black spruce clonal seed orchard. Can. J. For. Res. 17: 379-382.

Bousquet, J., W.M. Cheliak, and M. Lalonde. 1987. Genetic differentiation among 22 mature populations of green alder (Alnus crispa) in central Quebec. Can. J. For. Res. 17: 219-227.

Bousquet, J., W.M. Cheliak, and M. Lalonde. 1987. Allozyme variability in natural populations of green alder (Alnus crispa) in Quebec. Genome 29: 345-352.

Cheliak, W.M., F.C.H. Yeh, and J.A. Pitel. 1987. Use of electrophoresis in tree improvement programs. Forestry Chronicle 63: 89-96.

Fast, W., B.P. Dancik and R.C. Bower. 1986. Mating system and pollen contamination in a Douglas-fir clone bank. Can. J. For. Res. 16: 1314-1319.

Furnier, G.R., and W.T. Adams. 1986. The mating system in natural populations of Jeffrey pine. Amer. J. Botany 73: 1002-1008.

Furnier, G.R., and W.T. Adams. 1986. Geographic patterns of allozyme variation in Jeffrey pine. Amer. J. Botany 73: 1009-1015.

Furnier, G.R., P. Knowles, M.A. Aleksiuk, and B.P. Dancik. 1986. Inheritance and linkage of allozymes in seed tissue of whitebark pine. Can. J. Genet. Cytol. 28: 601-604.

Furnier, G.R., P. Knowles, M.A. Clyde, and B.P. Dancik. 1987. Effects of avian seed dispersal on the genetic structure of whitebark pine populations. Evolution 41: 607-612.

Govindaraju, D.R., and B.P. Dancik. 1986. Relationship between allozyme heterozygosity and biomass production in jack pine (Pinus banksiana Lamb.) under different environmental conditions. Heredity 57: 145-148.

Knowles, P., G.R. Furnier, M.A. Aleksiuk, and D.J. Perry. 1987. Significant levels of self-fertilization in natural populations of tamarack. Can. J. Botany 65: 1087-1091.

Perry, D.J., and B.P. Dancik. 1986. Mating system dynamics of lodgepole pine in Alberta, Canada. Silvae Genetica 35: 190-195.

Sun, M., and F.R. Ganders. 1986. Female frequencies in gynodioecious populations correlated with selfing rates in hermaphrodites. Amer. J. Bot. 73: 1645-1648.

Wagner, D.B., G.R. Furnier, M.A. Saghai-Maroof, S.M. Williams, B.P. Dancik, and R.W. Allard. 1987. Polymorphisms within and divergence between the chloroplast DNA genomes of lodgepole and jack pine. Proc. Nat. Acad. Sci. U.S.A. 84: 2097-2100.

Webber, J.E., and F.C. Yeh. 1987. Test of the first-on, first-in pollination hypothesis in coastal Douglas-fir. Can. J. For. Res. 17: 63-68.

Williams, S.M., G.R. Furnier, E. Fuog, and C. Strobeck. 1987. Evolution of the ribosomal DNA spacers of Drosophila melanogaster: different patterns of variation on X and Y chromosomes. Genetics 116: 225-232.

Yeh, F.C., and S. Rasmussen. 1985. Heritability of height growth in 10-year-old Sitka spruce. Can. J. Genet. Cytol. 27: 729-734.

Yeh, F.C., M.A.K. Khalil, Y.A. El-Kassaby, and D.C. Trust. 1986. Allozyme variation in Picea mariana from Newfoundland: genetic diversity, population structure, and analysis of differentiation. Can. J. For. Res. 16: 713-720.

Yeh, F.C. and J.T. Arnold. 1986. Electrophoretic and morphological differentiation of Picea sitchensis, Picea glauca, and their hybrids. Can. J. For. Res. 16: 791-798.

Yeh, F.C., and K. Morgan. 1987. Mating system and multilocus associations in a natural population of Pseudotsuga menziesii (Mirb.) Franco. Theor. Appl. Genet. 73: 799-808.

TREE BREEDING, PROVENANCE AND ASSOCIATED RESEARCH ACTIVITIES OF THE BRITISH COLUMBIA MINISTRY OF FORESTS AND LANDS 1985 - 1987

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Keywords: Douglas-fir, white spruce, Engelmann spruce, lodgepole pine, western hemlock, Sitka spruce, yellow-cedar, breeding, progeny testing, forest genetics, selection, inbreeding, rooted cuttings, provenance testing

GENETIC IMPROVEMENT OF COASTAL DOUGLAS-FIR (PSEUDOTSUGA MENZIESII [MIRB.] FRANCO)

Chris Heaman (1)

Diallel Program

The breeding program, using a 6-parent disconnected diallel mating design, reached its target, and progeny from 372 parents have been planted in the field. Each parent is represented in five full-sib families, each of which have been planted on eleven test sites across coastal B.C., separated into eight annual projects. While 372 represents a minimal base population, the program is designed to meet reforestation needs for higher site lands below 650 m and the population target is realistic. As information on performance and adaptability accumulate, the need to expand the population will be considered. Measures of height increment and survival are taken at 7 years and in 1987 the first set of measurements at 12 years will be taken. Progenies from 246 of these parents have now been measured and general combining ability estimates are available. These figures are being used in an attempt to cull the present seed orchards which are now producing. Although these are mainly O.P. seedling orchards, culling will have some positive effects. The seven year heights have also been used for the selection of material for the first replacement orchard. Clones are now established in a holding area for final planting in 1990.

Testing U.S. Parents

Provenance tests have shown that at least in the early years and on some sites, coastal United States sources can provide gains in performance over local B.C. sources. The diallel program does not contain many U.S. selections and there is a need to provide genotypes from this area, evaluated under B.C. conditions for inclusion in long-term breeding and seed production projects. With the cooperation from United States

agencies, 160 open-pollinated families from Forks to Waldport are being planted in B.C. providing an option for future breeding. Five sites and 75 families were planted in 1986 and an additional five sites and 92 families are being grown for planting in 1987.

Douglas-fir Farm-field Testing — J.H. Woods (2)

A retrospective early selection trial (farm-field test) of coastal Douglas-fir was outplanted in March 1986, on a carefully prepared site at the Cowichan Lake Research Station. Seventy full-sib families from the diallel breeding program described above were established. All families are currently represented on eleven field sites which are eight years older than the farm-field test. Family performance and variance components will be compared using the two test methods. If GxE remains low in the field tests, and performance correlations are high, the less expensive farm-field test may offer substantial cost and time savings.

Low-level Inbreeding Effects in Coastal Douglas-fir — J.H. Woods (2)

In 1985, a project was initiated to investigate the effect of different inbreeding levels on the seed production and growth of coastal Douglas-fir, to aid in the design of advanced generation selection and breeding programs. Breeding was carried out in clone banks and a 12-year-old factorial progeny test to develop six cross-types representing 5 different levels of F (inbreeding coefficient). One hundred and sixty-two crosses were executed, and 6119 cones assayed. Filled seed production, as measured by filled seed per cone (FSPC), is negatively and linearly correlated with F. The following mean FSPC values were obtained: outcross (F=0.0) 31.6, half-sib cross (F=0.125) 21.3, full-sib cross (F=0.25) 16.7, parent-offspring cross (F=0.25) 15.5, self (F=0.5) 1.2, and second generation self (F=0.75) 0.0.

Seed from this study was sown in 1987, and two test sites will be outplanted in 1988.

GENETIC IMPROVEMENT OF WHITE AND ENGELMANN SPRUCE

Gyula K. Kiss (3)

The objective of this project is to produce genetically improved planting stock of white and Engelmann spruce (Picea glauca (Moench) Voss and P. engelmannii Parry)).

Progeny Trials

Analyses of the 10-year height measurements for the East Kootenay and Prince Rupert selection units' progeny trials have been completed. The results essentially confirm those reported for the Prince George selection unit trials (Kiss 1985). In general, family age-age correlations were high. Realized gain using the top 25% of families ranged from 8% (Prince Rupert) to 16% (East Kootenay). Most of the good general combiners were identifiable at plantation age 3 (6 years from seed). Genotype-environment interactions were small.

New open-pollinated progeny trials involving 850 spruce parent trees have been established in spring of 1986 in accordance with our previous report (Kiss 1985).

Controlled Crossing Program

Flowering in Vernon Breeding Arboretum was moderate in 1986 and very heavy in 1987. All 390 matings have been completed for the comprehensive controlled crossing program (Kiss 1984).

Matings for second generation breeding production have commenced in 1987. The design for this project is as follows:

1. The top 50 percent of the tested trees in each of the three selection units are used for further breeding. Selection units are kept separate.
2. Trees are randomized into groups of four.
3. Half diallel crosses in each group are carried out.
4. Full-sib progeny trials will determine the best two crosses in each group incorporating all four parents.

GENETIC IMPROVEMENT OF INTERIOR LODGEPOLE PINE

M.R. Carlson (3)
J.C. Murphy (3)

Breeding Work

First generation parent-tree selection work is complete for seven interior breeding zones with a total of more than 1,500 phenotypic selections made. Approximately 1,200 of these are now in wind-pollinated family tests with the remainder to be planted in tests in the spring of 1988. Our first series of 5-year height measurements will be made in the fall of 1988. Rogued production seed orchard grafting will commence in the spring of 1989.

Applied Research

Research efforts during this period include: 1) first measurement of existing trials aimed at improving progeny testing efficiencies; 2) completion of breeding work for intra/inter-population crossing trial and progress on long-term inbreeding effects trial, 3) establishment of a steckling/seedling growth and development comparison trial with accompanying hedge orchard; 4) initiation of a harvest index trial, 5) two studies in our grafted breeding arboretum aimed at (a) learning the effects of severe crown pruning and shaping techniques on crown form and flower production; and (b) a stock-type trial to determine the long-term effects of stock type on estimation of growth parameters.

Miscellaneous

The B.C. MOFL hosted the 1987 Western Forest Genetics Association meeting in Prince George, B.C. in July. Also organized was a B.C. tour for the Finnish dendrological society of Helsinki.

GENETIC IMPROVEMENT OF INTERIOR DOUGLAS-FIR

B. Jaquish (3)

The tree improvement program for Douglas-fir (Pseudotsuga menziesii var. glauca (Beissn.) Franco) in the British Columbia interior was initiated in 1982 and has advanced rapidly.

Parent Tree Selection

Because of poor cone crops, no parent tree selection occurred during this reporting period. The number of selected parents remains at 1320 from six breeding zones.

Breeding Orchards/Gene Archives

The breeding orchards at Vernon and gene archives at Barnes Creek continued to expand. Three ramets of each selected parent from the Mica/West Kootenay Low, and West Kootenay High breeding zones were planted at Vernon in 1986 and 1987, respectively. Five ramets of each parent were planted at Barnes Creek.

Progeny Testing

Progeny testing with wind-pollinated families is presently the most active phase of the program. To date, over 1000 families from four breeding zones are established in field tests. Three-year baseline height measurements were made on two sites from the Series I progeny tests (Cariboo Transition breeding zone) in fall, 1986.

Provenance Testing

In 1985, ten-year height measurements were made on the range-wide interior Douglas-fir provenance test at Trinity Valley. In general, provenances from the east slopes of the Coast and Cascade Ranges were the tallest (D'arcy, B.C. mean ht. 472 cm and Cle Elum, Wash. mean ht. 461 cm), and showed little evidence of maladaption. Dry belt and northerly provenances were generally the shortest. Salmon Arm (mean ht. 450 cm) was the tallest interior source. Regression analysis indicated a significant inverse relationship ($r=-.76$) between provenance 10-year height growth and source elevation.

GENETIC IMPROVEMENT OF COASTAL WESTERN HEMLOCK

J.H. Woods (2)
C. Woon (1)

The western hemlock (Tsuga heterophylla) breeding program has gone through a period of review and adjustment, and will continue as outlined in a new genetic improvement strategy completed in 1986. Twenty-two open-pollinated test sites, and two diallel sites have had five year height measurements completed. Ten year measurements on the first series of the O.P. tests will commence in the fall of 1988.

Height and diameter measurements were completed on a single 16-year-old O.P. test on west central Vancouver Island. This test was measured previously at 8 years. Genetic correlations, based on block means, between 8-year height and 16-year height, diameter and volume are 0.67, 0.60 and 0.67 respectively. Predicted gain in 16 year volume, based on selection for 8-year height, is about half the gain expected if selections are based on 16-year volume.

Seven existing clonal seed orchards will be tested using a polymix breeding design which will be carried out to complement the existing O.P. tests. Matings have begun on one seed orchard, and more are planned for 1988 and 1989.

A range-wide provenance testing program is also planned. Fifteen seed sources were collected in the Prince Rupert-Skeena River-Nass River areas in 1986 to take advantage of a good cone crop.

PROVENANCE RESEARCH

Cheng C. Ying (1)

The highlight of the provenance program in the past two years is the revision of seed zones and seed transfer guidelines for coastal Douglas-fir, which was the first species in B.C. to receive systematic provenance testing. Field tests were established from 1968 to 1974, and most of them are now over 15 years of age. The results indicate:

1. Genetic differentiation parallels the major climate gradients from maritime to subcontinental. After differences among climatic regions were accounted for, provenance variation, although still large, was only weekly correlated with environmental and ecological factors. We interpret the genetic differentiation along major climate regions as evidence of direct response to natural selection, and provenance variation within regions is largely the result of an evolutionary bi-product (chance effect).

2. No evidence that local source is optimal and remarkable stability in growth shown by provenances from north eastern Washington.

According to the pattern of genetic differentiation, four seed zones, west maritime, dry maritime, southern submaritime, and central submaritime, were recommended as the basis to control seed movement of coastal Douglas-fir. We also recommended the introduction of these productive Washington seed sources.

DEVELOPMENT OF TECHNIQUES FOR THE LARGE-SCALE PRODUCTION OF ROOTED CUTTINGS FOR OPERATIONAL PLANTINGS

John Russell (2)

The production of yellow-cedar (Chamaecyparis nootkatensis) rooted cuttings for operational plantings (Karlsson 1981) has steadily increased since the start of the program in 1975, to the current annual production of 600,000. The cuttings are taken from three sources: two soil-based hedge orchards and one containerized hedge orchard (kept under four-years old). The orchards are composed of untested seedlings from open-pollinated families and seedlots.

Current research includes:

i) annual testing of hedge orchard material to monitor maturation and its effects on rooted cutting production and quality;

ii) developing full-sib families from potted parent tree grafts for inclusion into future hedge orchards; and

iii) physiological testing of yellow-cedar rooted cuttings and seedlings to monitor stock quality.

Recent analysis of an eight-year old seedling:rooted cutting comparison showed no significant difference in height and form between the two stock types.

Interior Spruce

Techniques for the large-scale production of interior spruce rooted cuttings from genetically superior families are currently being investigated (Russell 1987). Research is being conducted into:

i) methods of 'bulking up' families;
ii) rooting techniques;
iii) seedling:rooted cutting comparisons; and
iv) genetic variability in rooting.

Currently, seed from genetically superior families are grown under accelerated conditions in combination with hedging for eight-months. Cuttings are taken when laterals are just setting buds. Rooting success has been greater than 90% with no significant variation in rooting among families. Two seedling:rooted cutting comparisons with family structure will be outplanted in the Prince George area in the spring of 1988.

COASTAL GENE ARCHIVES

J.H. Woods (2)
H.P. Jensen (2)

Gene archive objectives and development has been reported previously (Woods 1985).

The primary objective of the coastal gene archive is to conserve valuable genetic material from coastal forest tree species. This involves maintenance of clonal material from selected parent trees, and valuable trees resulting from experimental breeding. This material is available to breeders and other researchers, and is a source of vegetative material for seed orchard development.

The coastal gene archives contain the products of selection and breeding dating back to 1952. Located at the Cowichan Lake Research Station on southern Vancouver Island, the gene archives consist primarily of clonebanks of Douglas-fir, western hemlock, Sitka spruce (Picea sitchensis), western red cedar (Thuja plicata), yellow cedar, Pacific silver fir (Abies amabilis), grand fir (Abies grandis) and Engelmann spruce. Development of the clonebanks is continuing, with 3450 clones now established. There is also a large Douglas-fir provenance arboretum containing 148 population samples from throughout the species range, as well as material from Douglas-fir inbreeding experiments, with several lines inbred to the S_3 generation. Other major plantations in the gene archives include a native tree arboretum, yellow cedar hedging orchard, Douglas-fir inter-racial cross progeny test, and a lodgepole pine provenance collection.

PUBLICATIONS AND REFERENCES

Karlsson, I. 1981. Propagation of Alaska yellow-cedar (Chamaecyparis nootkatensis (D. Don) Spach.) by rooted cuttings for production planting. Int. Plant Prop. Soc. Comb. Proc. Vol. 31: 112-116.

Kiss, G.K. 1984. Genetic improvement of white and Engelmann spruce in British Columbia 1981-83. In Proc. 19th Mtg. Can. Tree Improve. Assoc., Part 1:181-183.

Kiss, G.K. 1985. Genetic improvement of white and Engelmann spruce in British Columbia 1983-1985. In Proc. 20th Mtg. Can. Tree Improv. Assoc., Part 1:191-193.

Russell, J. 1987. Research priorities and technology transfer opportunities for rooted cuttings of interior spruce and yellow-cedar. B.C. Ministry of Forests & Lands, Internal Report. 32 pp.

Woods, J.H. 1985. Gene archive and western hemlock genetic improvement in British Columbia. In Proc. 20th Mtg. Can. Tree Improv. Assoc., Part 1:208-211.

THE ACCOMPLISHMENTS OF THE SILVICULTURE BRANCH, B.C. MINISTRY OF FORESTS AND LANDS IN COOPERATIVE TREE IMPROVEMENT, 1985-1987

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Keywords: Seed orchards, parent trees, information systems, seed zones, seed orchard management

Silviculture Branch staff were active both administratively and directly in British Columbia's cooperative tree improvement program. This report highlights recent contributions within this framework.

ADMINISTRATIVE SUPPORT

The Branch is responsible for the administration of the province's expanding cooperative seed orchard program which now includes nine species. At present 10 producing, 32 established and 12 developing orchards spanning 34.5, 85.6 and 53.3 hectares respectively are included (Table 1). Since 1985, eight of these orchards reached the established stage. Forest companies presently manage 18 of the established/producing orchards and the Branch manages the rest.

An additional 29 planned orchards (180 ha) are to be established by the year 2000, and will mostly be located near Vernon and Prince George. It is anticipated that forest companies will continue to manage about half the orchards in the program.

Several hundred new selections were added to the parent tree register since 1985. The register now totals over 12,000 trees for the province. A new cooperative selection program for western white pine (Pinus monticola D. Don) was initiated and plans for selection of western larch (Larix occidentalis Nutt.) are now in place.

A joint Silviculture/Research Branch project to establish containerized interior spruce orchards was initiated at Skimikin in the interior and Duncan on the coast. One of the main objectives of this pilot scale test project is to evaluate feasibility and cost effectiveness of this approach after a five year test period.

A comprehensive, microcomputer-based information system, for the maintenance of seed orchard records, was also developed under contract and installed at several sites for evaluation. A second system for tracking orchard costs and labour requirements is presently under development.

Table 1: Number (hectares) of seed orchards in B.C.'s cooperative tree improvement program by zone, species and stage reached.

Zone	Species[a]	Stage Reached[b] Producing	Established	Developing	Totals
Coast	Ba	--	2 (8.6)	1 (2.0)	3 (10.6)
	Cw	--	3 (1.3)	--	3 (1.3)
	Cy	--	2 (1.4)	--	2 (1.4)
	Fdc	5 (24.9)	2 (7.2)	2 (2.8)	9 (34.9)
	Hw	1 (0.7)	6 (16.8)	1 (3.8)	8 (21.3)
	Se	--	--	1 (3.6)	1 (3.6)
	Ss	3 (4.7)	--	1 (2.7)	4 (7.4)
	Sx	--	1 (0.1)	--	1 (0.1)
Southern Interior	Pl	--	1 (4.1)	3 (20.7)	4 (24.8)
	Sx	--	12 (36.3)	1 (7.4)	13 (43.7)
Central Interior	Pl	1 (4.2)	3 (9.8)	2 (10.3)	6 (24.3)
Totals		10 (34.5)	32 (85.6)	12 (53.3)	54(173.4)

[a] Fdc - Douglas-fir (coastal) (Pseudotsuga menziesii (Mirb.) Franco var. menziessii)
Se - Englemann spruce (Picea engelmanni Parry)
Hw - Western hemlock (Tsuga heterophylla (Raf.) Sarg.)
Ss - Sitka spruce (Picea sitchensis (Bong.) Carr.)
Ba - Amabalis fir (Abies amabilis (Dougl.) Forbes)
Cw - Western red cedar (Thuja plicata Donn.)
Cy - Yellow cedar (Chamaecyparis nootkatensis (D.Don) Spach.)
Sx - Interior spruce (commonly white x engelmann hybrids) Picea sp.
Pl - Lodgepole pine - Pinus contorta var. latifolia Dougl.

[b] Developing - site preparation and/or propagation underway (approximate area only)
Established - 80%+ planted
Producing - seed production in any one year at least 40% of annual target

Both the Coastal and Interior Tree Improvement Councils and their associated Technical Planning Committees continued to meet and monitor progress. The first Progress Report of the Interior Tree Improvement Council (1982-1984) was published in May 1986 and the Second Progress Report of the Coastal Tree Improvement Council was published in the autumn of 1985.

Provenance and progeny tests in both interior spruce and lodgepole pine were reviewed by a seed zone and seed transfer task group. This has resulted in the identification of superior provenance sources and revision of seed zones and seed transfer rules. Coastal Douglas-fir provenance and progeny tests were also reviewed in 1985 and 1986. The results indicate a reduction in the number of seed zones, revision of seed transfer rules, and identification of superior provenance sources.

DIRECT INVOLVEMENT

Coast

Activities in the four producing Douglas-fir orchards managed by the Branch consisted primarily of growing stock maintenance (e.g. crown management, fertilization, graft scoring) and crop management [e.g. induction via rootpruning, fertilization, GA injection and girdling; supplemental mass pollination (SMP); insect control]. Resultant seed production for 1985/1986 totaled 213.4 kg (sufficient for 10 million plantables).

Sites were prepared and trickle irrigation systems installed for the Branch's eight developing orchards on the coast. Stock established in adjacent holding areas was maintained and evaluated for inclusion in the orchards. Phenological synchroneity and cone production potential, as gauged following application of GA, were two of several selection criteria used.

Crop management techniques for western hemlock and operational flower induction in Douglas-fir via GA application and girdling were studied. Estimates of male and female bud production were also derived, on an individual tree basis, during 1986 and the parental contribution to the harvested seed evaluated. Survey techniques and computer software designed specifically for this task were employed.

Southern Interior

Branch staff managed 11 established orchards located at Skimikin (near Salmon Arm) and Kalamalka (Vernon). Activities in these young orchards, all established since 1979, consisted primarily of growing stock maintenance, fill-in planting and pest management against root rot,

spruce budworm and cone rust. Seed produced in four of these orchards in 1985 and 1986 totaled 7.0 kg (yield of about 1.7 million plantables). SMP was employed to enhance seed yield and genetic quality of these early crops. A polycross program was also undertaken in several orchards to enable genetic testing and future roguing. Flowers were induced on select clones, via root pruning, and pollen was obtained from both natural stands and orchards. Staff were also active in several parent tree selection/ collection projects in the southern interior.

At Skimikin a large pot grafting program, exceeding 5000 grafts annually, was conducted with good success. Field grafting was also employed for the first time in the interior to fill in vacant orchard positions and establish an entire lodgepole pine orchard.

Central Interior

Staff at the newly named Prince George Tree Improvement Station (formerly Red Rock Seed Orchards) maintained various tree improvement plantations established on site and managed four lodgepole pine orchards which, during 1985 and 1986 produced 2.4 kg of seed (yield of about 1.4 million plantables). Pollen was collected from superior provenances established at the Station and will be applied to the oldest orchard (planted 1974) beginning in 1988. Limited roguing of this orchard was also initiated and early cone/seed production data, collected since 1980, summarized. Off-site assistance was offered in various other aspects of the program, (e.g. scion collection; grafting; plantation establishment, maintenance, measurement; controlled pollinations). This Station hosted the Western Forest Genetics Association meeting for 1987.

At the adjacent Red Rock Nursery a pot grafting program, exceeding 3,000 grafts in 1987 was undertaken.

SPECIAL NOTE AND ACKNOWLEDGEMENT

Through the Federal/Provincial - Forest Resource Development Agreement (FRDA) direct delivery funding was provided by the Province to construct a new tree seed Centre at Surrey on the southcoast mainland. Construction began in September 1985 and was completed late in 1986. The 1986 cone collections and preparation of seed for the 1987 sowing season were done at this modern new facility.

The authors wish to gratefully acknowledge the contributions made by P. Adamson, C. Hewson, and J. Parkinson, Seed Orchard Projects Coordinators for the Central Interior Zone, Southern Interior Zone, and Coastal Zone respectively to make this progress report possible. The authors also acknowledge the assistance of C. Bartram, Seed Production Planning Officer, Victoria Headquarters Office, for the compilation of this report.

SEED ORCHARD MANAGEMENT RESEARCH

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Keywords: cone induction, container seed orchards, crown management, gibberellin application methods, pollen management, pollen storage, pollen viability, seed yields, genetic efficiency, pollen maturation.

This report summarizes progress during 1985-87 in the following major areas aimed at improving the efficiency of breeding and seed production programs for commercially important B.C. conifers:

1. development of container orchards as a cost-effective alternative to field orchards for achieving earlier flowering and higher realized genetic gains;

2. development of crown training regimes for size control;

3. development of cost-effective methods of gibberellin (GA) application;

4. development of pollen management strategies for improving seed orchard yields and genetic efficiency.

CONTAINER ORCHARD RESEARCH

Progress since our last biennial report (Ross and Eastham 1985) is summarized in the following publications and reports (Bower and Ross 1986; Pharis and Ross 1986; Ross 1987a,b,c,d; Ross and Pharis 1987).

Interior Spruce

Research has concentrated on defining the optimal temperatures for flowering and pollen and seed development in potted *Picea engelmannii* Perry and *Picea glauca* (Moench) Voss grafts. Flowering was maximized by cool (ambient) temperatures and moderate water stress during active shoot elongation, followed by 3 weeks of heat treatment (>20 <30°C) and adequate water in a polyhouse (Ross 1987a,b). Under ambient temperatures the following spring, the induced cones developed normally and yielded high quality pollen and seed. The use of heat to force early shedding of pollen resulted in abnormally small cones, and reduced the yield and quality of both pollen and seed (Ross 1987c).

Foliar $GA_{4/7}$ sprays can be phytotoxic to interior spruce and other conifers, especially under drought and/or heat conditions. When foliage was not subjected to the rinsing action of rain or overhead irrigation, it appeared that the residue surfactant (Aromox C-12/W) slowly broke down the cuticle layer. A water rinse 4 days after each spraying minimized the injury in interior spruce without reducing the flowering response to $GA_{4/7}$ (Eastham, Hollefreund and Ross, unpublished).

An operational pilot test of the container orchard concept for interior spruce was implemented in spring 1987 as a joint project between Silviculture Branch and Research Branch. Duplicate pilot orchards were established at Duncan (Chesterfield Nursery) on Vancouver Island and at the Skimikin Seed Orchard in interior B.C. The two sites will allow comparison of performance and potential management problems under a moderate maritime and a harsher continental climate. These are 1.5-generation orchards containing approximately 36 grafted ramets, 3 to 5 years old, from each of 59 clones (total of 1,464 grafts) from the top 50% based on 6-year height ranking in the Prince George selection unit. The pilot program is scheduled for 5 years, with the first seed crop in 1988. Each pilot orchard is anticipated to have an annual productive capacity of about million filled seed, with opportunity for rapid expansion upon demonstration of favorable cost-benefits in comparison with similar field orchards.

Western hemlock

Research to date has shown Tsuga heterophylla (Raf.) Sarg. to be an ideal candidate for container seed orchards. On this basis, and with technical support from Research Branch and funding from Section 88(1), MacMillan Bloedel Ltd. implemented the approach operationally in 1987 at its Harmac Tree Improvement Centre (see R.C. Bower, this volume, also Bower et al. 1986).

Douglas-fir

With the selection of 2nd-generation parents, there is growing interest in the use of containerized orchards to accelerate the advance-generation breeding of this major coast species. Previous work established the ease with which potted Pseudotsuga menziesii (Mirb.) Franco seedlings and vegetative propagules could be induced to flower by means of properly timed applications of $GA_{4/7}$ plus drought (or rootpruning) and nitrate fertilization. However, the optimal temperature regime and potential value of heat treatment within the polyhouse had yet to be resolved, and was the subject of a recent study (Ross 1987d). Douglas-fir proved to be similar to interior spruce. Six weeks of heat (25/15°C) upon completion of shoot elongation was highly effective in promoting female flowering in $GA_{4/7}$-treated grafts, whereas similar treatment during active shoot elongation had a slightly inhibitory effect. Both the early and late heat treatments were effective in promoting male flowering, and together the effect was additive.

CROWN MANAGEMENT STUDY

After 6 years, annual top pruning in a young western hemlock seed orchard (Ross and Eastham 1985) continues to provide effective control of tree height (at 2 m) for ease of induction, pollination and harvesting of cones, with no loss of seed production. A final report is scheduled for late 1988.

HORMONE APPLICATION RESEARCH

Practical problems of application have precluded the operational use of $GA_{4/7}$ to enhance cone production in Douglas-fir seed orchards. Philipson (1985) recently described the successful promotion of flowering in girdled Picea sitchensis grafts by $GA_{4/7}$ using a simplified stem-injection technique. A concentrated ethanolic solution of $GA_{4/7}$ is injected into shallow holes drilled around the stem, with retreatment 2 weeks later. Ross and Bower (1987) tested this technique on Douglas-fir and found it to be safe, effective and very cost efficient. A properly timed single injection was as effective as the same dosage of $GA_{4/7}$ (3.82 mg cm^{-2} stem XS area) spread over two or three injections; also the promotive effects of $GA_{4/7}$ and girdling were additive. Taking into account fixed orchard costs, the production cost-per-conebud without treatment was $0.92, compared to $0.20 with girdling alone and $0.13 with girdling plus $GA_{4/7}$.

Pollen Management Research

In our last biennial report (Webber 1986), the importance of pollen management for improving seed yields and genetic efficiency in seed orchards was stressed. A recent report (Webber 1987) summarizes several years of data collected for Douglas-fir pollen. Results for pollen storage, viability tests and application trials verify that pollen can be effectively stored and when applied correctly can improve seed yields. Adding supplemental pollen can also improve the genetic value of seed but the procedures for achieving this requires stored pollen of the highest possible viability to be applied as early as possible to receptive seed-cone buds (Webber and Yeh 1987).

Emphasis is now being placed on developing pollen management strategies for white spruce and lodgepole pine seed orchards. Initially we assumed that procedures which proved effective for Douglas-fir and western hemlock pollen would also apply to spruce and lodgepole pine pollen. Although this generally appears to be the case we have noted that white spruce pollen may be more sensitive to handling and drying conditions which can have a serious impact on its storability.

Trials are currently underway to test conditions for optimizing pollen storage of white spruce and lodgepole pine. We must also define the optimal conditions for reapplication. Since the pollination mechanism for spruce and pine are entirely different than for Douglas-fir, timing and rates of pollination and preconditioning effects (prehydrating) pollen are being considered.

In order to maximize pollen viability over its storage period, factors affecting pollen maturation are also being studied. This is particularly important for the container seed orchard programme where environmental conditions during the maturation of cones can result in abnormalities affecting both yield and quality of pollen obtained (Ross 1987c). Post meiotic maturation seems to be affected most and low starch levels are associated with poor pollen viability. It also appears that low starch levels are associated with poor storability. The relationship between carbohydrates (starch, sucrose and glucose) and pollen viability may hopefully indicate optimal environmental conditions for maturing pollen crops in container stock and, in general, indicate the importance of carbohydrates in pollen destined for storage.

REFERENCES AND PUBLICATIONS

Bower, R.C. and S.D. Ross. 1986. Evaluation of ULV sprays for seed orchard application of $GA_{4/7}$. In: Proc. 20th Mtg. Can. Tree Improvement Assoc. Part 2. Edited by F. Caron, A.G. Corriveau, and T.J.B. Boyle. Environ. Can., Can. For. Serv., Ottawa. pp. 103-110.

Bower, R.C., S.D. Ross and A.M. Eastham. 1986. Management of a western hemlock containerized seed orchard. In: Proc. Joint Mtg. IUFRO Working parties on Breeding Theory, Progeny Testing Seed Orchards, 12-18 Oct. 1986, Williamsburg, Virginia. In press.

Pharis, R.P. and S.D. Ross. 1986. Hormonal promotion of flowering in Pinaceae family conifers. In: Handbook of Flowering, Vol. 5. Edited by A. Halevy. CRC Press, Boca Raton FL. pp. 269-286.

Phillipson, J.J. 1985. The promotion of flowering in large field-grown Sitka spruce by girdling and stem injections of gibberellin $A_{4/7}$. Can. J. For. Res. 15:166-170.

Ross, S.D. 1987a. Temperature influences on reproductive development in conifers. In: Proc. Forest Climate '86: Symposium on Climate Applications in Forest Renewal and Forest Production, 17-20 Nov. 1986, Orillia, Ont. In press.

Ross, S.D. 1987b. Effects of temperature, drought, gibberellin $A_{4/7}$, and their timing on flowering in potted Picea engelmannii and P. glauca. Submitted to Can. J. For. Res.

Ross, S.D. 1987c. Pre- and post-pollination temperature effects on pollen and seed development in potted Picea engelmannii grafts. Submitted to Can. J. For. Res.

Ross, S.D. 1987d. Effect of heat treatment in a polyhouse and its timing on flowering in potted Douglas-fir grafts. Submitted to Can. J. For. Res.

Ross, S.D., and A.M. Eastham. 1986. Seed orchard management research. In: Proc. 20th Mtg. Can. Tree Improvement Assoc. Part 1. Edited by C.W. Yeatman, and T.J.B. Boyle. Environ. Can., Can. For. Serv., Ottawa. pp. 199-202.

Ross, S.D., and R.P. Pharis 1987. Control of sex expression in conifers. In: Hormonal Control of Tree Growth. Edited by S.V. Kossuth and S.D. Ross. Martinus Nijhoff, Dordrecht, The Netherlands. In press.

Webber, J.E. 1986. Improving seed yield and genetic quality of seed orchard seed. In: Proc. 20th Mtg. Can. Tree Improvement Assoc. Part 1. Edited by C.W. Yeatman, and T.J.B. Boyle. Environ. Can., Can. For. Serv., Ottawa. pp. 204-207.

Webber, J.E. 1987. Increasing seed yield and genetic efficiency in Douglas-fir seed orchards through pollen management. For. Ecol. Manage. 19: (in press).

Webber, J.E. and F.C.H. Yeh. 1987. Test of the first-on, first-in pollination hypothesis in coastal Douglas-fir. Can. J. For. Res. 17:63-68.

PACIFIC FORESTRY CENTRE 1985-1986

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Keywords: Cone slicing and seed counts, Douglas-fir cone gall midge, Douglas-fir cone moth, ferbam fungicide, monoclonal antibodies, reproductive structures, seed certification and testing, seed sorting, spruce cone rust, spruce seed moth.

Research on seed quality, and the seed testing and certification programmes, together with studies on cone and seed insects and diseases at the Pacific Forestry Centre, are outlined.

IMPROVING THE USE-EFFICIENCY OF CONIFER SEEDLOTS

D.G.W. Edwards

Emphasis on the so-called "IDS" (incubation-drying-separation) method of sorting germinable and non-germinable seeds continued in the research programme. For some white spruce (Picea glauca (Moench) Voss) seedlots, sorting was easier before the seeds were stratified, while in others it was more effective after stratification. Other tests showed that IDS-sorted seeds returned to cold storage retained their viability well into the second year, and decreases in germination were usually less than 10% after 2 years of storage. Drying trials were made on 2-3 kg quantities of white spruce and lodgepole pine (Pinus contorta L.) seeds at the Pine Ridge (Alberta Forest Service) seed processing plant. Using a commercially built seed drier, part of the Hilleshög-designed seed processing equipment, a thin layer of seeds was dried almost exactly as in laboratory separations. Further tests to dry thicker layers of seeds will be conducted when similar equipment has been installed at the British Columbia Ministry of Forests and Lands' new Seed Centre near Vancouver, B.C.

Tests on more than 30 British Columbia white pine (Pinus monticola Dougl.) seedlots showed that compound (warm followed by cold) stratification produced better germination than the application of a surface sterilant (bleach) followed by cold stratification; the bleach method was based on research in the United States. Although it does not produce complete germination in all seedlots, compound stratification is the most practical method available for stimulating germination in this species. Some lots germinated equally well after 2 weeks' (instead of 4 weeks')

warm treatment, especially if the "warm" temperature was raised to around 25°C. A 2-day soak was generally better than a 1-day soak, but this did not appear to be related to a change in seed moisture content, and a 2-day soak when air was bubbled through the water has produced the best results so far.

A study (in collaboration with CIP Inc.) of the effects of flowering phenology, cone collection date and handling, on seed maturation in a Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) seed orchard found no discernible effect of flowering phenology. Higher germination and yield of filled seeds occurred in cones collected in mid-August, some 2 weeks prior to cone opening, than from cones collected just as they began to open. Seeds extracted from the cones immediately following harvest germinated better than those from cones stored for 2 months. Seeds from all collections were dormant, and responded to prechilling by exhibiting increased germination rates.

REPRODUCTION OF CONIFERS: A HANDBOOK FOR CONE CROP ASSESSMENT

S. Eis

Development of reproductive structures and reproductive characteristics of coniferous species in Canada have been studied during the last few years. Eighteen species have already been described in looseleaf publication; these include Douglas-fir, lodgepole pine, western hemlock, yellow cedar, western larches, grand fir, "interior" spruces, ponderosa pine, western red cedar, Sitka spruce, mountain hemlock, western white pine, red spruce, balsam fir, alpine fir, amabilis fir, Norway spruce and eastern white pine. Two more western species and six additional ones from eastern Canada - namely, whitebark pine, limber pine, black spruce, jack pine, red pine, eastern larch, eastern white cedar and eastern hemlock - are now ready for publication, bringing the total to 26, and covering all commercially important species in Canada. Since the original publication is out of print, the material will be reorganized to follow the generally accepted botanical sequence of genera and republished in a bound format.

CONE AND SEED INSECTS

G.E. Miller

Evaluation of cone slicing as a technique for indexing the number of seeds in cones has been completed for Douglas-fir, white spruce, Engelmann spruce, Sitka spruce, western red cedar, yellow cedar, western hemlock, lodgepole pine and western white pine. Ponderosa pine and western larch are currently being processed.

Sampling schemes have been developed, in collaboration with B.C. Forest Service, for estimating cone and seed efficiencies and the number

of filled seeds per cone in Douglas-fir seed orchards. A two-phase system, consisting of slicing a number of cones longitudinally along their axes and dissecting about one-third of these, was recommended for estimating number of filled seeds per cone.

Female spruce seed moths are being examined to determine the pheromones being produced. Field trials, which have led to inconclusive results so far, have been postponed until chemicals produced by the females are identified. Chemical identification of the Douglas-fir cone gall midge pheromone is continuing in cooperation with Simon Fraser University.

A field release of Trichogramma minutum, using cards with parasitized Sitotroga eggs, against Douglas-fir cone moth eggs resulted in about 5% parasitism. Problems encountered included ant predation and lingering of the emerged wasps on the cards.

An evaluation revealed that several commercially available diets for tortricids are not optimal for rearing Douglas-fir cone moth. Many insects had problems completing the larval-pupal molt. Placing conelet bracts with attached eggs onto the diet improved establishment rates considerably.

CONE AND SEED DISEASE RESEARCH

J.R. Sutherland

A paper was published (Can. J. Forest Res. 16: 360-362) relating control of Inland spruce cone rust (Chrysomyxa pirolata Wint.) to application of ferbam fungicide, basidiospore production by the pathogen, rainfall, and cone phenology. Losses from the disease, which can affect up to 65% of the white spruce cones in an orchard, were reduced to 2-3% by two applications of ferbam during the pollination period. The fungicide had no adverse effect on the numbers of cones produced, seed yields, or seed germination. Application is being made to have ferbam registered for use against cone rust. In another area, L. Mitchell and J. Sutherland published a paper (Can. J. Forest Res. 16: 945-948) on use of monoclonal antibody and ELISA techniques for detection of the seed-borne pathogen Sirococcus strobilinus Preuss. These new techniques are much quicker and more sensitive than traditional detection-by-plating techniques. J. Sutherland also prepared a working sheet on isolation and identification of the seed-borne pathogen Caloscypha gulgens (Pers.) Boud. for inclusion in an ISTA handbook on seed health testing. In March 1987 a book, edited by J.R. Sutherland (Canada), T. Miller (U.S.A.) and R. Salinas-Quinard (Mexico), was published by the North American Forestry Commission on the Cone and Seed Diseases of North American Conifers.

OFFICIAL CERTIFICATION AND TESTING OF TREE SEEDS

D.G. Edwards, F.T. Portlock and D.W. Taylor

As the Certifying Authority under the OECD scheme for the Pacific and Yukon Region, 169 certificates representing 2184 kg of seeds in the "source-identified" category were issued in 1985. The bulk of these were for 724 kg of Pinus contorta Dougl. seeds; also included were 128 kg of Pseudotsuga menziesii (Mirb.) Franco seeds in the "untested seed orchard" category. In 1986, 137 certificates representing 2269 kg of source-identified seeds were issued. These included 765 kg of Pinus contorta and 1462 kg of Picea sitchensis (Bong.) Carr. seeds.

Under the ISTA seed testing rules, 115 certificates of seed quality were issued in 1985/1986. These represented 4810 kg of commercially collected seeds of 13 conifer species, the bulk of which was made up of Pinus contorta and Picea sitchensis. In addition, 70 advisory germination tests were conducted.

The "Tree seed inspector's manual" for CFS inspectors under the OECD scheme, was completed, as was the "Methods and procedures for testing tree seeds in Canada." Both are expected to be published in 1987. The CFS successfully protested a ban imposed by the European Economic Community concerning the importation of Canadian Picea sitchensis seeds into the EEC. This will allow British Columbia seed merchants to market the large crop collected in 1986. The CFS OECD Officer attended the biennial OECD meetings of Designated Authorities in Paris in 1985 and 1987. In 1986, the federal government withdrew support for CFS-drafted Regulations for Forest Tree Seeds drafted by the CFS; these regulations were to have accompanied the Seeds Act of Canada. In their place, guidelines for grading and labeling Canadian tree seeds have been written, and they are expected to be published in 1987.

PUBLICATIONS

Edwards, D.G.W. 1986. Special prechilling techniques for tree seeds. J. Seed Technol. 10: 151-171.

Edwards, D.G.W. 1986. Cone prediction, collection and processing. Proc. Conifer Tree Seed in the Inland Mountain West, Sympos., (Shearer, R.C., compiler), Missoula, MO, August 1985. USDA For. Serv., Gen. Tech. Rep. INT-203: 78-102.

Edwards, D.G.W. and F.T. Portlock. 1986. Expansion of Canadian tree seed certification. Forest. Chron. 62: 461-466.

Miller, G.E. 1986. Sampling major Douglas-fir cone and seed insects in British Columbia. IUFRO Cone and Seed Insects Working Party Conference Proc., 1986 September 3-6, Briançon, France, p. 103-112.

Miller, G.E. 1986. Insects and conifer seed production in the Inland Mountain West: a review. Proc. Conifer Tree Seed in the Inland Mountain West, Sympos., (Shearer, R.C., compiler) Missoula, MO, August 1985. USDA For. Serv., Gen. Tech. Rep. INT-203: 225-237.

Miller, G.E. 1986. Distribution of Contarinia oregonensis (Diptera: Cecidomyiidae) eggs in Douglas-fir seed orchards and a method of estimating egg density. Can. Ent. 118: 1291-1295.

Miller, G.E. 1986. Damage prediction for Contarinia oregonensis (Diptera: Cecidomyiidae) in Douglas-fir seed orchards. Can. Ent. 118: 1297-1306.

Miller, G.E. and D.S. Ruth. 1986. Effect of summer temperature on termination of prolonged diapause in the Douglas-fir cone moth (Lepidoptera: Olethreutidae). Can. Ent. 118: 1073-1074.

Mitchell, L.A. and J.R. Sutherland. 1986. Detection of seed-borne Sirococcus strobilinus with monoclonal antibodies and an enzyme-linked immunosorbent assay. Can. J. Forest Res. 16: 945-948.

Sutherland, J.R. 1985. Influence of diseases on seed production. Review paper in Proc. Conifer Tree Seed in the Inland Mountain West symposium, Missoula, MT, Aug. 5-6, 1985. pp. 260-266, USDA Forest Serv. INT Res. Stn. Gen. Tech. Rept. INT-203, Ogden, UT.

Sutherland, J.R. 1987. Work sheet on isolation of Calascypha fulgens. ISTA seed health testing handbook (in press).

Sutherland, J.R., T. Miller and R. Salinas-Quinard (eds.). 1987. Cone and seed diseases of North American conifers. North American Forestry Commission Publ. No. 1, pp. 77.

Summers, D. and G.E. Miller. 1986. Experience with systemic insecticides for control of cone and seed insects in Douglas-fir seed orchards in coastal British Columbia. IUFRO Cone and Seed Insects Working Party Conference Proc., 1986 September 3-6, Briançon, France, p. 267-283.

Summers, D., J.R. Sutherland and T.A.D. Woods. 1986. Inland spruce cone rust (Chrysomyxa pirolata) control: ferbam fungicide application related to basidiospore production, rainfall and cone phenology. Can. J. Forest Res. 16: 360-362.

Tanaka, Y. and D.G.W. Edwards. 1986. An improved and more versatile method of prechilling Abies procera Rehd. seeds. Seed Sci. and Technol. 14: 457-464.

WESTERN WHITE PINE IMPROVEMENT PROGRAM FOR BRITISH COLUMBIA 1985-1987

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Keywords: Pinus monticola, Cronartium ribicola, rust genetics, chloroplast DNA, karyotype

"Operational" program of selection and testing

Selection of canker-free parent trees of western white pine (Pinus monticola Dougl.), under Section 88(1) contract support from the B.C. Ministry of Forests and Lands, began in 1985. To date, over 300 have been selected and open-pollinated seeds are on hand from the majority. The first major artificial inoculation of families from these selections will be attempted in 1987. Seedlings will be selected from the most-resistant parents to constitute seed orchards for both coastal and interior zones. A Ribes garden was initiated in 1986 on C.I.P. Tahsis-Pacific Region land at Saanichton, but most inoculum will be obtained from artificially-inoculated, natural Ribes plants for the next few years.

Cooperation with the U.S. Forest Service has enabled the initiation of nursery trials to test for racial differences in the rust, and to grow stock for plantations to demonstrate rust impact on seedlots possessing known resistance level and defense mechanisms. Some Idaho seedlings planted on Vancouver Island showed very high susceptibility to blister rust, raising the prospect of rust races (Hunt and Meagher, 1985). Furthermore, range-wide provenances have been planted within and beyond the range of white pine to test their resistance to serious root rots.

Three successive seed crops have been collected from a young natural stand in order to assess the spatial and temporal variation in outcrossing rate. The results will assist in management planning of seed-production areas and in capitalizing on bumper seed crops.

Ten plantations of "rust-resistant" stock planted in coastal areas prior to 1975 have been examined and rust depredation determined. Eastern white pine (P. strobus L.) was least affected by rust, and untested western white pine stock suffered the heaviest losses.

A proposal to obtain interim seed supplies with a potential for some genetic rust resistance, based upon seed-production areas of trees rogued to leave only uncankered trees, is under consideration.

Silvicultural control of rust by branch pruning and canker excising is being studied under FRDA contracts. Five-year results from CFS trials will be obtained in 1987-88.

The inoculation process, followed by rust spores on white pine

The effects of environmental factors such as light, CO_2 and humidity levels on the germination of basidiospores and subsequent germ tube growth on foliage of intact white pine seedlings is being studied with the goal of developing more-reproducible, controlled inoculations in progeny testing.

Biochemical genetics of white pine and blister rust

Biochemical techniques are being employed to detect variation in both white pine and the rust. Variation has been detected in the chloroplast DNA of western white pine. Work is continuing to determine the extent of this variation, and whether it will be useful as a provenance marker.

Seedlings have been inoculated with rust for comparison of cDNA libraries from infected and non-infected seedlings. The objective is to determine which genes are turned on in response to fungal attack. Inoculum derived from a single urediospore is being cycled on ribes plants to obtain genetically-uniform material for studying the rust genome.

Studies of provenance variation in protein patterns and cell culture are in abeyance pending staffing of the position left vacant by Dr. L. Mitchell's departure.

In conjunction with the foregoing, Dr. M.M.L. Leong, University of Victoria, is studying white pine's karyotype in order to detect gene linkages and morphological markers and thereby improve the basic understanding of white pine's genetic structure and organization.

PUBLICATIONS AND REFERENCES

El-Kassaby, Y.A., M.D. Meagher, J. Parkinson and F.T. Portlock. 1987. Allozyme inheritance, heterozygosity and outcrossing rate among Pinus monticola near Ladysmith, British Columbia. Heredity 58:173-181.

Hunt, R.S. 1985. Experimental evidence of heterothallism in Cronartium ribicola. Can. J. Bot. 63:1086-88.

Hunt, R.S. 1986. Pruning white pine to control blister rust in British Columbia. 34th Ann. West. Int. For. Dis. Work Conf. Juneau, Alaska Proc. pp. 27-28.

Hunt, R.S. and M.D. Meagher. 1985. How to recognize White Pine Blister Rust cankers. Fact Sheet. Can. For. Serv., Fac. For. Centre, Victoria, B.C.

Hunt, R.S. and M.D. Meagher. 1985. A putative new race of Cronartium ribicola in British Columbia. Phytopathology 75: 1295.

White, E.E. 1985. Chloroplast DNA in western white pine, Proc. I.U.F.R.O. conference on the molecular genetics of trees, Avon Lake, Ohio, U.S.A. Oct. 1985.

White, E.E. 1986. A method for extraction of chloroplast DNA from conifers. Plant Molecular Biology Reporter, Vol. 4: 98-101.

CIP INC., TAHSIS PACIFIC REGION'S TREE IMPROVEMENT PROGRAM AND FOREST GENETICS ACTIVITIES 1985-1987

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Keywords: seed orchards, progeny testing, farm field test, breeding

During the period under review, CIP Inc. has gone through a reorganization that yielded three major forestry operations: Tahsis Pacific Region in British Columbia, CIP Inc. in Quebec, and NBIP Forest Products Inc. in New Brunswick. Tree improvement activities for these three operations were reported separately in the 1985 Proceedings. Tree improvement and forest genetics activities for Tahsis Pacific Region are located in the SAANICH FORESTRY CENTRE, Saanichton, B.C., and include breeding, progeny testing, orchard establishment and management, and several support research projects.

BREEDING AND PROGENY TESTING

The disconnected diallel mating design was adopted for testing both the low and high elevation Douglas-fir populations. For each breeding population seven diallel units, each with six parents, were completed (105 crosses). Progeny tests for both populations were planted in 1986 and 1987, respectively. Each testing program consisted of conventional and farm field test sites. The conventional tests were planted on two sites each with 6 tree-row-plots replicated five times while the farm field test was planted in one location but with two spacings. Each spacing contained a 5 tree-row-plot replicated twice. Buffer rows were planted around all sites and local seed sources were used as a control. Information gained from the farm field test (IP+2BR seedlings) will be related to that collected from the conventional test. The remaining untested parents in both breeding populations will be evaluated through a polycross mating design.

SEED ORCHARDS

Most of our seed orchards are in their productive phase and updated statistics for all orchards appear in Table 1. In addition to existing orchards, new first generation clonal western hemlock and 2nd generation Douglas-fir orchards are in the development stage. Propagation for both orchards is near completion and the expected times for establishment are

1988 and 1990 for the western hemlock and Douglas-fir, respectively. Parent trees for the western hemlock orchard were selected from eastern Vancouver Island (dry sites) while Douglas-fir were selected from the Ministry of Forests and Lands' progeny test programs.

Table 1. Seed Orchards Information List

Orchard Complex	Status	Type[1]	Species	Area (ha)	# Clones/ Families	Est. Date	Seed Production (kg) 1985	1986
Saanichton	Private	C/S	Douglas-fir	3.40	80	1965/69	85.00	7.35
	Private	C/S	Douglas-fir	1.30	71	1965/69	5.84	2.24
	Private	S	Douglas-fir	6.30	112	1973	37.48	44.95
	private	S	Yellow cedar[2]	0.14	8	1974/75	0.15	0.15
Nootka	Co-op[3]	C/S	Douglas-fir	3.04	120	1970	7.90	5.31
	Co-op	C	Sitka Spruce	1.29	138	1971	-	2.00
	Co-op	C	Western Hemlock	0.81	84	1977	0.28	1.31
	Private	C	Douglas-fir	1.50	30	1969	17.30	4.36
	Private	C	Amabilis fir[4]	(1.50)	83	1977	-	-
	Private	C	Sitka spruce	0.23	50	1971	-	1.12

[1] C = Clonal; S = Seedling; C/S = Clonal/Seedling
[2] Experimental seed production area
[3] B.C. Ministry of Forests and Lands and the Industry Tree Improvement Co-operative Program
[4] Under-planted in private Douglas-fir orchard

RESEARCH

The seed orchard research program addressed the effect of management practices on seed quality and quantity (El-Kassaby, 1985; El-Kassaby et al. 1986a). Theoretical models were developed for estimating the mating system parameters (Ritland and El-Kassaby 1985) and contamination rates (El-Kassaby and Ritland 1986a). This research program investigated the rate of inbreeding of different crown segments (El-Kassbay et al. 1986c), effect of reproductive phenology on inbreeding rate (El-Kassaby et al. 1987c) and seed quality (Edwards and El-Kassaby 1987), the relationship between out-crossing and contamination (El-Kassaby and Ritland 1986b), inbreeding in seedling and clonal orchards (El-Kassaby et al. 1986d), and genetic variation in fruitfulness in clonal/seedling seed orchards (El-Kassaby et al. 1987d). Quantitative and statistical genetics research addressed the inter-provenance variation in the IUFRO Douglas-fir provenance/progeny trial (Fashler et al. 1985), effect of family size and number on the accuracy and precision of the estimates of genetic parameters (El-Kassaby et al. 1987a), use of trend surface analysis in progenv test trials (Thomson and El-Kassaby 1987), and multivariate data manipulation of a Douglas-fir common garden (Scagel et al. 1987), Douglas-fir cone and seed traits (Scagel et al. 1985a) and a Sitka spruce natural population (Scagel et al. 1985b).

The use of X-ray Energy-Dispersive Spectrometry technique as a tool for seed certification was investigated; natural populations showed significant differences in their trace element profiles (El-Kassaby and McLean 1985). These differences have been confirmed to be genotype (clone) specific (El-Kassaby et al. 1986b; McLean and El-Kassaby 1986).

Further projects completed include the compilation of an annotated bibliography of isozyme research of forest trees (El-Kassaby and White 1985), the mating system in western white pine (El-Kassaby et al. 1987b), genic variation in black spruce (Yeh et al. 1986), a numerical analysis of karyotypes in the genus Pseudotsuga (Sziklai et al. 1985), and the influences of initial spacing on growth of three western conifers 25 years after planting (Smith and El-Kassaby 1985).

During a visit by the senior author to the Dept. of Forest Genetics and Plant Physiology, Swedish University of Agricultural Sciences, the utility of chloroplast DNA as a tool for spruce seedlot identification was investigated (Szmidt et al. 1987), the genetic consequences of combining selective cone harvesting and genetic thinning in clonal orchards was studied (Lindgren and El-Kassaby 1987), and levels of inbreeding and contamination in two Scots pine seed orchards were estimated (El-Kassaby et al. 1987e).

Research projects in progress include the effect of long-term fertilization in seed orchards as a cone-induction method, pollen competition, genotype x fertilization interaction in Douglas-fir, the relation between germinative speed and early testing and between reproductive and vegetative outputs in Douglas-fir, OP testing in western hemlock and Sitka spruce, growth rhythm in spruces, and the effect of supplemental-mass-pollination on seed yield and quality in Douglas-fir and Sitka spruce seed orchards.

The Saanich Forestry Centre has continued to provide facilities to University Students and professors, B.C. Ministry of Forests and Lands researchers, and Canadian Forestry Service scientists.

PUBLICATIONS AND REFERENCES

Edwards, D.G.W. and Y.A. El-Kassaby. 1987. Effect of flowering phenology, date of cone collection, cone-storage treatment, and seed pretreatment on yield and germination of seeds from a Douglas-fir seed orchard. For. Ecol. Manage. (submitted).

El-Kassaby, Y.A. 1985. CIP Forest Products' Tree Improvement Program and Forest Genetics Activities. 1983-1985. In: Proc. 20th meeting of the Canadian Tree Improvement Association, (C.W. Yeatman and T.J.B. Boyle, eds.). Part 1: 231-236.

El-Kassaby, Y.A. and J.A. McLean. 1985. Identification of the origins of lodgepole pine seeds by X-ray energy spectrometric determination of mineral profiles. For. Sci. 31: 539-551.

El-Kassaby, Y.A. and E.E. White. 1985. Isozymes and forest trees: an annotated bibliography. Can. For. Serv., Pac. For. Res. Cent., Inf. Rep., BC-X-267. 79 pp.

El-Kassaby, Y.A. and K. Ritland. 1986a. Low Level of pollen contamination in a Douglas-fir seed orchard as detected by allozyme markers. Silvae Genet. 35: 224-229.

El-Kassaby, Y.A. and K. Ritland. 1986b. The relation of outcrossing and contamination to reproductive phenology and supplemental mass pollination in a Douglas-fir seed orchard. Silvae Genet. 35: 240-244.

El-Kassaby, Y.A., R. Davidson and J.W. Webber. 1986a. Genetics of seed orchards: a Douglas-fir case study. In: IUFRO, A Joint Meeting of Work. Parties S2.04.02, S2.04.03 and S2.03.03, Williamsburg, Virginia, U.S.A. (A.V. Hatcher and R.J. Weir, eds.). p. 410-421.

El-Kassaby, Y.A., J.A. McLean and A.M.K. Fashler. 1986b. Inter-clonal trace element profiles variation in Sitka spruce seeds. Biochem. Genet. 24: 729-741.

El-Kassaby, Y.A., J. Parkinson and W.J.B. Devitt. 1986c. The effect of crown segment on the mating system in a Douglas-fir [Pseudotsuga menziesii (Mirb.) Franco] seed orchard. Silvae Genet. 35: 149-155.

El-Kassaby, Y.A., F.C. Yeh and O. Sziklai. 1986d. Estimates of outcrossing rate and heterozygosity in a combined clonal/seedling Douglas-fir seed orchard using allozyme polymorphisms. In: Proc. IUFRO, A Joint Meeting of Work. Parties S2.04.02, S2.04.03 and S2.03.03, Williamsburg, Virginia, U.S.A. (A.V. Hatcher and R.J. Weir, eds.). p. 440-456.

El-Kassaby, Y.A., A.M.K. Fashler and O. Sziklai. 1987a. Effect of family size and number on the accuracy and precision of the estimates of genetic parameters in the IUFRO Douglas-fir provenance-progeny trial. For. Ecol. Manage. 18: 35-48.

El-Kassaby, Y.A., M.D. Meagher, J. Parkinson and F.T. Portlock. 1987b. Allozyme inheritance, heterozygosity and outcrossing rate among Pinus monticola near Ladysmith, British Columbia. Heredity. 58: 173-181.

El-Kassaby, Y.A., K. Ritland, A.M.K. Fashler and W.J.B. Devitt. 1987c. The role of reproductive phenology upon the mating structure of a Douglas-fir seed orchard. Silvae Genet. (in press).

El-Kassaby, Y.A., K. Ritland, A.M.K. Fashler and M. Crown. 1987d. Genetic variation in fruitfulness in a Douglas-fir clonal/seedling seed orchard and its effect on crop management decisions. Silvae Genet. (submitted).

El-Kassaby, Y.A., D. Rudin and R. Yazdani. 1987e. Levels of outcrossing and contamination in two Scots pine seed orchards. Hereditas (submitted).

Fashler, A.M.K., Y.A. El-Kassaby and O. Sziklai. 1985. Inter-provenance variation in the IUFRO Douglas-fir provenance/progeny trial. In: Proc. IUFRO, Work. Party S2.02.05, Vienna, Austria (in press).

Fashler, A.M.K. and Y.A. El-Kassaby. 1987. The effect of water spray cooling treatment on reproductive phenology in a Douglas-fir seed orchard. Silvae Genet. (in press).

Lindgren, D. and Y.A. El-Kassaby. 1987. Genetic consequences of combining selective cone harvesting and genetic thinning in clonal seed orchards. Theor. Appl. Genet. (submitted).

McLean, J.A. and Y.A. El-Kassaby. 1986. Element profiles for Douglas-fir seeds: evidence for genetic control. Can. J. For. Res. 16: 650-654.

Ritland, K. and Y.A. El-Kassaby. 1985. The nature of inbreeding in a seed orchard of Douglas-fir as shown by an efficient multilocus model. Theor. Appl. Genet. 71: 375-384.

Scagel, R.K., R. Davidson, Y.A. El-Kassaby and O. Sziklai. 1985a. Variation of cone scale and seed morphology in Pseudotsuga menziesii. In: Proc. IUFRO, Work. Party S2.02.05, Vienna, Austria (in press).

Scagel, R.K., Y.A. El-Kassaby and J. Emanuel. 1985b. Assessing sample size and variable number in multivariate data, with specific reference to cone morphology variation of Picea sitchensis. Can. J. Bot. 63: 232-241.

Scagel, R.K., Y.A. El-Kassaby and J. Maze. 1987. Multivariate variation within and between open-pollinated families of Douglas-fir (Pseudotsuga menziesii). Can. J. Bot. (in press).

Smith, J.H.G. and Y.A. El-Kassaby. 1985. Influences of initial spacing on growth of Douglas-fir, western hemlock, and western red cedar after 25 years from planting. In: University of British Columbia, Faculty of Forestry, Research and Publications 1984/1985, (G.F. Weetman, ed.). p. 33-35.

Sziklai, O., Y.A. El-Kassaby and R.K. Scagel. 1985. Relationship of Pseudotsuga menziesii with other Pseudotsuga species inferred from karyotype reconstruction. In: Proc. IUFRO, Work. Party S2.02.05, Vienna, Austria. (in press).

Szmidt, A.E., Y.A. El-Kassaby, A. Sigurgeirsson, T. Alden, D. Lindgren and J-E. Hallgren. 1987. An efficient method for classifying seedlots of Picea sitchensis and P. glauca in zones of introgression using restriction analysis of chloroplast DNA. Theor. Appl. Genet. (submitted).

Thomson, A.J. and Y.A. El-Kassaby. 1987. Trend surface analysis of a Douglas-fir provenance-progeny transfer test. Theoer. Appl. Genet. (submitted).

Yeh, F.C., M.A.K. Khalil, Y.A. El-Kassaby and D.C. Trust. 1986. Allozyme variation in Picea mariana from Newfoundland: genetic diversity, population structure, and analysis of differentiation. Can. J. For. Res. 16: 713-720.

MACMILLAN BLOEDEL LIMITED PROGRESS REPORT 1986-1987

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Keywords: Seed Orchards, Cone Induction, Progeny Tests

MacMillan Bloedel Limited has been involved in several tree improvement/forest genetics activities during the period covered by this Report. These activities have included seed orchard management, cone induction research, and progeny testing.

SEED ORCHARDS

MacMillan Bloedel Limited is a member of the Coastal Tree Improvement Cooperative (CTIC), and is managing five clonal seed orchards:

- western hemlock (Tsuga heterophylla (Raf.) Sarg.)
- amabilis fir (Abies amabilis (Dougl.) Forbes)
- western red cedar (Thuja plicata Donn)
- yellow cedar (Chamaecyparis nootkatensis (D. Don) Spach)
- Sitka spruce (Picea sitchensis (Bong.) Carr.)

A 5.5 hl Sitka spruce crop in 1986 was the first production from these orchards.

Based on previous work with potted western hemlock, the Company has established an operational scale, containerized western hemlock seed orchard.

CONE INDUCTION STUDIES

These projects have been done in cooperation with Dr. S.D. Ross (BC MoFL).

Girdling as an adjunct to GA 4/7 application in western hemlock - there is considerable disparity between the effectiveness of GA 4/7 when applied to soil-based and potted western hemlock, primarily because of the increased ability to drought stress the potted material. This project was initiated to determine if girdling would improve the response of soil-based trees to GA 4/7. Flower counts in spring 1987 look quite promising.

Cone induction trials on yellow cedar - this study was initiated in 1984 (Bower 1986). The May 20 to June 23 treatment period at a GA 3 rate of 200 mg/l weekly gave a very good response in terms of both male and female flowering as well as cones harvested, however, filled seed counts were lower than expected. A new study, "Dormancy requirements for cone development in potted yellow cedar," has been initiated to see if treatments can be developed to solve this problem.

PROGENY TESTS

Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco)

The project was initiated in 1982 (Bower 1986). The present plan is for the material to undergo a 3 to 5 year farm field testing phase to reduce the population by 25 to 30 percent before field testing begins. Two hundred forty-three families were sown in the nursery in spring 1987.

PUBLICATIONS AND REFERENCES

Bower, R.C. 1986. MacMillan Bloedel Limited. Progress Report 1984-1985. Twentieth Canadian Tree Improvement Association Proceedings, Part 1. p. 227-230.

Bower, R.C., S.D. Ross, and A.M. Eastham. 1986. Management of a western hemlock containerized seed orchard. In: Proc. Int'l Union For. Res. Organizations Symposium, Williamsburg, Virginia. p. 604-612.

Bower, R.C. and S.D. Ross. 1986. Evaluation of ULV sprays for seed orchard application of GA 4/7. Twentieth Canadian Tree Improvement Association Proceedings, Part 2. p. 103-110.

Bower, R.C. 1987. Early comparison of an Idaho and a coastal source of western white pine on Vancouver Island. West J. Appl. For. 2: 20-21.

Fast, W., B.P. Dancik, and R.C. Bower. 1986. Mating system and pollen contamination in a Douglas-fir clone bank. Can. J. For. Res. 16: 1314-1319.

Ross, S.D., A.M. Eastham, and R.C. Bower. 1986. Potential for container seed orchards. In: Proc. Symposium on Conifer Tree Seed in the Inland Mountain West (R. Shearer, Ed.). U.S. For. Ser. Intermount. Res. Stat. Gen. Tech. Rep. INT-203. p. 180-186.

STUDIES IN VARIATION IN WESTERN NORTH AMERICAN CONIFERS

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Our studies are focussed on patterns of variation and covariation in western North American conifers such as Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco), yellow cedar (Chamaecyparis nootkatensis (D. Don.) Spach.), noble fir (Abies procera Rehd.), and ponderosa pine (Pinus ponderosa Dougl.). The attributes being studied are increments of growth, needle morphology/anatomy, and isozymes.

Douglas-fir

One study on Douglas-fir concerns variation in growth of two-year-old seedlings from 14 full-sib families established at Cowichan Lake Research Station, British Columbia Ministry of Lands and Forests. The seedlings were measured five times over 85 days during the summer of 1986 and the variation was apportioned to independent variables (block and family) and covariates (size at time of planting and growth during the first period). The data were also used to generate statistics to describe within-family covariation.

Covariation differed among families. Within families, covariation changed and variation increased with time. Among-family variation in size was high only at time of planting and it declined once growth started. Growth during the first period accounted for more variation in subsequent growth periods than did size at time of planting or either independent variable.

The increasing variation and changing covariation within families, in relation to time, becomes increasingly complex. This phenomenon is also seen in within-individual development (Scagel et al. 1986; Maze et al. 1987).

Differing covariation among families indicates that correlated responses to selection may not be constant for all families. Also, changing within-family covariation with time may indicate different within-family correlated responses, depending on when selection is exercised. The increasing variation over time indicates that estimating growth by using mean values may become less accurate with time.

Because these results are based on two-year-old seedlings, they may not be consistent with time. Thus, growth of these same seedlings will be monitored in the future. Regardless, these data indicate that factors other than family structure may be worth pursuing in attempts to make decisions about reforestation. Based on our data, a better response of planted seedlings may be realized if the criteria for selecting trees for planting was based on growth rate rather than specific genetic origin.

In order to expand our studies on Douglas-fir, a similar study has been started at the University of British Columbia. The details differ slightly from that of the Cowichan Lake study, but preliminary analyses indicate that general results are the same. This study will also be continued over several years.

The study of growth of Douglas-fir seedlings at Cowichan Lake is being conducted along with a study on needle morphology/anatomy for the same plants. We found no relationship between needle morphology/anatomy and growth. As well, most of the variation in needle morphology/anatomy was within families. These results would seem to indicate that the production of individual variants has a greater impact on the maintenance of diversity than crosses between specific individuals.

Yellow cedar

The study on yellow cedar is designed to ascertain the within- and among-tree and population variation in morphology, growth, and isozymes in trees growing at two ecologically different but geographically contiguous sites. This study, the M.Sc. project of S.M. Banerjee, is being done in cooperation with CIP, Inc., Saanichton, B.C. Within- and among-tree and population variation in offspring taken from cones from known levels within the trees is also being assessed. With this data, it will be possible to determine the mating system of yellow cedar. Data from this study may be useful in establishing a seed orchard policy and a reforestation protocol for this species.

Other species

The studies on ponderosa pine and noble fir are both analyses of growth. For ponderosa pine, tree ring data generated by Forintek are being used. For noble fir we are using increments of branch growth. Through these studies, we would like to relate growth rate to ultimate size (ponderosa pine) and describe the general attributes of growth (noble fir).

Our research has emphasized covariation, a mathematical expression of organization. By studying organization, which differs among biological systems, it may be possible to obtain new insights into variation of forest trees. Through these insights we may develop a better understanding of how to manipulate this variation.

LITERATURE CITED

Maze, J., R.K. Scagel, and L.R. Bohm. 1987. Quantitative studies in ovule development. III. An estimate of shape changes in Phyllostachys aurea. Can. J. Bot. 65: (in press).

Scagel, R.K., J. Maze, L.R. Bohm, and N.L. Vogt. 1985. Quantitative studies in early ovule development. I. Intra-individual variation in Nothofagus antarctica. Can. J. Bot. 63: 1769-1778.

FOREST GENETICS AND TREE BREEDING AT THE FACULTY OF FORESTRY, UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER, 1985-1987

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Keywords: education, variation, idiogram, provenance/progeny test, phenology, acclimation, relative wood density, Picea, hybridization

TEACHING AND RESEARCH

O. Sziklai

UNDERGRADUATE PROGRAM

Undergraduate enrollment in the elective forest genetics course was 8 and 6 during the last two years which is mainly due to the implementation of the new 4 year vs 5 year program, and the reduction in the available elective units.

The winners of G.S. Allen prize in Forest Genetics were Brian Barber in 1986 and Ling Cherng-hsi in 1987 obtaining the highest mark in the forest genetics course.

GRADUATE PROGRAM

Two students completed their graduate program. Dong: "Container nursery methods for producing seedlings of Chinese pine (Pinus tabulaeformis Carr.) and oriental arborvitae (Thuja orientalis (L.) Franco)" obtained a Master of Forestry degree in 1985. Rabulan: "The significance of hydrocarbon-producing plants in the Philippines" achieved a Master of Science degree in 1986.

Presently Ms. Davidson is working toward her Ph.D degree. Her course work and comprehensive examination are behind her, but since she has taken up employment, the thesis preparation on "Genetic variation in seed and seedling characteristics of Abies amabilis" is slowly progressing.

Ms. Ling is working toward her Ph.D degree and her proposed research will be on tissue culture of selected western conifer species.

Kantarli commenced his M.F. program and successfully completed his first year course work.

RESEARCH

Research has concentrated mainly on Douglas-fir and lodgepole pine.

(a) Karyotype of the genus Pseudotsuga. Although seven species idiograms have now been completed, samples from the eighth have not yet been obtained.

(b) Lodgepole pine genotype-environment interaction study. Progeny tests were established at five locations in Canada and at three locations in Sweden during 1986 using the full- and half-sib families obtained from a seed orchard established in Sweden from plus trees selected in 1970 and 1974.

(c) Inter-provenance variation. The IUFRO Douglas-fir provenance/progeny test was remeasured, pruned and thinned in 1986. Data from the 16th growing season are presently being analyzed.

PUBLICATIONS

Chen, Y. and O. Sziklai. 1985. Preliminary study on the germination of Toona sinensis (A. Juss.) Roem. seed from eleven Chinese provenances. For. Ecol. and Mgt. 10: 269-281.

Dong, H., A.N. Burdett and O. Sziklai. 1986. Chemical root pruning controls root morphogenesis of container-grown Chinese pine (Pinus tabulaeformis Carr.) seedlings. (Submitted Nanking For. School Bull.).

El-Kassaby, Y.A., A.M. Fashler and O. Sziklai. 1987. Effect of family size and number on the accuracy and precision of the estimates of genetic parameters in the IUFRO Douglas-fir provenance-progeny trial. For. Ecol. and Manage. 18: 35-48.

Sziklai, O. 1985. Polyembryony of Pinus contorta Doug. in central Yukon. In: Proc. of the Int'l. Symposium on Seed Problems under Stressful Conditions, Vienna and Gmunden, Austria. 12: 52-57.

Sziklai, O. 1986. Polyembryony of Pinus contorta Doug. in central Yukon. In: Provenances and Forest Tree Breeding for High Latitudes - Proc. of the Frans Kempe symposium in Umea June 10-11, 1986, Sweden. p. 251 Abstract.

POLDI BENTLEY NSERC/INDUSTRIAL CHAIR IN FOREST GENETICS AND TREE IMPROVEMENT

D.T. Lester

In 1986, the Natural Sciences and Engineering Research Council of Canada matched contributions from four industrial forestry associations in B.C. and the B.C. Ministry of Forests and Lands to establish a Chair at UBC. The Chair is named after the late Poldi Bentley, a leader in B.C. forest industry, co-founder of Canfor Corporation, and founder of the B.C. Council of Forest Industries. The Chair is guided by a research advisory committee of six including representatives of each sponsor.

On July 1, Dr. D.T. Lester was appointed to the Chair and in January, 1987, Dr. J.A. Loo-Dinkins joined the program as Research Associate. Dr. Lester has done research on a variety of topics including genetic variation at the progeny and provenance level, disease resistance breeding, and cytology as well as managing an industrial research group. Dr. Loo-Dinkins has specialized in quantitative genetics and has worked on questions of efficiency in progeny testing and of wood quality.

Two research projects are in progress. One deals with the relationship of phenology, acclimation to climate, and relative density of wood. Lodgepole pine and western hemlock are the species under study. A second project involves exploratory crossing among the B.C. spruces and will estimate whether coastal-interior matings offer potential for hybrid vigor, broadened ecological amplitude, or creation of exceptional individuals. Eighty single-pair matings have been made among selected individuals from two coastal and two interior breeding zones.

A graduate-level course in tree improvement has been developed and three students have been admitted to the graduate program.

PUBLICATIONS

Lester, D.T. 1986. Genetic considerations for Douglas-fir. In: Douglas-fir: Stand Management for the Future. C.D. Oliver, D.P. Hanley, and J.A. Johnson (eds.). Univ. of Washington, Institute of Forest Resources. Contrib. no. 55: p. 151-154.

Lester, D.T. 1985. Applied tree improvement (Book Review). For. Sci. 31: 301-302.

RESEARCH AT FORINTEK CANADA CORP. RELATING TO TREE IMPROVEMENT

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Keywords: Wood quality, intensive management, relative density, juvenile wood, extractive content, rate of growth.

One of the important goals of Forintek's Wood Science Department has been to assist groups in the incorporation of wood quality considerations in tree improvement programs. At the biennial meeting of the CTIA in 1985, Forintek organized a workshop on Wood Quality Considerations in Tree Improvement Programs (Keith & Kellogg, 1985) and was instrumental in the formation of a Wood Quality Working Group within the CTIA. During the past two years, research of interest to tree improvement workers has been underway at the Forintek laboratories and information on the progress of these activities is summarized in the following report.

WOOD QUALITY STUDIES

Parent-Tree Density Assessment

Since 1974, Forintek's western laboratory has been involved in the assessment of the density of increment cores taken from parent trees in order to advise tree improvement councils on the best quality trees to be included in their tree breeding programs. This work has continued with lodgepole pine (Pinus contorta Dougl.), (Gonzalez, 1987a) and Interior Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco), (Gonzalez, 1986) during the last two years.

Development of a Field Wood Density Tester

Because of the large numbers of trees involved in both parent-tree and progeny testing programs, an instrument is urgently needed for rapidly assessing wood density in the field. Our work on such an instrument (Hamm, 1987) is based on the principle that solid wood substance has an essentially constant density and is incompressible. Compression of an increment core into a constant density material would allow determination of bulk density from the initial and compressed volumes. A compression cylinder apparatus was constructed to accommodate 5 mm diameter increment

cores up to 16 cm in length. Consistent results have been obtained over a substantial range of densities. A regression of actual versus predicted density gave a correlation coefficient of 0.983. A prototype field model is currently being developed.

Circumferential Variability of Relative Density in Lodgepole Pine

This study showed that two samples taken at 180 degrees to each other, gave better estimates of mean relative density than three to four samples randomly selected (Gonzalez, 1987b).

Wood Density Survey of Tree Species in British Columbia

Values of density of 22 British Columbia tree species have been analyzed and collated (Gonzalez, 1987). Density values varied with the method of sampling and analysis. Where plus-tree increment cores were divided into inner and outer portions, wood density values were usually lower for the inner portions than for the outer ones.

Predicting Mature Whole-Stem Density from Juvenile Trees

Using data for 60 coastal Douglas-fir trees, densities at breast-height at ages 5, 10, 15 and 20 years were regressed against whole-stem densities of the same trees at ages 35, 40, 45 and 50 years (Gonzalez and Richards, 1987). All relationships were linear and statistically significant but the coefficients of determination were much lower for ages 5 and 10 years than for ages 15 and 20 years. Breast-height density of 15-year-old trees provided a reliable indication of whole-stem density of the same trees at 50 years of age.

Characterization of Wood of Rapidly-Grown Conifers in Canada

Exploratory studies of western conifers have been carried out on Douglas-fir (both coastal and interior forms), western hemlock (Tsuga heterophylla (Raf.) Sarg.), lodgepole pine, interior spruce, white (Picea glauca (Moench) Voss.) or Engelmann (Picea engelmannii Parry), and western red cedar (Thuja plicata Donn). Similar studies of eastern conifers began in 1985 with jack pine (Pinus banksiana Lamb.) and European larch (Larix decidua Mill.), and continued in 1986 with black spruce (Picea mariana (Mill.) B.S.P.). Five trees from each of two sites have been sampled for each species. Characteristics examined include radial and longitudinal patterns of variation in growth rate, relative density, proportions of heartwood and sapwood, longitudinal shrinkage, chemical extractives and lignin content. Attention is being paid to differences between juvenile and mature wood properties and to means of delineating the boundary between juvenile and mature wood zones. Various aspects of this work have been reported by Jozsa and Kellogg (1986), Keith (1986), Nault (1986) and Barbour (1987).

Douglas-fir Provenance Analysis

Correlations of density versus volume for the ten 15-year-old trees sampled within a provenance were negatively significant in the majority of cases. A ranking of the 66 provenances based on biomass, density, and several other factors, was developed (Hamm, 1986).

Properties of Wood from Intensively Managed Forests

Forintek Canada Corp., in cooperation with PAPRICAN, has begun a national program of research into intensively managed second-growth timber. The program consists of integrated studies on all aspects of properties and utilization of the timber resource. This research will provide the most comprehensive assessment available on the future managed forest resource and will permit planning for its optimum utilization. The results will be important to tree improvement workers in terms of defining the wood quality characteristics of importance to end-product quality for a particular species. Coastal Douglas-fir was chosen as the species for initial study but similar coordinated work is now proceeding on lodgepole pine and jack pine.

PUBLICATIONS AND REFERENCES

Barbour, R.J. 1987. A preliminary study of the wood properties of fast-grown black spruce (Picea mariana (Mill.) B.S.P.) from Quebec. CFS Report No. 33.

Gonzalez, J.S. 1986. Density evaluation of interior Douglas-fir parent trees. CFS Report No. 04-55-12-156.

Gonzalez, J.S. 1987a. Density evaluation of lodgepole pine parent trees. CFS Report No. 04-55-12-156.

Gonzalez, J.S. 1987b. Circumferential variability of relative density in lodgepole pine. CFS Report No. 04-55-12-156.

Gonzalez, J.S. and J. Richards. 1987. Relationship between breast-height and whole-stem density in 50-year-old coastal Douglas-fir. CFS Report No. 04-55-12-156.

Hamm, E. 1986. Douglas-fir provenance trial wood density analysis. Forintek Contract Report No. 04-55-79-641.

Hamm, E. 1987. Development of a field wood density tester using an increment core compression technique. Forintek Contract Report No. 04-55-69-643.

Jozsa, L.A. and R.M. Kellogg. 1986. An exploratory study of the density and annual ring weight trends in fast-growth coniferous woods in British Columbia. CFS Report No. 02-80-12-017 and 02-80-55-010.

Keith, C.T. 1986. An exploratory study of the properties of fast-grown jack pine and European larch in Eastern Canada. CFS Report No. 04-55-12-002.

Keith, C.T. and R.M. Kellogg. 1986. Wood quality considerations in tree improvement programs. Proceedings of a workshop held in Quebec City, August 19, 1985. Forintek Canada Corp. Special Publication SP-513E.

Nault, J.R. 1986. Radial distribution of thujaplicins and thujic acid in old-growth and second-growth western red cedar (Thuja plicata Donn). Forintek Contract Report No. 04-55-43-010.

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