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Proceedings of the twelfth
meeting of the committee on
**Forest Tree Breeding
in Canada**

Comptes rendus de la douzième
conférence du comité
**Canadien D'amélioration des
Arbres Forestiers**



Université Laval
Québec, Qué.
August 17 - 20 Août
1970

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

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The Thirteenth Meeting of the Committee will be
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Canadian and foreign visitors will be welcome. Detailed
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PROCEEDINGS OF THE TWELFTH MEETING OF
THE COMMITTEE ON FOREST TREE BREEDING
IN CANADA

PART 2

REPORTS AND PAPERS

Editor: E.K. Morgenstern

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- Part 1, Minutes and Discussions, received restricted distribution to Committee members only.
- Part 2, received wider distribution to persons and organizations actively engaged or interested in forest genetics and tree improvement.

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TREE IMPROVEMENT IN NEWFOUNDLAND

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Tree improvement work continued to center around the local black spruce [*Picea mariana* (Mill.) B.S.P.] and trials of exotic species and races.

BLACK SPRUCE

Seed collections for a provenance study of local black spruce was initiated in 1967 and a nursery experiment was sown in the spring of 1968. Measurements of height and observations on dormancy were made in the fall of 1969. In general, there was a decrease in height growth with increase in latitude of the seed source. This was especially apparent with provenances from the Northern Peninsula which were significantly shorter than the others. They also set buds up to a month earlier than the other provenances. The distinct behavior of this group of provenances is thought to be related to the climate of that region which has comparatively colder winters and cooler, shorter summers.

Other work on black spruce was the sowing in the spring of 1970 of bulked seedlots of local provenances for outplanting experiments, and provision of local seed and acquisition of mainland seed for the cooperative all-range provenance experiment being coordinated by Dr. E.K. Morgenstern of PFES.

SITKA SPRUCE

A Sitka spruce [*Picea sitchensis* (Bong.) Carr.] provenance experiment was initiated in 1965. Twelve provenances, including a local black spruce control, were established in each of seven plantations in 1969 and two plantations in 1970. Plantation sites were selected on the better site types in most of the important forest growing regions of the Island. The experimental design was an eight-replicated randomized block with 16 trees per plot.

A combination spacing-fertilizer experiment using the black spruce and two of the Sitka spruce provenances was established in three locations. This project is being done in cooperation with a silviculturist.

WHITE SPRUCE

A plantation containing 31 white spruce [*Picea glauca* (Moench) Voss] provenances from the Great Lakes - St. Lawrence Region was established, in cooperation with Mr. Mark Holst of P.F.E.S., in central Newfoundland in 1963. A measurement at age of 10 years from seed was carried out in 1968. Survival

of all provenances was generally good. Those showing the best height growth were from southeastern Ontario and southwestern Quebec, i.e. Algonquin Park and Beachburg, Ont., and Grandes Piles and Cushing, Qué.

TREE BREEDING IN THE MARITIMES REGION, 1968-69

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INTRODUCTION

The objectives of the Tree Improvement and Reforestation Support Area are as follows:

1. To provide direct support to the problem area programs of the Region by consultation, by supplying genetically improved tree materials, and by carrying out research on specific projects within defined problem areas.
2. To obtain information on the genetic variability of native and exotic species considered to be of present or future importance in the Region. This information will be used to produce improved strains or types of trees for reforestation and will provide a basis for genetic manipulation of existing forest stands.
3. To assist the provincial governments and industries of the region to develop economically sound methods of mass producing tree seeds and seedlings of improved genetic quality.

During 1968 and 1969, tree breeding work in the Maritime Region was concentrated on four projects: Breeding and breeding systems of forest trees - D.P. Fowler; Provenance and progeny testing - H.G. MacGillivray; Genecology of red and black spruce - S.A.M. Manley; Haploid and homozygous diploid trees - J.M. Bonga and D.P. Fowler.

BREEDING AND BREEDING SYSTEMS OF FOREST TREES

The objective of this project is to obtain the necessary information and breeding materials to make possible the mass production of genetically superior trees for the Maritimes Region. An understanding of the natural and potential genetic variability of native and promising exotic species is essential if genetic improvement is to be maximized.

Because of the present importance of *Picea* species and the potential importance of *Larix* species for reforestation, work has been concentrated on these genera.

Picea

Picea glauca (Moench) Voss (white spruce), *P. mariana* (Mill.) B.S.P. (black spruce), and *P. rubens* Sarg. (red spruce) are sympatric over much of the region. Hybridization and introgression between red and black spruce have been shown to be important features of the forests of the region (Manley 1969). No evidence of gene exchange between white spruce and red

or black spruces has been found in the region, although white-black spruce hybrids have been reported elsewhere.

To further elucidate the genetic relationship between the three native spruces and to provide material for further genecological work, a series of controlled pollinations were attempted. In 1968 and 1969, all possible crosses between the three spruces were attempted. The summarized results are presented in Table 1. Only a few full seeds were obtained from any of the interspecific white spruce crosses (morphological examination of the seedlings will be required to determine if any hybrids were obtained). Considerable tree to tree variation in interspecific crossability was observed in black and red spruces. On the average, red and black spruces appear to be 25-50% cross-compatible. Self incompatibility is greater than interspecific incompatibility.

Table 1. Interspecific Hybridization Between Three Native Spruces - Average Number of Full Seeds per Cone.

Female parent		Male parent			
Species	Trees	<i>P. glauca</i>	<i>P. mariana</i>	<i>P. rubens</i>	Self
<i>P. glauca</i>	8	2.2 ^a	0.01	0.01	0.71
<i>P. mariana</i>	4	0.07	9.3	4.0	3.1
<i>P. rubens</i>	4	0.05	2.5	9.8	0.65

^aOpen pollination.

In 1969, all possible crosses were attempted between three sets of the following phenotypes: pure black spruce, 25% red spruce, 50% red spruce, 75% red spruce, and pure red spruce. The results of these crosses have yet to be analyzed.

As part of a study to determine the interspecific relationship between the eastern Canadian spruces and exotic spruces, a number of controlled pollinations were attempted in 1968 and 1969. The summarized results are presented in Table 2. Seed yields from these crosses were very low and evaluation will be dependent on morphological examination of seedlings.

Larix

Due to their rapid juvenile growth, good form, high wood density, and ease of handling in the nursery, *Larix* species are of potential value for reforestation within the region. On the basis of species trials and provenance tests, it is evident that selected strains of *Larix laricina* (Du Roi) K. Koch, *L. leptolepis* (Sieb. and Zucc.) Gord., and *L. decidua*

Table 2. Interspecific Hybridization Using White Spruce as Female Parent.

Male parent	Crosses yielding full seed	Full seeds per cone	Total number of full seeds
<u>1968</u>			
<i>P. asperata</i>	6	0.20	106
<i>P. koraiensis</i>	5	0.01	7
<i>P. koyamai</i>	6	0.08	8
<i>P. omorika</i>	4	0.01	8
<i>P. orientalis</i>	4	0.01	6
<u>1969</u>			
<i>P. omorika</i>	3	0.01	4
<i>P. schrenkiana</i>	8	0.09	107

Mill. are promising. That interspecific *Larix* hybrids are often heterotic, has been well documented, thus species hybridization appears to be the most promising approach to *Larix* improvement.

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

Five populations of the hybrid (*Larix laricina* x *leptolepis*) x *L. decidua* were produced in 1967. At the end of the second growing season, one of these populations appears heterotic in that it is clearly superior in height (avg 112 cm) to comparable populations of the three parent species (avg less than 100 cm for the next best population).

In 1968, all possible crosses (including self-pollinations) were made between two selected trees of each of *L. laricina*, *L. leptolepis*, and *L. decidua*. In addition, the hybrid *L. laricina* x *leptolepis* was backcrossed to both parent species. The summarized results are presented in Table 3.

Table 3. Results of 1968 Controlled Pollinations with Larch.
Percentage of Full Seeds.

Female parent	Male parent					
	<i>L. laricina</i>		<i>L. leptolepis</i>		<i>L. decidua</i>	
	Tree 495	Tree 119	Tree 7	Tree 10	Tree 19	Tree 27
<i>L. laricina</i> (495) ^a	5.3	<u>34.6</u> ^b	0.0	0.9	<u>28.1</u>	<u>1.4</u>
<i>L. laricina</i> (119)	<u>21.7</u>	<u>1.1</u>	<u>3.8</u>	3.5	<u>2.6</u>	<u>4.5</u>
<i>L. leptolepis</i> (7)	0.2	0.0	<u>4.9</u>	<u>78.3</u>	<u>2.2</u>	<u>5.1</u>
<i>L. leptolepis</i> (10)	0.2	0.0	<u>71.7</u>	<u>28.3</u>	<u>13.2</u>	<u>1.5</u>
<i>L. decidua</i> (19)	<u>0.8</u>	0.0	<u>24.0</u>	<u>37.5</u>	<u>0.3</u>	<u>12.2</u>
<i>L. decidua</i> (27)	0.5	0.7	14.2	<u>32.6</u>	<u>51.3</u>	0.5
<i>L. laricina</i> x <i>leptolepis</i> (368)	<u>12.5</u>	-	-	<u>10.2</u>	-	-
<i>L. laricina</i> x <i>leptolepis</i> (352)	<u>5.4</u>	-	-	<u>6.0</u>	-	-

^aTree number in parentheses.

^bUnderlined numbers denote populations with living seedlings at age 4 months.

Pollen from two selected *L. decidua* trees was used in crosses with *L. laricina*, *L. leptolepis*, and *L. decidua*. The results are given in Table 4.

Although *L. laricina* can be crossed with both *L. leptolepis* and *L. decidua* (and often produces heterotic progenies), the very low seed yield, as well as differences in flower phenology will make mass production of hybrids difficult. Only if early evaluation of individual hybrids is successful and if commercially acceptable methods of vegetative propagation can be developed, will it be possible to produce these hybrids in quantity.

Pinus resinosa

Three small studies of maternal effects in *Pinus resinosa* Ait. were concluded in 1969. It was concluded that maternal effects, other than seed size, could cause approximately 10% variation in height growth of young red pine seedlings. Estimates of genetic variation based on evaluation of young provenance or one-parent progeny materials should be reduced accordingly.

Table 4. Interspecific Hybridization of Larch Species, with *L. decidua* as Male Parent - Number of Cones Harvested.

Species	Female parent		Male parent	
	Provenances	Trees pollinated	Tree 29	Tree 30
<i>L. laricina</i>	3	11	645	622
<i>L. leptolepis</i>	8	15	385	422
<i>L. decidua</i>	2	2	123	109
<i>L. laricina</i> x <i>leptolepis</i>	-	3	145	136

It is recommended that controlled pollination studies, including reciprocal crossing should be employed in future genetic evaluation of this species (Fowler 1970).

PROVENANCE AND PROGENY TESTING

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

Picea

An all-range study of 1,100 provenances of *Picea abies* (L.) Karst. was planted in May 1968 at the Bronson Burn, near Chipman, N.B. This study is being conducted in cooperation with Dr. Olof Langlet and Mr. Peter Krutzsch of Stockholm, Sweden. Dr. Klaus Stern, Schmalenbeck, Germany assisted with the design. The Bronson plantation contains 11 randomized blocks each with 25 trees from each of 100 provenances for a total of 27,500 trees. The roots of the trees were washed free of soil in Germany and shipped air freight to New Brunswick. Despite this and the considerable handling they received in Germany and on their arrival in New Brunswick, survival in August 1969 was 80%.

Two replicated trials of provenance of *P. sitchensis* (Bong.) Carr. were established as coastal windbreaks, one in southern Nova Scotia, the other in northwestern Prince Edward Island. A third replicated provenance test of this species was planted at the Acadia Forest Experiment Station. Unreplicated observation plots were established in southern Nova Scotia.

Seed collections of *P. mariana* were made in the Maritimes for the all-range provenance study that is being directed by Dr. E.K. Morgenstern, PFES.

During 1968-69, data was collected from provenance tests of *P. abies* (partial range), *P. glauca* (one all-range and one partial range), and *P. rubens* (one all-range and one partial range). The data have not yet been analyzed.

Larix

Significant differences in average height and average basal areas (10 years from seed) were found among 20 provenances of *L. leptolepis* planted at Acadia Forest Experiment Station. This study also included two provenances of *L. laricina* and three provenances of *L. decidua*. Trees from the best *L. leptolepis* provenances were taller and of greater diameter at breast height than the *L. laricina* or *L. decidua*. The five best provenances of *L. leptolepis* were

Village	Prefecture	Elev m	Avg height m	Avg dbh cm
Nakawa	Nagano	1920	4.32	4.8
Tsumakoe	Gumma	1900	4.31	5.5
Kawakami	Nagano	1500	4.23	4.7
Kilamaki	Nagano	1750-1800	4.21	4.7
Mitake	Nagano	1380	4.19	4.8

Survival ranged from 83 - 92% for all provenances. Porcupines showed a definite preference for *L. decidua* over *L. leptolepis* or *L. laricina*. In *L. leptolepis*, no correlations were established between average heights and the seed source factors of latitude, longitude, or elevation.

Abies - (Christmas trees)

Abies balsamea (L.) Mill. free of damage by the balsam gall midge (*Dasineura balsamicola* Lint.) were selected by personnel of the Forest Insect and Disease Survey. These selections were made in areas where there were heavy infestations of this insect. Susceptible trees were also selected in each area for use as controls. Both the apparently resistant and the susceptible trees were propagated by rooting cuttings and by grafting. This material will be inoculated with gall midge to test further the apparently resistant clones.