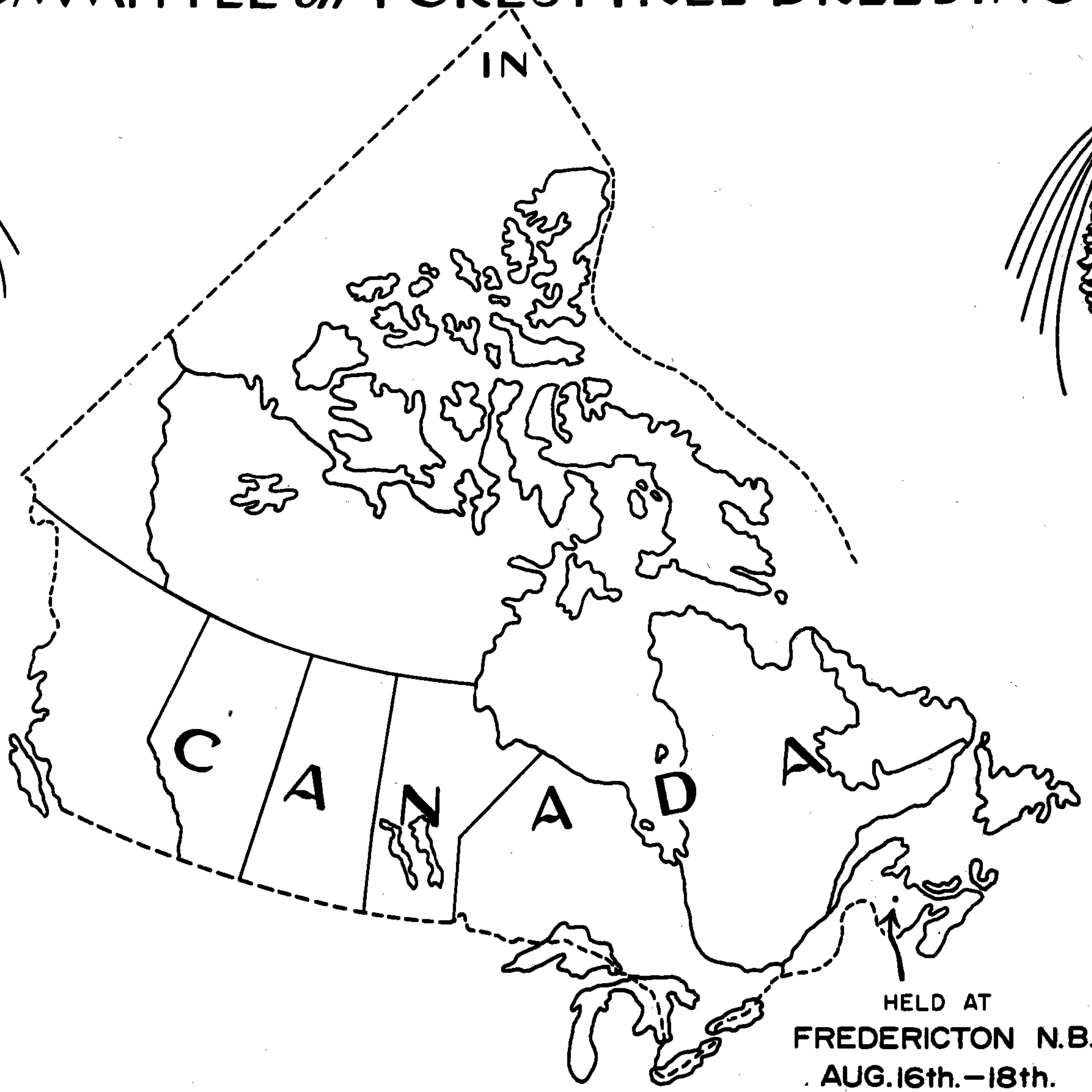
Proceedings of the Eighth Meeting

OF THE

COMMITTEE on FOREST TREE BREEDING

IN

CANADA



Part II

Progress Reports

PROCEEDINGS OF THE EIGHTH MEETING OF

THE COMMITTEE ON FOREST TREE BREEDING

IN CANADA

Held at the University of New Brunswick,
Fredericton, N.B., August 16-18, 1962.

PART II

MEMBERS' PROGRESS REPORTS

Assembled and Distributed by the
Forest Research Branch, Department of Forestry, Ottawa.

Part I, Minutes and Discussions, received restricted distribution to Committee members only. Part II received wider distribution to persons and organizations actively engaged or interested in forest tree breeding and improvement.

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Report to Committee on Forest Tree Breeding

1962

Michael G. Boyer

Canada Department of Forestry
Maple, Ontario.

One request by tree breeders with respect to white pine blister rust work has been for methods of selecting seedlings and grafted material which would establish with certainty the resistance or susceptibility of the host. While probably the most effective method would involve the characterization of the rust resistant factors, the aspect we are at present investigating, techniques of inoculation could perhaps be improved. During initial studies on the physiology of the disease some techniques of inoculation were investigated to provide information on specific aspects of the disease. Four were attempted on white pine seedlings in the laboratory; a) pre-germinated teliospores prepared by removing telia from *Ribes* leaves incubating on 2 per cent water agar at 16°C for 12 hours and applying them to parts of the seedling, b) aeciospore inoculation of leaves and stems with and without wounding and with or without *Ribes* leaf extract, c) implantation of diseased leaf tissue in the hypocotyl region of the seedling and, d) inoculation with excised *Ribes* leaves.

Infection was attempted by incubating seedlings at 15°C in the dark for five days in closed containers. Number of inoculations and successful transmission are indicated in Table I. A brief discussion of each method follows.

Table I

Effect of method of inoculation on infection of white pine seedlings

Number of Seedlings	Method	Place of Inoculation	Number	Number infected
50	aeciospores*	hypocotyl	50	0
6	"	cotyledons	20	0
10	"	primary leaves	23	0
66	excised telia	cotyledons	122	2
	"	primary leaves	120	5
	"	true leaves	100	4
	"	hypocotyl	21	0
34	infected white pine leaves	hypocotyl	34	3
24	Ribes leaves			24

*Methods of aeciospore inoculation are not listed completely because none was successful.

Inoculation with aeciospores

Scholz's report* that aeciospores caused canker-like infections when wound inoculated on white pine stems suggested a possible simple method of infecting seedlings. As a consequence seedlings were inoculated at various locations (Table I) either directly without wounding or by brushing viable aeciospores into a small longitudinal wound made with a sharp scalpel. An extract of Ribes leaves was included in some inoculations. To complement this study field inoculations were carried out on 50 first, second and third year shoots of approximately 15-year-old white pine. Under these circumstances no infection developed after five months although germination of aeciospores in the wounds were observed in all embedded material. Since in the case of seedlings infection could be induced on all parts by other methods it would appear that infection may be attained only under more restricted circumstances.

Inoculation with excised telia

The purpose of using excised telia was two-fold. By selections of vigorous productive telial columns it was hoped to be able to assure infection at any point and also to study the effect of distance of inoculum from the stem. Since viable telial columns were selected and transfer after 12 hours to 2 per cent water agar resulted in the active production of sporidia the failure to obtain a higher incidence of infection is puzzling. Penetration of sporidia on hypocotyls was observed frequently. Further work has been limited by space, and modification of the method has not been attempted as yet. However, it has been possible to show that all of the leaves are susceptible and while no infections on the hypocotyl were observed the fact that sporidial penetration was evident suggested that some resistance to sporidial infection is present.

Inoculation with the diseased pine leaf sections

Attempts to inoculate seedlings by transfer of thin sections of diseased leaf tissue into the pith region at the base of the cotyledonary node was prompted by the observation that the transfusion tissue of first year leaves promptly forms callus when wounded and placed in a high humidity. The possibility of grafting infected tissue to seedlings was considered. The technique involved the transfer of approximately one mm. leaf sections in which the fungus was located in the transfusions tissue into the base of the node by making a longitudinal incision and inserting the leaf section in such a way as to obtain contact between the pith cells of the hypocotyl and the transfusion tissue of the leaf. In two of the three successful transfers examined in detail the fungus had apparently moved directly into the proliferating cells of the pith and from thence into the ray cells of the xylem. Of the 34 inoculations (Table I)

* See Scholz, E. 1960. Zuchter 30(2), 61-72.

made at about 2 weeks after germination (the cotyledonary stage) none died and further growth impediment was slight or not observable. Failure to obtain a higher incidence of infection was investigated with free-hand material. In most cases the inability to obtain contact between the tissues either because of improper placement of leaf sections or because the leaf sections were not cut at right angles appeared to be the primary cause of failure.

Inoculation with excised leaves of Ribes

This method which has been used frequently in the past was employed to determine if the conditions used for inoculation, i.e., 5 days at 15°C in the dark, were satisfactory. Of the 24 seedlings inoculated 100 per cent exhibited dense multiple infections within one month.

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ONTARIO
DEPARTMENT OF LANDS AND FORESTS

Toronto, Ontario

REPORT TO COMMITTEE
ON
FOREST TREE BREEDING

August, 1962

Hon. J. W. Spooner
Minister

F. A. MacDougall
Deputy Minister

J. A. Brodie, Chief
Timber Branch

REPORT TO COMMITTEE ON FOREST TREE BREEDING

August 1962

A. J. Carmichael

Ontario Department of Lands and Forests

1 PROVENANCE TESTS

A. Red Pine

A red pine provenance test composed of 12 Ontario seed sources was outplanted in 1956. Measurements of total height, after 10 growing seasons from seed, were made in fall 1961 at Cochrane, Sault Ste. Marie and Lindsay Districts in northern, central and southern Ontario.

Mean Height in Feet for Red Pine Sources

Provenance		Planting Location - Site Region		
Site Region	Locality	3E	5E	6E
3W	Port Arthur	1.6	3.1	3.9
4S	Eagle River	1.5	2.9	3.8
4E	Timagami	1.7	3.2	3.9
5E	Barry's Bay	1.5	3.2	4.0
	Douglas	1.7	3.3	4.1
	Golden Lake	1.7	3.2	3.7
	Mattawa	1.5	3.1	3.7
	Pembroke	1.7	3.3	4.0
	Thessalon	1.6	3.3	3.6
	Average	1.61	3.20	3.86
6E	Angus	1.6	3.1	3.9
	Bruce	1.7	3.2	3.8
	Kemptville	1.7	3.4	4.2
	Average	1.67	3.25	3.97
General Average		1.62	3.18	3.90

An analysis of variance was completed following the design prepared by Dr. D. B. DeLury. This indicated, first, that the experiment had failed to show any significant difference between the heights of different provenances at each of the planting sites; and second, that there was a highly significant difference between the heights of all provenances when grown in different Site Regions. The height of all provenances was greater in the southern planting.

SUMMARY OF ANALYSIS

Source	df	ss	ms	F	F.05
Bet. Climatic Regions	2	129.5	64.7	176.4	4.3 **
Reps. (Within Regions)	9	3.3	0.37		
Bet. Provenances	11	1.6	0.14	<1	2.45
Regions x Provenances	22	0.93	0.04	<1	1.84
Reps. (Within Regions) x Provenances	99	17.1	0.17		
	143				

B. Jack Pine

A jack pine provenance test composed of 12 Ontario seed sources was outplanted in 1955. Measurements of total height after 10 growing seasons from seed, were made in fall 1961, at Swastika and Pembroke Districts in northern and central Ontario.

Mean Height in Feet for Jack Pine Sources

Provenance		Planting Location - Site Region		
Site Region	Locality	4E	5E	Average
3W	Geraldton	5.8	5.5	5.65
	Kab Lake	7.0	6.2	6.60
	Pickle Lake	6.2	5.8	6.00
3E	Connaught	6.6	6.2	6.40
	Timmins	7.1	7.1	7.10
	Franz	6.1	6.0	6.05
	Mobert	5.6	6.3	5.95
4S	Sioux Lookout	7.3	6.6	6.95
4W	Goldie	6.8	7.2	7.00
	Hardwick	6.9	6.8	6.85
5E	Markstay	7.4	7.2	7.30
	Algoma	6.4	6.4	6.40
General Average		6.40	6.60	

An analysis of variance was completed following the design prepared by Dr. D. B. DeLury. This indicated, first, that the experiment had failed to show any significant difference between the height of jack pine grown in different site regions; and second, that there was a highly significant difference in the height growth of different provenances, when the region in which they were grown was not considered.

Summary of Analysis

Source	Df	ss	ms	F	F.05
Bet. Climatic Regions	1	1.16	1.16	3.24	5.99
Reps. (Within Regions)	6	2.15	0.35		
Bet. Provenances	11	27.84	2.53	4.71	1.94**
Regions x Provenances	11	4.60	0.42	< 1	1.94
Reps. (Within Regions)x Provenances	66	33.80	0.51		
	95				

11 SEED ORCHARDS

The emphasis on seed orchard establishment has been reduced currently in favour of the development of seed production areas. The present target is for 10,000 grafts to be carried out annually at five nursery locations (Sb 3000, Sw 3000, Pr 25000, Pw 1500).

Some changes have been made in grafting procedure to improve scion development. Grafts made at an earlier stage of stock plant development, seem to be beneficial for both spruce and red pine. Spruce are grafted when stock plant root activity is evident and before bud swelling occurs. Red pine are grafted when bud swelling is evident but before shoot elongation has progressed.

The release of developing spruce shoots from constriction within bud scales has been necessary and has resulted in greater survival with better shoot development.

Various methods for fall and early winter storage of understock have been employed to simplify maintenance procedures. Storage of stock growing in 5 inch clay pots has been carried out adequately in unheated sheds with limited natural light. Red pine and white pine have been carried over in excellent condition when no mulch was used on the pots. Some difficulties were experienced when pots and trees were covered with a conifer brush mulch. Further testing is indicated to obtain uniform results and these are being developed at each nursery.

The selection of orchard planting sites for spruce and pine has led to the examination of hardwood areas for the exclusion of foreign pollen. A few sites are available, however the difficulty in locating accessible areas that can be cleared at a reasonable cost, has indicated the possible value of using locations on large burned areas and controlling future planting around the orchard site.

111 SEED PRODUCTION AREAS

A. General

The selection of stands suitable for seed production area development has been hampered by the apparent lack of younger age classes. Therefore, older stands are being selected in which there are from 50 to 100 seed producing trees per acre at heights of from 40 feet to 80 feet. Cone collection from such trees will require the use of tree-climbing bicycles and thus increase seed collection costs. The use of truck or tractor-mounted ladders may be possible in some locations, however, stands of better quality are not always readily accessible and will require less cumbersome climbing equipment.

When tree-climbing bicycles are used extensively, it will be possible to train staff and develop collecting techniques that should enable more extensive collections from the better stands.

The development of plantations from selected seed sources offers one solution to the problem. Some white and black spruce sources are being grown for this purpose. A more extensive local development of select plantations, using seed from the best stands in the district, would provide ultimately for a cone collection source to supplement that from seed orchards and seed production areas in thinned natural stands.

B. White Spruce - Site Region 3W

A location at Pagwa in Geraldton District was scarified to induce seedlings beneath an excellent white spruce stand. Regeneration on the 20 acre block resulted in 20,000 seedlings per acre at the end of the first year. Subsequent counts have not been made, but there are still an adequate number of 2 year old plants.

C. Red Pine, Lynn Tract, Simcoe County

Trees of 12 ft. to 20 ft. in height were thinned to a 12 ft. x 12 ft. and an 18 ft. x 18 ft. spacing in 1957. Five years later the crowns of trees at the 12 ft. spacing again required release, whereas the 18 ft. spacing will be adequate for at least another 5 years and possibly 10 years. The 18 ft. spacing has been accepted generally for thinning in stands up to a 40 ft. height.

The seasonal changes in foliar nutrient levels are being examined on this area by Professor K. Armson. His work will determine the best sampling procedure to assess the nutrient capital of young red pine. When coupled with a measure of the tree's photosynthetic potential it should be possible to differentiate those trees that produce cone crops above their normal level and thus evaluate the true effects of fertilizer treatments.

The physiological factors involved in flower induction and the effects of fertilizer applications on these still need to be examined.

D. Wood Quality

The development of a black spruce seed production area from seed obtained at Parnell Township in Kapuskasing District, necessitated the felling of 32 trees for cone collection. Each of the felled trees was sectioned and blocks 1 foot in length were taken to represent each 100 inch level above the ground. Blocks were measured to develop stem analyses for each tree and then shipped to the Forest Products Laboratory in Ottawa for cellular examination.

REPORT ON TREE BREEDING - 1962

L. P. Chiasson
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After the loss of promising hybrid material in 1960, efforts were continued to produce interspecific Abies hybrids.

In the spring of 1960, the following exotic pollens were used on Abies balsamea female cones: A. cephalonica, A. concolor, A. homolepis, A. homolepis var. umbellata, A. koreana, A. lasiocarpa, and A. nordmanniana.

The hybrid seeds were collected in early September, 1960 and stored in a dry room over winter. They were stratified for a month at approximately 5°C, and then sown in specially prepared outdoor beds. These beds were covered with a double layer of cheesecloth, and were sprinkled once a day through the summer months.

Table I shows the results in terms of cones collected for each cross.

TABLE I

Putative Male Parent	No. of cones collected	Seeds germinated-1961
A. cephalonica	10	
A. concolor	17	
A. homolepis	303	X
A. homolepis var. umbellata	84	X
A. koreana	167	
A. lasiocarpa	70	X
A. nordmanniana	68	

The germination was extremely low not only for these potentially hybrid seeds but also for balsamea seeds that had been collected, planted and stored under identical conditions.

In the spring of 1962 the balsamea-lasiocarpa crosses seemed to be the only ones that had overwintered successfully, but more careful examination of the beds is required before a final assessment can be made.

In the spring of 1961, the only exotic pollen available was from A. nordmanniana. A crop of 49 cones presumably containing hybrid seeds were collected, and after stratification, have been planted this spring.

In the spring of 1962, the following exotic pollens have been used on balsamea ovulate cones: alba, cephalonica, cilicica, concolor, ernesti, Fraseri, homolepis, lasiocarpa var. arizonica, nephrolepis, nordmanniana, sachilanensis, sibirica, Veitchii. Only 92 ovulate cones were isolated this spring, as there was a scarcity of these and many of those that were visible were not available for isolation with the equipment at our disposal.

Investigation of the comparative cytology of Abies species is continuing in anticipation of obtaining confirmed interspecific crosses.

1960-61 Biennial Progress Report

Shelterbelt Tree Breeding

W.H. Cram,
Superintendent

Forest Nursery Station,
Canada Department of Agriculture,
Indian Head, Saskatchewan.

GENERAL

Drought conditions, which have prevailed since 1957, were unfavourable to the Nursery and Breeding research programs in 1960 and 1961. 1961 was the driest year on record for this station with an annual precipitation of only 7.5 inches. The frost free period of 1960 was 117 days (May 17 to September 10) and of 1961 was 112 days (May 13 to September 2) and the precipitations in these periods were 4.9" and 1.6" respectively. Heavy losses, due to drought and extreme temperatures, were noted for germination capacity, seedling stand and even mature stands of trees in permanent plantings.

Staff changes included the appointment of Dr. R. Grover in October 1960 as Plant Physiologist, to conduct Herbicidal and seed technology investigations related to tree production, and Mr. P.J. Salisbury, Pathologist in April 1960 to conduct investigations in disease problems related to tree production.

CARAGANA BREEDING

Evaluation of combining ability for self-incompatible selections continued to be the major phase of the Breeding program for *Caragana arborescens* Lam. Preliminary research led to the selection of vigorous self-incompatible plants from Indian Head material. These selections were cross-incompatible and therefore unsuited for planting in isolated natural-crossing blocks to mass produce intra-specific crosses. This demonstrated the need for new accession material to provide additional self-incompatible plants of genetic diversity and cross-compatible with existing material. Cross-compatibility of nine self-incompatible selections from accession material with pollen of five similar selections from Indian Head material was determined in 1961, with the results listed in Table 1.

Table 1. Cross-Compatibility[1] of 9 Self-incompatible Accession Selections with 5 Self-Incompatible Local Selections of Caragana

Accession Selection	Source	Indian Head Selections (♂) A1	V16	V17	B24	V2
(♀)	(country)	(%)	(%)	(%)	(%)	(%)
D10-13	Sweden	0	0	0	0	0
D11-8	U.S.A.	0	0	0	0	0
D14-71	Czech.	0	0	0	0	0
D16-3	France	0	0	0	0	0
D16-10	France	0	0	0	0	6
D14-26	Czech.	0	0	0	0	19
D14-13	Czech.	0	2 ?	0	0	50
D14-112	Czech.	0	0	0	17	48
D14-12	Czech.	0	0	11	15	17

[1]Compatibility as % of cross pollinated flowers setting pods
?Extreme deviate may be contamination due to protruding flowers

The nine selections listed in Table 1 were made in 1959 and 1960, by selfing 140 vigorous plants produced from eight seed accessions. Regretably the 1961 breeding program was seriously disrupted and the results distorted by the prevailing drought and high temperatures. Nevertheless, cross-compatibilities listed in Table 1 suggest four of the accession selections carry the same incompatibility factors as five local selections, and are of the genotype S_1 S_2. However, five of the accessions appear to carry one or more different incompatible factors, which permit cross-compatibility with pollen from three local selections. These accessions offer promise as parental material for the establishment of natural-crossing blocks. In the next few years, it will be necessary to repeat and confirm these 1961 compatibility tests, propagate the selections by cuttings and evaluate the vigor potential of hybrid progenies for all possible combinations.

Relative vigor of hybrid caragana progenies, when evaluated in terms of plant height, was found to change until the seedlings reached sexual maturity after 6 years of growth. Height data, as recorded for eleven polycross progenies after 3, 4, 5 and 6 years of growth from seed, have been summarized in Table 2. Relative vigor, as portrayed by the juvenile seedlings after 3 and 4 years of growth, was maintained beyond sexual maturity for only one of the eleven progenies, namely for V-13. On the other hand that of all other progenies changed in the 5th and 6th years of growth. This change was slight or gradual for some progenies but extreme for others. For example the vigor rankings for the polycrosses V-2 and 21-28 changed from fourth and first place to second and third place, respectively, in the 5th and 6th year, whereas that of 21-31 changed from eleventh to first place. As a result ratings for the vigor potential of hybrid caragana progenies should be postponed until the seedlings attain sexual maturity after 6 years' of growth.

Table 2. Comparative Mean Heights and Rankings of Heights[1] for Eleven Polycross Progenies as 3, 4, 5, and 6 year-old seedlings.

Polycross progeny	Height in centimeters				Rankings for Height			
	3Yr.	4Yr.	5Yr.	6Yr.	3Yr.	4Yr.	5Yr.	6Yr.
21-31	54	80	145	194	11	11	2	1
V-2	73	109	143	187	1	1	4	2
21-28	72	109	148	184	2	2	1	3
21-16	64	98	140	181	7	8	6	4
V-15	68	97	136	178	6	9	8	5
A-1	69	102	142	177	3	3	5	6
A-3	59	99	134	176	9	7	9	7
21-27	68	100	144	173	5	6	3	8
V-16	68	101	140	171	4	5	7	9
V-13	59	92	130	166	10	10	10	10
21-32	64	102	114	156	8	4	11	11

[1]Mean height of some 40 seedlings for each year and progeny

Pollen viability and storage investigations were continued for caragana in 1961. One study involved the influence of sucrose content of water-agar culture media on pollen germination. Pollen from two selections of caragana (V16 and V17) was incubated in petri dishes on 2% water-agar media with 1, 5 and 10% sucrose content. Germination was recorded after 5, 20, 52 and 76 hours of incubation with the results given in Table 3. Germination of pollen increased with each increment

Table 3. Pollen Viability[1] for Two Caragana Selections at Three Sucrose Levels

Incubation Period[2] (Hrs.)	A-2 1% (%)	A-2 5% (%)	A-2 10% (%)	V-17 1% (%)	V-17 5% (%)	V-17 10% (%)	Means
5	45	42	56	32	40	70	47.4
20	26	40	69	45	56	77	52.1
52	26	53	63	24	63	88	52.6
76	43	41	65	33	53	88	53.6

[1]Viability as % germination in one field across petri dish

[2]Then sample removed and stained with Aceto-carmine for recording germination

in the sucrose content of the agar media for both selections and for all periods of incubation. The data showed that germination after 20 hours of incubation on 2% water-agar substrate with 10% sucrose provides a reliable measure of pollen viability for caragana.

Viability of pollen from bud and bloom stages of caragana after two types of storage at two temperatures was investigated. Buds in full color and freshly-opened flowers were harvested from one selection (V17) on June 1st. These were placed in manila paper and polyethylene bags, then stored at 0° and 40°F. Pollen samples were taken from these buds and open flowers after 7, 13, 28 and 42 days of storage, and the germination recorded after incubation for 24 hours at 70°F on 5% sucrose-agar medium. The following conclusions on viability of caragana pollen were drawn from the results of this study: -

(1) Storage temperature at 40°F was superior to that of 0°F;

(2) Storage in paper bags was better than storage in poly bags;

(3) Pollen viability decreases rapidly from 66% to 8% after 13 days of storage;

(4) Buds in full color if stored in paper bags at 40°F seem to provide the best pollen for extending the period for cross-pollinations in a caragana breeding program.

Four types of media were investigated for the rooting of softwood caragana cuttings in 1960. In all cases the rooting media were placed in wooden flats and cultured on heating cables under intermittent mist. Shoots were collected from one clone at 5 bi-weekly intervals from June 8 to August 3 and made into 4" terminal and basal cuttings. Ten cuttings of each sample of 20 cuttings were dipped in 'Rootone' hormone just prior to planting. Records for rooting were taken 21 days after planting and are summarized in Table 4. Rooting was greatest (38%) in a pure medium of local screened sand, and next highest in Flint-shot Ottawa-silica sand. Peatmoss additives had no beneficial influence, whereas applications of Rootone hormone materially increased rooting.

Table 4. Rooting[1] for Terminal and Basal Cuttings of Caragana in Four Media with (+) and without (-) Hormone Treatment

Rooting media	Terminal +	Terminal -	Basal +	Basal -	Media Means
Local screened sand	26	4	72	52	38.5
Ottawa sand Flint shot	2	6	74	52	33.5
Local sand & moss	28	4	44	40	29.0
Ottawa sand & moss	10	16	46	28	24.5
Means	16	7	59	43	

[1]Mean value for 10 cuttings & 5 dates as % of number planted.

SPRUCE BREEDING PROGRAM

Self- and open-compatibility was determined for 31 selections of Colorado spruce (*Picea pungens*) in 1960. Self-compatibility of these trees ranged from 0 to 46 seeds-per-cone and averaged 12; while open-compatibility ranged from 0 to 118 and averaged 51 seeds-per-cone. This wide range for self-compatibility in the species suggests the potential use of self-incompatible lines for the breeding program.

Open-, cross-, and self-compatibilities were also investigated for nine selections of Colorado spruce, which had differed as to self-compatibility in 1959. Two previous selections, RC1 and RC2, which were outstanding for 'blue' needle color, were utilized as pollen parents to test relative cross-compatibilities and subsequent inheritance of needle color. Colorado spruce produced few flowers in 1960 so that it was impossible to conduct all the desired pollinations. The results for 1959 and 1960 appear in Table 5.

Table 5. Open-, Cross-, and Self-compatibility[1] for Nine Selections of Colorado Spruce in 1959 and in 1960

Seedtree	Open-pollination[2] 1959	Open-pollination[2] 1960	Cross- 1960 RC-1	Cross- 1960 RC-2	Self-pollination 1959	Self-pollination 1960
	(%)	(%)	(%)	(%)	(%)	(%)
NC4-5	87.4	50.0	0	0	1.4	0
NC5-23	65.3	41.5	8.0	14.6	3.5	0
NC5-25	128.0	67.0	14.5	34.0	0.6	0
NC4-51	29.4	15.5	37.0	-	1.5	0
NC5-28	144.8	-	42.7	4.6	32.4	0
NC4-18	33.3	29.5	0	25.0	0.0	*
NC4-60	61.4	53.8	13.2	15.5	0.0	2.5
NC5-16	100.6	75.6	10.8	43.8	4.5	6.8
NC5-58	44.0	28.3	33.8	45.0	1.2	-
Weighted Means	68.5	51.6	15.4	26.1	5.4	1.5

[1]Compatibility expressed in terms of the sound seeds-per-cone
[2]Seed set reduced by losses due to pre-harvest shedding of seed
*No male flowers in 1960, - - no data available.

Seed set was generally less in 1960 than in 1959. For example the average set from open-pollination in 1960 was 45 seeds-per-cone, only 66% of that for the same trees in 1959. Nevertheless, the efficiency of the techniques for artificial cross-pollinations approached 40% of that for natural open-pollinations, despite possible cross-incompatibility interactions. Differential seed sets for pollen of RC1 and RC2 with the seedtrees NC5-28 and NC4-18 suggest that degrees of cross-compatibilities exist within the species. Failure of both pollens to effect seed-set with the seedtree NC4-5 indicates the possibility that cross-incompatibilities exist within the species. However, inconsistency of the seedsets following self-pollination of six trees in 1959 and 1960 demonstrates a need for further research to ensure comparable results from year to year.

Self-compatibility was determined for 41 selections of Colorado spruce in 1961 and in addition self- and cross-compatibility were checked for 10 selections showing low self-compatibility in 1960. Regretably, drought, heat and seed insect problems seriously disrupted the 1961 spruce breeding program and generally reduced seed set. These results suggested precautions must be taken in the future to reduce insects and temperatures within isolation bags.

Survival, height and needle coloration data were recorded in 1961 for 13-year-old plants in open-pollination progenies of 24 Colorado spruce selections. Similar data were recorded for these plants in 1953, and height data were compiled in 1956. The results have been listed in Table 6. An average survival of 91% demonstrates the ability of Colorado spruce, which had become adequately established under favorable conditions from 1954 to 1956, to withstand subsequent adverse conditions while in the juvenile stage. Blue coloration of the needles of 13-year-old plants bore no relationship to that of the same plants when 5 years old. All plants of three progenies exhibited some degree of blue needle color, and only three progenies had high average color ratings exceeding the mean. Height of plants after 13 years of growth was closely related to that after 8 years of growth as indicated by a correlation coefficient of 0.88.

Table 6. Performance of 24 Open-pollinated Progenies of Colorado Spruce Selections as 5-, 8-, and 13-year-old Plants in 1953, 1956 and 1961.

Progeny & Selection	Survival[1] 1961	Blue Sdlgs[2] 1953	Blue Sdlgs[2] 1961	Blue[3] rating	Average height 1953	Average height 1956	Average height 1961
(no.)	(%)	(%)	(%)		(cm)	(cm)	(cm)
42-8	80	55	93	2.7	14	29	60
40C-18	48	3	83	2.1	16	25	67
47-19	57	0	80	2.0	14	20	71
40C-223	72	9	89	2.2	16	27	81
RC-3	100	25	76	2.2	17	38	84
OC-1	96	27	100*	3.3*	14	30	90
40C-249	84	2	100*	2.3	17	34	104
PC-4	96	9	83	2.9	16	33	105
40C-41	96	5	96	2.2	17	37	110
EC-6	91	7	69	2.3	14	38	113
40C-24	83	16	62	2.1	16	35	121
EC-1	97	5	97	2.6	13	35	124
42-7	100	10	61	2.1	15	43	128
40C-13	97	21	97*	3.6*	15	39	130
40C-25	100	12	96	2.1	16	39	132
42-6	94	36	73	2.7	17	41	134
40C-81	100	17	91	2.6	17	38	134
RC-5	100	18	89	3.0	17	37	137
40C-10	91	20	89	3.0	16	40	138
40C-22	100	8	93	3.3*	17	42	140
WC-3	97	29	65	2.8	16	42	143
40C-1	100	4	97	2.3	17	41	149
EC-2	100	10	58	2.6	16	40	150
40C-221	97	19	100*	2.7	20	50	169
Means	91	11	85	2.3	16	37	117

[1]Plant survival as % of original planting in 1954
[2]Percentage of plants with any evidence of Blue needle coloration
[3]Average blue rating of plants on a 1(green) to 5(intense blue) basis in 1961
*Dominant blue needle-color factors carried by seedtree

It would appear the potential of Colorado spruce progenies could be estimated from the height of the plants at 8 years of age. This may provide a short cut for the early evaluation of the vigor potential of specific hybrid combinations. Two selections (RC-1 and 40C-13) seem to carry dominant factors for blue needle color and produce only blue progeny averaging 3.3 to 3.6 for color density.

<u>Viability of spruce pollen</u> was determined in 1961 on 2% water-agar media with four levels of sucrose content. Fresh pollen from two trees of Colorado spruce and a mixture from several white spruce were dusted on the agar media in petri dishes and incubated at 70°F for 24 hours. Then the dishes were flooded with aceto-carmine stain and the germination recorded with the results listed in Table 7. It was evident the addition of sucrose to the water-agar media

increased germination and so provided a more reliable estimate of pollen viability. The results suggest the best germination medium tested for spruce pollen was 2% water-agar with 5% sucrose.

Table 7. Germination for Pollen of Colorado and White Spruce on Water-agar Media with Four Levels of Sucrose.

Sucrose levels	Colorado RC1	Colorado NC5105	White (mixture)	Means
(%)	(%)	(%)	(%)	(%)
0.0	23	32	28	28.8
1.0	29	45	45	39.8
5.0	53	75	75	69.1
10.0	51	70	76	65.0
Means	39	55	56	50.7

In another study, pollen from two selections (P-9& NC4-60) was dusted on sucrose-agar media in petri dishes and incubated at 70°F and 90% humidity for 6 to 60 hours. Records for the resulting germination and growth of the pollen have been summarized in Table 8. From these data it is evident that germination of one pollen (NC4-60) started 14 hours earlier than that for the other (P-9). On the other hand, the rate of pollen tube growth for the latter was greatest after 27 hours of incubation, and for the former after 31 hours. No increase in the germination capacity or viability was evident for either pollen after 22 hours of incubation.

Table 8. Viability and Growth of Pollen from Two selections of Colorado Spruce on Sucrose-agar Media after Six to Sixty Hours of Incubation

Hours after pollination	Viability[1] P-9	Viability[1] NC4-60	Growth[2] P-9	Growth[2] NC4-60
	(%)	(%)	(u)	(u)
6	0	0	0	0
8	0	36.3	0	15
10	0	63.6	0	28
12	0	63.6	0	41
22	50	90.9	41	96
27	60	90.9	88	122
31	60	90.9	122	166
36	60	90.9	149	209*
46	60	90.9	204*	268*
54	60	90.9	219*	287*
60	60	90.9	219*	301*

[1]Percentage germination for same field of pollen
[2]Average length in microns of pollen tube for same field
*Some mold and tubes bursting

A second viability test was conducted using pollen from all 39 seed-trees involved in the 1960 breeding program. Pollen samples were cultured on a sucrose-agar media and incubated for 24 and for 48 hours, after which the pollen was stained with aceto-carmine and the germination recorded. Germination after 24 hours of incubation ranged from 20 to 80% for a mean of 56%, and after 48 hours incubation ranged from 18 to 93% for a mean of 56%. Germination data for 24 and 48 hours were highly associated as indicated by a correlation value of .885. As a result of these two pollen studies it was evident viable pollen was used for all controlled pollinations of Colorado spruce in 1960.

Self-pollination seed, which was produced by 27 self-compatible trees of Colorado spruce in 1960, was sown in the greenhouse in January 1961. Only one of these trees, PC-26 was found to carry the recessive factor for albinoism, and the selfed seed produced 27 green to 8 albino seedlings. Survival and height data were recorded for two inbred and four hybrid progenies of Colorado spruce, which were started in the greenhouse in 1957 and transplanted to the field in 1959. The hybrid progenies of both selections manifested four times the survival and from 20 to 134% greater height growth than the respective inbred progenies.

Efficiency of seven types of isolation bags for spruce breeding were investigated in 1961. Three weaves of cotton and four treatments of cellulose bags were compared for isolation and controlled pollinations on two trees of White spruce. Two of the three cotton bags provided ineffective isolation, while all treatments of cellulose bags proved highly efficient. Cellulose bags, which had been painted with aluminum, proved most satisfactory. This treatment prevented excessive temperatures within the bag, being only 83°F as compared to 92°F for clear cellulose and 81°F for open air temperatures under the extreme conditions prevalent in 1961. Seed set within the aluminum-painted cellulose bag was generally superior to all other cellulose treatments, but on the other hand only approached 50% of that for natural open-pollination. It would appear the southern exposures of cellulose isolation bags should be painted with aluminum for future spruce breeding work to offset adverse effects of high temperatures from sun radiation.

Germination capacity of Colorado spruce seed at four temperatures was investigated for four seedtrees and four pre-sowing treatments with the results listed in Table 9. It was evident that moisture content of the seed was not materially increased after 15 days of stratification at 41°F even by soaking in water. Both stratification and soaking treatments improved germination capacity of spruce seed, but only under certain temperatures. Generally, stratification proved a superior treatment to soaking for seed of Colorado spruce. Germination for non-stratified seed of Colorado spruce was equal to that for stratification at a temperature range of 75 to 80°F, and inferior at temperatures from 54 to 71°F. Thirty days of stratification is required if Colorado spruce seed is germinated at temperatures below 67°F. Temperatures of 89 to 95°F completely inhibited the germination of this seed.

Table 9. Average Germination for Colorado Spruce Seed at Four Temperatures After Four Pre-sowing Treatments.

Seed treatments	Seed[1] Moisture	Temperatures[2] and Germination[3]			
		93°	77°	68°	61°
	(%)	(%)	(%)	(%)	(%)
nil (check)	6.6	0	91	75	17
Strat. 15 days	31.2	0	91	90	91
Strat. 30 days	32.3	0	95	88	96
Soak 30 days	32.6	0	78	62	74

[1]Moisture content of seed after treatment
[2]Temperature ranged from 89-95, 75-80, 62-71 and 54 to 66°F, respectively
[3]Germination capacity as % emergence in 35 days

PROVENANCE TRIALS

Two co-operative provenance studies of Scots pine were planted to the field in 1960 and 1961. Some 2,000 seedlings involving eleven provences from M, Holst of Petawawa were planted in 1960 into 20 replications of single-plant plots and three replications of 50 plants per plot. Seedlings of the provenance from Orel, Russia, have exhibited the greatest vigor and survival to date. A

1961 planting involving 25 replicated single-plant plots of 31 Russian provenances was destroyed by drought conditions and replanted in 1962 with an average survival of 92%

Only 1.9% of a 1960 planting, involving 600 seedlings each of 13 Norway spruce provenances from M. Holst, have survived to date. This planting suggests that none of the Russian-Swedish-Siberian-Polish strains of Norway spruce involved can survive the extremes of a mild winter (1960-61) and summer drought (1961) in the prairies even under irrigation.

Nineteen provenances of White spruce from Dr. H. Nienstadt of the Lake States station were transplanted under irrigation in 1960 with an average survival of 17% to date. This material has been severely ravaged by a mild winter and extreme drought. Results to date suggest some provenances of Quebec, Ontario and New York have greater tolerance to adverse climatic conditions than those of Saskatchewan and Manitoba.

A high mortality of conifers in plantings and natural stands appeared to be general throughout the prairie provinces in 1961. Losses were serious in old established plantings, especially for White spruce and to a lesser degree for Colorado spruce and Scots pine. These results suggest Scots pine may be more resistant to prairie drought conditions (high temperatures, salinity and insects) than are White or Colorado spruce. Research has been undertaken to determine the factors inducing needle-burn and mortality of conifers in this region.

Biennial Report to Committee on Forest Tree Breeding in Canada

May 1962

B. W. Dance
Laboratory of Forest Pathology
Southern Research Station
Maple, Ontario

Testing Poplars for Disease Resistance

In 1960 and 1961, techniques were tested for inducing disease in poplar species and varieties, and for assessing the resistance of these hosts to different pathogens whose life histories were studied. These tests were conducted at the Petawawa Forest Experiment Station, Chalk River, Ontario.

Emphasis was on three pathogens: Gloeosporium sp., Hypoxylon pruinatum (Kl.) Cke., and Dothichiza populea Sacc. & Briard. However, studies on other potentially import pathogens either were kept active, or initiated.

1. Gloeosporium sp. on Populus alba X grandidentata

Studies were conducted to determine when Plagiostoma populi Cash & Waterman, the suspected ascigerous state of this foliicolous, imperfect fungus, discharges ascospores suspected of initiating springtime infections. Starting on June 23, 1961, spore traps were set out daily in the presence of perithecia-bearing, overwintered leaves of the hybrid host. This date was selected because, in the previous year, microscopic observations indicated that ascospores did not mature until mid-June.

While the ascospores were trapped regularly in moderate numbers, no peak period of spore dispersal was detected. Instead, with only minor variations, the numbers of ascospores trapped daily declined steadily until July 24-28 when no spores were obtained and trapping was concluded.

Therefore it was considered likely that, contrary to earlier indications, most spores were released prior to June 23, and that infections probably occurred sometime between leaf emergence in May and mid-June, before the majority of leaves matured. Trapping will be conducted in late May and early June, 1962, in an attempt to confirm this conjecture. Meanwhile, data will be collected, as previously, on rainfall, temperature, and relative humidity.

It was determined that sporulating acervuli develop from mid-August onward for an undetermined period prior to leaf fall. However, since no new infections resulted from the micro-conidia released, it was concluded that these spores have only a spermatial function and, therefore, that the fungus requires the entire growing season to complete one cycle of the parasitic phase of its life history.

From these observations it seems evident that ascospores only, rather than conidia, are likely to be effective in starting artificially induced infections designed to demonstrate variation in disease-resistance between different clones of P. alba X grandidentata.

2. Hypoxylon pruinatum

Artificial inoculations were carried out with this pathogen to determine which types of inocula and infection techniques are effective in starting artificially produced infections on Populus tremuloides Michx., P. grandidentata Michx., and P. tremula L.

Inocula used were ascospores, conidia, and mycelia. Ascospores were discharged directly from perithecia onto exposed cambia; conidial suspensions were injected into unwounded bark, or painted onto exposed cambia and crushed bark; and, mycelia in agar were placed on exposed cambia and covered with moist cotton and tinfoil.

In November, 1961, a series of inoculations was made with mycelia inserted into bark wounds. This test was intended to show if, as has been reported, trees are most susceptible to infection during periods when the bark moisture content is low.

Of 53 inoculations with H. pruinatum made in 1959, 12 may have caused infections by late 1961. In six of these, cankers were well-advanced (1-foot-long) and nearly girdling the stems. Furthermore, stromata had formed with perithecia and maturing asci. In every instance, the control remained healthy. These cankers had resulted from mycelial inoculations, and were consecutive in the same series. It seems significant that these most successful inoculations were made in mid-September, and constituted the last of the series that year, because bark moisture content at that time probably was lower than in trees inoculated earlier and which remained healthy.

Recovery of the ascigerous stage from inoculations, and the healthy condition of the controls in late 1961, proves that these artificial inoculations were effective in starting infections. Furthermore, the observed infection period of more than two years agrees with the results of other investigators.

It may be concluded from these tests that ascospores, conidia and mycelia of H. pruinatum are ineffective in starting infections if they are used as inocula on wounded bark during periods of high bark moisture content and with the inoculation techniques used in these experiments. However, it is indicated that a high percentage of infections can be secured with mycelia in wounded bark if the inoculations are made in mid-September, and probably subsequently, when the bark moisture content probably is decreasing.

In 1960, twenty-one inoculations were made with H. pruinatum in the field, on saplings of trembling and large-toothed aspens. Conidial spore suspensions were brushed onto bruised bark. These were examined in August, 1961, but no infections had developed.

In 1961, 70 inoculations were made in the field using conidial and ascosporic suspensions. These were injected into nail holes in the park. By November, incipient infections were evident.

3. Dothichiza populea

To confirm and extend the significant results obtained in 1959 with this pathogen, a massive testing program was executed in 1960. Three hundred and eight, terminal shoots were inoculated in the field with conidial spore suspensions prepared from pycnidia that had developed on the 1959 series of inoculations.

In 1961, most of these inoculations were microscopically inspected for fruiting structures of the pathogen. With only a few doubtful exceptions, the inoculations were uniformly negative.

No explanation is evident for this reversal of results from those previously obtained. However, defective inoculum may have been responsible.

In the 1961 series, the following poplar species and varieties were inoculated:

> Populus tremuloides, grandidentata, balsamifera, deltoides, candicans, tremula, canescens, alba, nigra, Simonii, tristis, koreana, generosa, Rasumowskyana, cathayana, berolinensis, Jackii, robusta, alba X grandidentata, Maine, Geneva, Gelrica, Vernirubens, Carolina, Roxbury, Strathglass, Northwest, Calgary and Brooks.

4. Other Studies

Investigations were continued, or initiated, on fungi having incompletely understood life histories.

(a) Progress was made in establishing the taxonomic status of a new Venturia sp. on P. alba X grandidentata.

(b) A lethal stem canker on large-toothed aspen, caused by Nectria sp? was studied.

(c) The ontogeny and morphology of Marssonina populi (Lib.) Magn., prevalent on P. alba X grandidentata, were investigated.

(d) The orange stain and cambial streaking conditions in clones of P. alba X grandidentata heavily attacked by Gloeosporium sp. was studied.

PHYSIOLOGY OF FLOWERING AND CONE PRODUCTION IN DOUGLAS FIR, 1960-61

by L. F. Ebell

Two replicated, randomized block fertilizer trials using single tree plots and containing 12 treatments had been established in July, 1957, partially refertilized in May 1958, and all trees refertilized in May 1959, in flower induction experiments. The July, 1957 applications were too late for flower bud formation, and although the effective treatments of the partial 1958 refertilization produced double the number of cones as the non-refertilized portion, no statistically significant cone induction response was obtained in 1959, a near record cone crop year. The nitrate nitrogen treatments of the 1959 refertilization produced highly significant cone crop responses in 1960 despite absence of natural cone production. Ammonia nitrogen treatments did not significantly elevate cone production until 1961, the second season after refertilization. Since growth responses were the same for both forms, it seems probable that nitrate nitrogen may promote specific metabolic responses favouring floral initiation. In 1962, the third season after refertilization, both forms produced highly significant cone crop responses, possibly indicating an increased turnover and elevation of nitrogen in the nitrogen cycle. Significant regressions of cone count on diameter growth of the previous season were obtained for the 1959-1961 cone crop years, but while the best cone production occurred on trees with average or better-than-average growth, the fastest growing individuals produced few or no cones. The basic data has been obtained for further investigation of this regression on material not confounded by cone induction treatments. A report, for publication, on the results to date from the fertilizer experiments has been prepared.

Biochemical analysis, conducted to date, on branch tissues from check and girdled trunks of double-trunked Douglas fir indicate heavy cone crop production induced on the girdled trunk was not preceded by higher levels of free sugars but was preceded by elevated starch food reserves. Part of the photosynthates confined to the crown by girdling were diverted to increased diameter growth. A specific micromethod of starch analysis, which is not influenced by hemicellulose pentosans or variations in amylose : amylopectin ratios due to anatomical or seasonal factors, has been developed for this work.

Two of six Douglas fir clones established by grafting in 1959 contained male and female cone-producing ramets in the spring of 1962. One of these clones was from an exceptionally heavy and reliable cone-producing parent tree, the other from a good cone-producing parent at the elevational limit of Douglas fir on a central Vancouver Island mountain. No evidence of flowering or cone production was found on the clones representing barren parental material.

Some members may recall that the first evidence of rooting of June, 1959 air-layers was uncovered at the August 1960 meeting at Lake Cowichan. Further examination revealed a rooting success of 20-40% on three trees on which layers had been placed on 2-3 year old branch wood. The layers on two other trees suffered from extensive breakage and suppression due to placement on thinner, one-year-old branch tissue. Although no further trials have been made it would seem essential to place Douglas fir air-layers no later than the latter part of April in order to obtain rooting within a single season. Due to extremely rapid callusing and bridging in the early spring it might then be necessary to re-girdle and re-apply rooting hormones.

Pollen sampling studies conducted in the 1958-1960 period have been concluded with the report cited below. One important conclusion is that it is unlikely that rainy weather can seriously impede pollination success. The bulk of the pollen of all species was invariably shed in only four to five days interspersed throughout the flowering period, regardless of whether the season was abnormally wet or unseasonably dry.

Submitted for Publication:

Ebell, L. F. and R. L. Schmidt. Influence of meteorological factors upon coniferous pollen production and dispersal on Vancouver Island, British Columbia.

APPENDIX G

Report to Committee on Forest Tree Breeding in Canada, July 1960–June 1962.

Faculty of Forestry, University of Toronto

by J. L. Farrar

1. Introgressive Hybridization in *Picea rubens* and *P. mariana*.

This study began with a comparison of twig characters of the progeny of certain stands grown by Mr. Mark Holst at the Petawawa Forest Experiment Station, Canada Department of Forestry. It was extended to include a field investigation of certain of the parental stands and other trees located from North Carolina to the University Forest in Haliburton County, Ontario. The study indicated that consistent differences exist between the two species with respect to morphology of fruit and twigs, and ecological relations. No differences were found in chromosome morphology. Hindrances to hybridization were attributed mainly to ecological isolation. The two species have likely co-existed since the Pliocene epoch. The variation between various populations was analyzed by Anderson's hybrid index method and pictorialized scatter diagrams. The analysis indicated that introgressive hybridization has occurred between the two species. In Quebec, black spruce seems to be essentially pure with the direction of gene flow being toward red spruce. In the Maritime provenances gene flow has occurred in both directions with a somewhat greater flow toward black spruce. Little evidence of introgression was found in the Northeastern region of the United States. The study is the subject matter of the thesis submitted by Mr. Morgenstern as one of the requirements for the Master's Degree in Forestry.

2. A Provenance study of seedlings of *Pinus banksiana*

Seedlings of nine provenances of jack pine from across Canada were germinated and grown in a growth chamber. The more northern provenances were more responsive to photoperiodic treatments than were the southern ones. The total dry weight, height, dry weights of leaves and roots, and dry weight per unit of nitrogen content were all positively correlated with the number of growing degree-days (base 42° F) in the locality of origin. The study was carried out by Mr. M. M. Giertych, using seed lots supplied by Mr. Mark Holst.

Publications

Giertych, M. M. and J. L. Farrar. 1961.
The effect of photoperiod and nitrogen in the growth and development of seedlings of jack pine. Can. Jour. Botany 39:1247-1254.

BIENNIAL REPORT - HARD PINE BREEDING

1960 and 1961

D. P. Fowler

Ontario Department of
Lands and Forests,
Research Branch,
MAPLE, Ontario.

The development of new types, resistant to the European pine shoot moth and superior in growth form and growth rate continued to be the aim of this project. During the academic year 1959-60 the writer was on educational leave from the Department of Lands and Forests. During this period the hard pine work maintained its status quo. No hard pine pollinations were made in the spring of 1960. In 1961 the pollination program was almost completely devoted to a study of the effects of inbreeding in red pine, *Pinus resinosa*.

Acquisitions: During 1960 and 1961 the following new clones and populations were acquired:

Species	No. clones	No. populations
P. resinosa	25	20
P. leucodermis	2	
P. radiata	5	
P. nigra austriaca x silvestris	3	
P. rigida x taeda		1
	35	21

Seeds and seedlings from 1959 pollinations: Controlled pollinations carried out in 1959 produced the following seeds and seedlings in 1960 and 1961 respectively:

Cross	No. Crosses	No. Flowers	No. Cones	No. Full Seed 1960	No. Seed to Germ.	No. Seedlings 1961
(densiflora x austriaca) x resinosa	1	118	52	36	36	32
" " x silvestris	1	98	51	577	100	98
" " x self	1	99	44	28	28	24
(austriaca x densiflora) x self	1	98	84	77	77	71
resinosa x (austriaca x densiflora)	1	79	41	10	10	7
silvestris x (densiflora x austriaca)	5	111	84	576	362	317
silvestris x (austriaca x densiflora)	1	25	18	3	3	3
nigra x silvestris	1	51	28	12	12	10
silvestris x silvestris (early flowering)	2	103	-	732	200	105
rigida x taeda	1	27	23	43	43	43
				2094	871	710

Effect of inbreeding: In the spring of 1961, 150 different red pine pollinations were made on 2068 flowers at Kane, Pennsylvania, the Lake Abitibi area, and Swastika and Chalk River, Ontario. The following pollinations were made:

Location	Origin	No. Trees	Number flowers pollinated Type Pollen: Self	Mixed Local	Mixed Maine	
Kane, Pa.	East. U.S.	4	55	56	57	
"	N. W. Minn.	4	58	58	62	
"	Central Wisc.	4	64	56	61	
"	N. E. Minn.	4	44	56	51	
"	N.E.Wisc.-S. Upper Mich.	4	43	47	47	
"	Head of Lakes	4	48	46	47	
"	Brainerd Cameron	4	39	46	40	
"	N. Upper Mich.	4	43	47	45	
"	Lower Mich.	4	56	53	52	
Northern Ont.	Lake Abitibi	4	59	58	53	
Central Ont.	Chalk River	5	78	111	89	
Northern Ont.	Swastika	5	66	86	91	
		TOTAL	653	720	695	2068
Central Ont.	Algonquin Park	2	76 flowers bagged but not pollinated.			

First cycle measurements were made on seedlings resulting from self and cross pollinations on five red pine trees at Vivian, Ontario in 1958. The results indicate that selfing had little or no effect on flower, cone, seed or early growth characters. These five trees are self-fertile and self-compatible. Seedlings resulting from self and cross pollinations of four additional trees pollinated in 1959 were not measured in 1961. Flower, cone and seed characters were not influenced by the type of pollen used in these crosses.

A small preliminary study of the effects of inbreeding in jack pine, <u>Pinus banksiana</u>, was initiated. The following crosses were made at the Southern Research Station:

No. trees	No. flowers pollinated	
	Self pollination	Cross pollination
5	136	128

<u>Selective fertilization in Pinus resinosa</u>: Two trees, one (#585), a known carrier of a recessive marker gene, and the other (#622), a possible carrier of this same gene, were used in this work. The following crosses were made in 1961:

Cross	No. flowers pollinated
585 x 585 (self)	9
585 x ½585 + ½ cross (four pollen mixtures tested)	35
622 x 622 (self)	24
622 x 585	24

<u>Vegetative propagation</u>: A grafting experiment, to determine if the cold period requirements of red pine could be satisfied by storing fall collected scions in a deep freeze, was carried out. Red pine scions were collected in early November of 1960 and stored in a deep freeze at -20^{o}C. Stored and freshly collected scions were

grafted on scots pine stock at two-week intervals from November 1960 to February 1961.

No significant differences were found (anal. of variance and anal. of covariance) between grafts made with stored and fresh scions for either survival or shoot production. Analysis of covariance, treating the relationship between survival, number of shoots and date as linear regressions, showed a significant regression between survival percentage and date (F = 4.90) and a highly significant regression between percentage of grafts producing shoots and date (F = 14.73). Survival percentages were 78% before January 1st and 46% after, and percentage producing shoots 57% and 12% respectively. It would appear from the experiment that the earlier grafting is done in the fall, the better, and that storage of scions in a deep freeze does not improve subsequent survival and growth.

Turkey Point planting area: The following clones and populations were planted at Turkey Point, Ontario in 1960 and 1961:

Species	No. Clones	No. Plants	No. Pops.	No. Plants	Purpose
P. resinosa	8	104			Plus trees, N.Ont.
			1	17	Observation
			6	270	Half-sib progeny test
P. nigra			5	360	Provenance test
			14	1172	Observation
P. silvestris			13	888	Freedom from Cronartium
			8	1750	Observation
P. thunbergii	2	17	2	876	Observation
P. densiflora erecta			1	583	Observation
P. densiflora x silvestris			10	389	Observation
P. silvestris x (densiflora x austriaca)			2	107	Observation
P. densiflora x thunbergii			1	440	Observation
P. nigra cebennensis x densiflora	1	1	1	4	Observation

Report to the Committee on Forest Tree Breeding in Canada

Tree Physiology Section

Petawawa Forest Experiment Station

D.A. Fraser
June 1, 1962

Apical and radial growth, and the developmental anatomy of vegetative and reproductive buds of white spruce were investigated. Apical growth of the leader occurred from mid-May until mid-July, that of the side branches from mid-May until late June or early July. Total apical growth of the side branches, in general, diminished with their distance from the leader. Initiation of radial growth started in the main axis behind the terminal bud and moved basipetally along the trunk. Cessation of radial growth followed the same order.

The apex of the vegetative bud which developed in late July or early August includes a central zone, a peripheral zone with needle primordia, and a basal zone of thick-walled cells. Reproductive buds could be recognized by early August as oblong structures with globose appendages. By mid-August, these appendages had differentiated into either pollen sacs with pollen mother cells in the male buds, or into bracts and ovuliferous scales in the female ones. The female cone entered winter with little visible internal differentiation. The formation of reproductive buds in white spruce was associated with higher than average day and night temperatures, together with more than average sunshine (usually associated with less rainfall).

Black and white spruce seedlings were grown for two years in growth chambers under extended photoperiods. Under continuous incandescent light, the black spruce grew 30 inches whereas the white spruce grew only 5 inches. Growth of both species was somewhat greater in the greenhouse, where the continuous light consisted of natural daylight plu light from a combination of fluorescent tubes and incandescent bulbs during the night period. Black spruce seedlings grown under continuous light in the laboratory during the winter were successfully transferred to an outside nursery in the spring and assumed there the normal seasonal periodicity of growth. Black spruce plants that were grown completely under a 24-hour photoperiod formed a terminal bud when transferred to a 16-hour photoperiod. The dormancy of this bud was broken when the needles were killed by high temperatures; apical growth continued then until new needles were formed. Apical growth of black, white, and red spruce seedlings in the nursery was significantly increased by a 24-hour photoperiod effected through supplementary illumination during the summer months.

. 2

Growth regulators (promoters and inhibitors) are being investigated by paper chromatography and *Avena* coleoptile assays. There was a high content of growth promoting substances in actively growing terminal buds with lesser amounts in lateral ones. The amount decreased as apical growth ceased in July and the terminal buds were formed. A growth inhibitor was extracted from dormant buds. This inhibitor also appeared in spruce and birch seedlings, when they were moved from long to short photoperiods in the growth chamber.

Paper chromatographic analysis of the ethanol extracts of spruce buds continues to elucidate the quality and quantity of free amino acids at different stages in the development of the apical meristem.

Oxygen uptake by buds of white and black spruce was determined in a microrespirometer. Increase of respiratory activity in the terminal buds at the top of the tree in May coincided with initiation of apical growth. The respiration of shoots destined to produce either vegetative or reproductive buds will be studied this summer.

Biochemical assay of bud homogenates was conducted to determine presence of enzymes considered active as terminal oxidases. Cytochrome oxidase activity was low. Ascorbic acid oxidase and polyphenol oxidase were present as active enzyme systems.

Publications:

FRASER, D.A. 1961. Transport of mineral nutrients in trees. *In* Recent Advances in Botany, 1311-1316, University of Toronto Press.

__________ 1961. Plant science in the service of man. The Crucible (Easter), 10-12. Abstract from a lecture for the annual meeting, Ontario Secondary School Teachers Federation, Dist. 25, Richmond, Ontario, October 28, 1960.

__________ 1961. Tree growth in relation to soil moisture. *In* Tree Growth, *Edited* by T.T. Kozlowski, The Ronald Press, New York, 183-204.

__________ 1962. Growth of spruce seedlings under long photoperiods. Canada Dept. of Forestry, Forest Research Branch, Tech. Note No. 114, 18pp.

__________ 1962. Apical and radial growth of white spruce (*Picea glauca* (Moench) Voss) at Chalk River, Ontario, Canada. Can. J. Botany 40: 659-668.

__________ and GAERTNER, E.E. 1961. Microenvironmental studies in Canadian forests. *In* Recent Advances in Botany, 1391-1396, University of Toronto Press.

__________ and GAERTNER, E.E. 1961. Use of radioisotopes in forestry research. *In* Recent Advances in Botany, 1381-1387, University of Toronto Press.

REPORT TO COMMITTEE ON FOREST TREE BREEDING

July, 1962

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The Assessment of Wood Quality of Trees Selected for Breeding Purposes

The program, as described in the report presented at the Seventh Meeting of the Committee for Forest Tree Breeding held at Cowichan Lake, B.C., August 21-23, 1960, has been continued with some changes in technique and a reduction in intensity of sampling and measurement.

Tracheid Length

Tracheid lengths were measured in detail in thirty-one trees. The normal pattern was a rapidly increasing tracheid length with an age from the pith followed by a period of less rapid increase. Based on age only without regard to growth rate, trees with high initial tracheid length did not always have longer tracheids at some distance from the pith than trees with shorter initial tracheids. Further study of the data is needed to clarify these relationships for the trees under study.

Because all of the trees studied rapidly reached a length of tracheid considered suitable for pulp and because of the great amount of routine work involved, further tracheid length studies will be confined to those trees for which progeny are available and on which the determinations of inheritability will be based.

Spiral Grain

Spiral grain was measured from pith to bark in 177 trees that are potential breeding material or are being used for genetic studies. It was not measured in all of the associated dominant trees collected along with the potential superior or plus trees. These associated trees were examined for purposes of comparison with plus trees to determine relative efficiency of site utilization, and comparisons of severity of spiral are of no value.

Within those trees measured an upper limit of 6° of spiral was set which corresponds to the permissible slope of grain of one inch in ten inches set out in lumber grading rules for construction grades. None of the trees selected as potential seed-orchard trees exceeded allowable limits. It was found that earlier measurements based on 0.16 inch diameter cores were frequently in error, apparently due to twisting of the cores during extraction. Cores collected with 12 mm. or 0.75 inch diameter borers appear to give a true reading.

Compression Wood

The presence of this defect was determined by the light-box method, and was found to be of limited occurrence and generally confined to the first few rings in the plus trees measured. These trees were selected for good form and straightness of stem and compression wood should not occur in them in large amounts. Material containing compression wood was excluded from calculations.

Age, Rate of Growth and Specific Gravity

Initially the age, rate of growth and specific gravity were determined for each radius of diametral core from pith to bark. The first ten years were measured in annual increments and the balance of each core in five-year increments. A pattern developed that showed great variability over the first ten years, frequently with very high initial values, but falling off to about ten years and then rapidly rising again. The period from ten years on gave relatively regular curves of specific gravity over age with a close approach to the final high level at about thirty-five years, although specific gravity of many trees was still increasing. Consequently the period ten to thirty-five years was chosen as a basis for comparison. Data from this period were used to draw regression lines for each radius. These were averaged to yield a single regression and, from this, the mid-point (22.5 years) was designated as the point of comparison between different trees. All comparisons were made within the limits of the population which was chosen as including those trees which had been measured. Through further mathematical treatment it was found possible to assign a comparative mathematical value on the scale 1 to 10 to each tree. It is proposed to try to integrate this into a numerical value for all tree characteristics.

Future Work

Recently the work of detailed measurement of collected cores was taken over by the Faculty of Forestry, University of British Columbia, under a grant from the Canadian Pulp and Paper Research Institute. The University is, in addition, undertaking to develop alternative or simplified techniques to speed up the obtaining of information. An analysis of the work done to date in this laboratory is being made.

Inheritability Studies

While the short-term objective of this study was the assessment of potentially superior trees for inclusion in seed orchards, the long-term aim is to study the inheritability of anatomical characteristics of various species. This work is still going forward.

The inheritability of wood quality is being investigated using several second-growth Douglas fir trees and their progeny from control-pollinated seed, including several apparently apomictic trees. A detailed analysis of the first parent has now been completed. This is a 22-year old tree 11.4 inches d.b.h.i.b. Two problems were studied:

1. The determination of stem tracheid length and specific gravity patterns with regard to age from the pith and height, and

2. The correlation of these features with branchwood.

The ultimate aim of such correlations is the accurate prediction of stemwood quality from branchwood in order to make possible the non-destructive evaluation of plus-tree progeny. Tracheid length and specific gravity were determined for stemwood at five levels, 4.5, 14.5, 24.5, 34.5 and 44.5 feet and for branchwood at the three upper levels. Measurements were recorded individually for the first 10 annual rings and thereafter in groups of five or less. Wood near the pith was measured in greater detail because the first material available from progeny will come from this area.

In general, analyses of variance for specific gravity regressions revealed no significant correlations between stemwood and branchwood, while those for tracheid length showed highly significant correlations. Progeny from this tree are available but measurements have not yet been made.

SUMMARY REPORT ON FOREST TREE BREEDING

1960 and 1961

C. Heimburger

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Research Branch,
MAPLE, Ontario.

Breeding work with white pine, aspen poplars, hard pines and white cedar was continued. Work with chestnut was reduced to a maintenance basis in 1961.

White Pine

Resistance to blister rust and weevil, and satisfactory growth form and growth rate were the main objectives in breeding. Acquisitions of new materials included scions of Idaho white pine showing high heritability of blister rust resistance, scions of *P. albicaulis* from Idaho, Alberta, California and Oregon, several *P. cembra* materials from Switzerland and a few clones of *P. flexilis*, *P. monticola*, *P. koraiensis* and *P. strobus*. The plantation of *P. koraiensis* at Orono, Ont. had an abundant cone crop in the fall of 1960 yielding 12 progenies in 1961. Selections from seedling populations screened for resistance to blister rust comprised 59 clones; of these, 30 clones were *P. griffithii* from high elevation in Pakistan and 25 clones were natural *P. griffithii* x *strobus* hybrids from the Arnold Arboretum. Hybridization in 1960 was centered on interracial work with native white pine, using pollen from one good tree at Pointe Platon, P.Q. on grafts of the same origin at Maple. Pollen of a promising

P. griffithii was received from Rochester, N.Y. and much of our pollen was used to determine the breeding value of our materials in respect to resistance to blister rust. A total of 86 intraspecific and interspecific crosses made in 1960 yielded 4,033 full seeds. A fairly large seed collection from resistant trees in Germany yielded numerous seedlings that, thus far, do not seem to be more resistant to blister rust than the average native white pine in our tests. The plantation of white pine selected for resistance to blister rust and established at Connaught Ranges near Ottawa, in co-operation with the Department of Forestry, received a heavy thinning in 1960, removing all trees with blister rust attack either directly or on their grafts at Maple. This caused abundant flowering in 1961 and gives promise of a good cone crop in 1962. Three kinds of interspecific crosses were made in 1961, namely 6 crosses of P. monticola x griffithii, 2 crosses of P. armandi x albicaulis and 30 crosses of P. koraiensis x albicaulis. The range-wide 5-station provenance test of white pine initiated in 1957 was outplanted in 1961. One outplanting was established at Turkey Point, Ont. with a total of 6,292 trees. Another outplanting, with the same 13 provenances, was established in the Ganaraska Forest and comprised 4,212 trees. The selection for resistance to weeviling, in co-operation with the Forest Insect Laboratory in Sault Ste. Marie, was continued. A plantation of white pine in the Kirkwood Management Unit was top-grafted in 1961 for this purpose with 1050 scions of 21 clones of various native and hybrid white pine materials selected for resistance to blister rust. An experiment in the propagation of juvenile white pine by stem cuttings, with the aid of growth hormones, was started in the fall of 1960. Next year it yielded 55% rooted cuttings after the application of Rootone, as compared with 3.3% rooting of untreated controls. Other hormone treatments yielded intermediate results. The rooting obtained is too low for routine propagation but is encouraging as a basis for further tests. Experiments in bench grafting were carried out during both winters of 1960-62 and established a good basis for the application of this method to routine propagation in the future.

Some white pine seeds were irradiated with thermal neutrons at the plant of Atomic Energy of Canada Ltd. in the fall of 1960. Two hours in the pile with a total dose of about 6000 rem reduced germination to 36% of untreated controls, i.e. the L 50 dose is somewhat lower than this treatment. Three hours in the pile with a total dose of about 9000 rem reduced germination to 9% of untreated controls and 4 hours to 2%. The surviving seedlings have thus far not shown abnormal growth peculiarities. Their resistance to blister rust in comparison with seedlings raised from untreated seeds of the same origin is being studied. Seeds from several plus trees at the Petawawa F.E.S. were obtained in 1960 and have yielded seedlings for progeny tests, mainly in respect to resistance to blister rust.

Poplars

The production of aspen-like hybrids, suitable for growing in southern Ontario continued to be the chief aim of this project. Acquisition of new materials was in 1960 restricted to a few clones of Populus alba, P. tremula and P. canescens from Switzerland and Yugoslavia. In 1961, 10 clones of P. euramericana were acquired from central Europe, 8 clones of P. tremuloides from Idaho, British Columbia, New Brunswick and Ontario, and 14 clones of P. canescens from the Netherlands and Germany. Hybridization was in both years centered on the production of second-generation hybrids between P. alba and aspens, using several first-generation hybrids and P. canescens materials in our collection that are beginning to flower. The breeding and selection of precocious aspen types was continued on a small scale. A good method for testing the rooting ability of stem cuttings was developed and applied to numerous new aspen materials. Several promising clones of silver poplar and aspen hybrids raised at this Station were selected on the basis of this new test. A cross of one of our P. alba with a P. alba from Spain yielded some materials with better rooting ability from stem cuttings than either of their parents, indicating the action of complementary genes in this respect. It was found that crossing of silver poplar of superior rooting ability with aspens varies considerably in the effect on the rooting ability of the hybrids, depending also on the aspen species used. P. grandidentata is one of the best for this purpose. Continued heavy attacks by a fungus believed to be a Gnomonia species is a serious problem in aspen breeding. Asiatic aspens and their hybrids seem to be particularly susceptible to attacks. Hybrids of P. trichocarpa

with various forms of P. alba are beginning to show promising possibilities of introducing the superior rooting ability of P. trichocarpa into aspen hybrids. One large test plantation was established in the spring and two smaller ones in the fall of 1960, and two in the fall of 1961.

Hard Pines

See report by D. P. Fowler; H-1 to H-4

White Cedar

The production of improved types of this species, Thuja occidentalis, and of western red cedar, Thuja plicata, and hybrids, hardy in southern Ontario, is the aim of this project. The large collection of western red cedar seedlings was so covered with snow in the winter of 1959-60 that it was not possible to subject them to a good freezing test. Instead, the seedlings were heavily culled in the beds, in respect to size and possible signs of winter damage. It was found that the hardy western red cedar, received previously from Rochester, N.Y. are most probably hybrids with Thuja standishii from Japan, which probably accounts, to some extent, for their hardiness under our conditions. A provenance test plantation, consisting of 15 provenances of white cedar from Ontario, Quebec, New Brunswick, Manitoba and Wisconsin, was established in the Ganaraska Forest in the spring of 1961. In the same year, two observation areas of western red cedar, one of 33 populations and another of 8 populations, were also established in the Ganaraska Forest, in addition to one small observation area of white cedar of 10 populations. A number of rooted cuttings and hybrid seedlings were set out on their permanent location at this Station to serve as future breeding materials.

Chestnut

The aim of this project is the production of hardy dwarf types, resistant to blight and suitable as dwarfing stock in the breeding program with timber-type chestnuts. In 1960, seeds of Chinese chestnut, from Beltsville, Md. produced plants of good growth and hardiness. The next year these plants were moved from the nursery to various places at this Station for further observation and breeding. Chinkapin seeds were again received from Virginia, but did not germinate. Seeds of European chestnut, obtained in a grocery store in Toronto, yielded seedlings that were not hardy. No new work was undertaken on this project in 1961.

Publications

Fowler, D.P. 1961. The effect of photo period on white pine seedling growth. The Forestry Chronicle 37 (2): 133-143.

Heimburger, C. 1960. Review of "Principles of Plant Breeding" by R. W. Allard, 1960. The Forestry Chronicle 37(1): 67-68.

Heimburger, C. 1961. Comments: Problems in Forest Tree Breeding. Recent Advances in Botany: 1699-1703.

BIENNIAL REPORT

APRIL 1, 1960 TO MARCH 31, 1962

FOREST TREE BREEDING AND GENETICS

AT THE

PETAWAWA FOREST EXPERIMENT STATION

M. J. HOLST

INTRODUCTION

This report gives a brief outline of the work done by the tree breeding group at Petawawa Forest Experiment Station.

Our early efforts start to bear fruit and many experiments have been established in Canada, the United States and overseas. We are still in the "provenance stage," as Canada is pitifully short of adequate provenance experiments. Both foresters and tree breeders will find our provenance work useful - but we are looking forward to the day when we can do more breeding work.

WHITE SPRUCE

An early provenance experiment (Exp. No. 93), including 32 races of white spruce mainly from the middle part of the Great Lakes-St. Lawrence Forest Region, has finally been field planted in 21 locations in Canada and the United States. This experiment is a forerunner to the more comprehensive white spruce provenance experiment (Exp. No. 194) conducted in co-operation with the Canadian Pulp and Paper Association, Ontario and Quebec Departments of Lands and Forests, and the University of Toronto. This last experiment is progressing on schedule. Two-year-old stock was distributed for the five western experiments in 1961, and seedlings for the five eastern experiments were shipped in 1962. In 1963 seedlings for four complete experiments will be transplanted in the nurseries at Acadia, Valcartier and Petawawa Forest Experiment Stations, and in the Fort William Nursery (Ontario Department of Lands and Forests). The first field planting will be in 1963.

The pilot white spruce provenance experiment to Exp. No. 93 has been rated annually. Furthermore a study was made of needle and wood dry weights to see whether some provenances have a more efficient photosynthesis than others. This certainly seems to be the case, but no clear pattern emerged. The wood/needle weight ratios show random distribution.

A number of inbred lines of white spruce were sown and followed closely for mortality, and for albino and yellow seedlings. We hope to be able to study the early occurrence of freak seedlings in relation to later growth. Perhaps we may also be able to estimate breeding value of plus trees by comparing the relative performance of the selfed progenies, and get rid of deleterious genes as we establish inbred lines for future outcrossing.

We have also started some grafting experiments with young, middle-aged and old white spruces to study the influence of scion topophysis, graft position, and root-stock pruning on the development of the grafts. (Exp.No.241)

Seed was distributed earlier to test Danish Sitka x white spruce hybrids against a number of white spruce and Norway spruce provenances for growth rate and resistance both to the Sitka spruce weevil and the white pine weevil. This material has been planted at the Green Timber Nursery in British Columbia (Exp. No. 129) and in six spruce weevil exposure plots in coastal Washington and Oregon (Exp.No. 127) by J.W. Duffield, Industrial Forestry Association, Nisqually, Washington. He writes that St. Zenon, P.Q. white spruce has better than average growth rate and some of them produce phenomenally straight leaders. This is a surprise as the St. Zenon lot in our experiments has been 14 percent inferior to local white spruce. One experiment was planted at Petawawa (Exp.No. 139) with certain misgivings about its hardiness. However, nearly all of the various Sitka x white spruce hybrids showed pronounced magnesium deficiency - perhaps a good indication to keep these hybrids in coastal areas. In Quebec this material has been planted in five localities (Exp.No. 135); in several localities in New Brunswick and Nova Scotia (Exp.No. 134), and in one locality in New York (Exp.No. 138) and Newfoundland (Exp.No. 136). This experiment should eventually give interesting information regarding performance in a western oceanic, a continental and in an eastern oceanic climate. If the hybrids on the west coast are resistant to the Sitka spruce weevil, this could be a very useful discovery as hardly any Sitka spruce is planted because of the weevil menace. For the east coast we can hope for a fast growing or at least a salt tolerant hybrid.

RED AND BLACK SPRUCE

We have at the Station material indicating that red spruce crossed with Petawawa black spruce produces a heterotic hybrid. This is a valuable lead, but the material originates from the area where the ranges of red spruce and black spruce overlap and where introgression is common. Chances for getting even more heterosis should be good if we use material of both species from outside their overlapping zone. We should also try to balance the climate because the hybrid will most likely be intermediate in climatic preference. If we want to use southern Appalachian red spruce, we should cross it with boreal or western black spruce to make a hybrid suitable for the Great Lakes-St. Lawrence Region or the Acadian Forest Region. This is the idea behind our hybridization work in red and black spruce.

The species flowered abundantly in 1960 and we concentrated on making black and red spruce hybrids. To that end Messrs. C.W. Yeatman and K. Morgenstern went to the United States and collected large amounts of red spruce pollen from Pennsylvania, West Virginia and North Carolina. This work was only partly successful because most of the pollen came too late to be of any use at the Petawawa Forest Experiment Station and the crosses were therefore repeated in northern Ontario at Cochrane.

In 1961 there were hardly any black spruce flowers in Ontario. By looking at climatic maps, we located an area in Manitoba that had above average spring temperatures in 1960, and a phone call to our District Office in Winnipeg confirmed that black spruce was flowering abundantly. So we repeated the red spruce crosses on black spruce in Sandilands Forest Reserve and Riding Mountain National Park.

All in all this pollination work has been a disappointment. Although the red spruce pollen germinated well (from 35 to 65 percent), we got very small cones and extremely low germination. This may be due to the following:

(1) the pollen germination test is a poor indicator of pollen viability; or
(2) our crown isolation tents are unsuitable for black spruce; or
(3) black spruce outside the overlapping zone is incompatible with red spruce.

To solve these problems we repeated these crosses on Petawawa black spruce with old and fresh pollen in 1962.

Our red spruce provenance experiment with 22 races (Exp.No. 95) has now been field planted in 23 locations in Canada and the United States. Seed of some of the provenances has been distributed overseas.

Mr. K. Morgenstern scored the seedlings of this red spruce provenance experiment and supplemented this material with field observations. Using an Anderson hybrid index, he was able to show that the North Carolina red spruce is uniform and typical (black spruce is absent and its presence there during glaciation is doubtful). In Pennsylvania weak introgression occurs, resulting from the restriction of both species to small swamp communities. In the southern New England States, where there is often distinct ecological isolation, black spruce growing in the swamps and red spruce at higher elevation surrounded by hardwoods, there is only a slight infiltration of black into red spruce. In northern New York, Nova Scotia, New Brunswick and Quebec introgression is usually strong as the two spruces usually meet on upland sites.

NORWAY SPRUCE

The I.U.F.R.O. Norway spruce provenance experiment has been remeasured for comparison with other experiments of this series. The results will be of limited value only because of white pine weevil damage. The experiment was given a very heavy thinning removing weevilled and suppressed trees. Weevil attack has been studied in relation to measurements taken before weevil attack to see what influence form factors and provenance may have on weevilling. A number of plus trees have been selected and propagated to make family breedings.

An experiment comparing Finnish, Latvian, Polish, Russian and Siberian Norway spruce provenances with the fast growing German provenances from Swedish plantations and locally selected hardy material went on trail in 15 localities (Exp.No. 200). The Russian and Siberian Norway spruce are slower growing than most of the European Norway spruce grown here. However, the Russian and Siberian provenances may be of particular interest in the Boreal Forest.

Open pollinated progenies of our apparently weevil resistant Norway spruce selections from Hydson's Place are on trial in New York and Ontario (Exp.No. 214). Our own experiment with this material (Exp.No. 120) was re-measured, but it is a little too early to assess weevil damage.

A number of Picea abies x asperata hybrids were planted in Ontario (Exp.No. 253). Picea asperata is not quite hardy at the Petawawa Forest Experiment Station and is badly weevilled. The hybrid may have some merit in areas with too warm summers for Norway spruce.

SPRUCE GRAFTING

An experiment with reciprocal grafting of white, red, black and Norway spruce gave interesting results. These four spruces were completely compatible, but scion growth was very much influenced by the rootstock. Black, Norway and white spruce scions grew poorly on red spruce rootstocks, while the black spruce rootstock stimulated scion growth of Norway and white spruce about 50 percent and red spruce scions by 130 percent. This stimulation (or lack thereof) may be explained in terms of efficiency of root systems and tolerance. Red spruce has an inefficient root system, has a high requirement for nutrition, and has the slow early growth typical of tolerant species. Black spruce - on the other hand - seems to have an efficient root system, a low requirement for nutrition, and the rapid early growth typical of an intolerant pioneer species. White and Norway spruce are intermediate in these respects. These reciprocal grafts have been planted on four different sites to study their reaction to soil fertility and moisture regime. (Exp.No. 212)

RED PINE

A night frost in early June, 1960, severely damaged the red pine provenance experiments in the Young Creek Area (Exp. Nos. 38, 39 and 74-B). The north-western Ontario red pines showed less damage than local red pine.

A provenance experiment and a single tree progeny test of Ontario and Wisconsin red pine (Exp. Nos. 215 and 216) were followed with measurements.

Seed of single red pines from many different local stands were gathered partly for Michigan State University and partly to provide material to settle the problem of how best to sample a red pine stand (Exp.No. 238). If we handle only 50 seed lots, for example, should we take one tree from each of 50 stands, 5 trees from 10 stands, or 10 trees from 5 stands?

The morphology of red pine is remarkably uniform throughout its range. A few minor and very localized variations are known to exist, e.g., the fastigiate forms in Wisconsin and the "tassel pines" from Bancroft, Ontario. In general there is little or no basis for individual tree selection based on the phenotype (except perhaps in the isolated occurrences in northern Ontario where Dr. Heimburger has noticed genetic drift). Provenance hybridization is one possible way to increase variability in red pine.

In the spring of 1961 we co-operated with Mr. D.P. Fowler in performing controlled pollinations in three locations: (1) Petawawa Forest Experiment Station; (2) Watabeag Lake near Swastika; and (3) Lake Abitibi west of Cochrane.

At each locality, a selfing, a crossing to the same stand, and a State of Maine provenance crossing were made for Mr. Fowler on each of five trees. Our own project involved provenance hybridization using pollen from Pennsylvania, Massachusetts, New York, Maine, Michigan, Wisconsin and Minnesota. About one thousand bags were used.

Trouble was expected with the red pine cone borer (Conophthorus resinosae) and the trees were sprayed for two years with D.D.T. Even then the borer has taken a heavy toll in the Petawawa area, while there were no borers at Watabeag Lake.

JACK PINE

Jack pine is a tree breeder's delight. Its fast growth and early flowering makes for easy handling and rapid turnover.

In 1960 we went through our collection of jack pine grafts, pinched off all male flowers and left the females to be pollinated with whatever local jack pine pollen there was in the air. To insure adequate pollination we supplied extra pollen to the open flowers. With very little effort we were able to make the following provenance hybrids.

Somerset Co., Maine Cumberland Co., N.S. Northumberland Co., N.B. Lake St. John, P.Q. Opawica Distr., P.Q. Laviolette-Letondal Co., P.Q. Espanola, Ont. Crawford Co., Mich. Vilas Co., Wis. Sandilands, Man. Smith, Alta. Fort Smith, N.W.T.	x Petawawa, Ontario

A hybrid population from northern Alberta where the range of jack pine and lodgepole pine overlaps, was also crossed with Petawawa jack pine. The individuals were separated into the following four groups according to cone characteristics:

1) smooth closed cones
2) smooth open cones
3) prickly closed cones
4) prickly open cones

The individuals with most lodgepole characteristics have the best form, but not the best growth rate. Furthermore, a number of the lodgepole and jack pine hybrids from Placerville were backcrossed to Petawawa jack pine. These hybrids are of extremely poor form and are slower growing than local jack pine.

In 1961 jack pine provenance experiments and clone collections were used to make 43 different provenance hybrids. Northern provenances were crossed with southern, and eastern with western. About 900 bags were used.

One hundred jack pine seed lots have been assembled for an all range jack pine provenance experiment. The intention is to run a number of nursery provenance experiments in as many climates as possible using all - or nearly all - provenances. We are trying a new technique with these experiments. Ordinarily we have planted 2-0 plants for our nursery provenance experiments. With the jack pine material we will sow seed spots on 1' x 1', use a 10-spot plot and up to 10 replications. The seed spots will eventually be weeded down to one plant per spot. The seed will be distributed to North Carolina, New Hampshire (three experiments), Massachusetts, Wisconsin, Michigan, New Brunswick, Quebec, and Longlac and Petawawa in Ontario. The same material will be grown in the growth chambers at Yale University. Other series of experiments using standard nursery practice and field planting will eventually be established across the jack pine range.

A number of older jack pine provenance experiments and observation plots have been measured twice to assess increment (Exp.Nos. 41, 41, 42 and 82). The Lake States jack pine provenance experiment that was planted in three locations in Canada has also been remeasured (Exp.Nos. 125, 132 and 133) and will be compared with the experiments planted in the Lake States.

Three hundred single tree progenies of jack pine will be studied for inheritance of cone opening, cone angle, branch angle and stem form. We found that jack pine from Massey, Ontario have a larger branch angle and more open cones (26%) than local jack pine. Petawawa jack pine had 16 percent open-coned trees and Notakim,Depot, P.Q., 11 percent.

SCOTS PINE

Our main effort has been the establishment of 24 provenance experiments and observation plots containing 13 Russian and Siberian Scots pine provenances (Exp.No. 201). Most of this material will be of particular interest in the Boreal Forest Region where hardiness counts more than growth rate. (Selected provenances from Europe should be faster growing than the Russian and Siberian provenances in the Great Lakes-St. Lawrence Forest Region). Two provenances from southern Russia (from Kozinsky, Kiev Forest District, Ukrania, and the Province of Woronesh) are of particular interest as potential sources for resistance to the European pine shoot moth, as they come from areas of high resin production.

Twenty-six new selections of potentially "perfect" Christmas trees were added to our Scots pine clone collection. Some of our earlier selections flowered and a limited number of controlled crosses were made. Lack of pollen on the young grafts was the limiting factor.

Observation plots of promising Scots pine provenances were established for future selection of Christmas trees. (Exp.No. 188). Seven Scottish, two French, one Hoch-Schwarzwald, one Campine, and one southern Ontario provenance went on trial. It is hoped that we will be able to make family breeding with this material. Such family breeding should give more uniform progenies than our earlier selections that have largely been of unknown parentage.

OTHER PINES

Single tree progenies of high and low resin yielders of P. nigra from Austria, several P. nigra varieties, and southern Russian Scots pine were planted in shoot moth tests on Turkey Point and at Elmira (Exp.No. 183). This is part of a co-operative study of European pine shoot moth preference, and of resistance breeding conducted by the Forest Research Branch and the Forest Entomology and Pathology Branch of the Department of Forestry, and the Ontario Department of Lands and Forests.

LARCH

Eleven provenance experiments and observation plots comparing Larix laricina, L. kurilensis, L. decidua and four Polish larch stands were planted in Canada and the New England States (Exp.No. 202).

Another experiment comparing European, Polish, Japanese, European x Japanese, and western larch was planted in 10 locations (Exp.No. 209). The experiments planted at Petawawa Forest Experiment Station were established along a moisture gradient to study the effect particularly on the European, the European x Japanese, and Japanese larch. It may well be that the Japanese larch and the hybrid will be superior on the moist sites while the European larch will grow best on the drier sites. Another interesting feature of this experiment was that two lots of L. occidentalis were fading away in the nursery and produced very small and poor plants. Our soil seems to lack some essential quality, possibly mycorrhiza.

OTHER SPECIES

Several birch experiments have been planted. Some are single tree experiments with paper birch and others are trials of exotic birches.

PLANT FORCING AND FLOWER INDUCTION

Quite a few research workers are working on techniques for accelerating growth. This is usually done by combining long days with adequate temperature and growing conditions. Several interesting differences between species have been found. However, sooner or later most plants stop shoot elongation by forming buds or become unhealthy because of too long exposure to an artificial environment. The spruces and the pines are particularly difficult to force. We have therefore concentrated on studying the chilling requirement of plants that have been treated with long days and long growing seasons. Preliminary experiments show that spruce chilled for four weeks will break dormancy only on the lower branches. Six weeks' chilling broke dormancy of the side buds, but not of the terminal bud. Only an eight weeks' chilling induced complete and normal flushing. We also tried chilling at different light intensities. Best was chilling in the dark (normal cold storage room). Low light intensity chilling in a growth chamber gave intermediate results. Poorest was chilling at high light intensity.

Plans for experiments with multiple growth cycles in one year, giving cycles of long days and warmth, short cool days, and a short period of chilling have been planned, but not done as Mr. Yeatman left for Yale.

A number of branch girdling experiments were done on spruce and pine in an attempt to pin down when the flower premordia are formed. Many of the branches broke and some of the experiments were not conclusive.

In red pine the girdling at any date reduced female flowering to about one third. Male flowers were stimulated 61 to 76 percent on branches girdled up till June 1; with June 15th girdling, there was a 7 percent reduction and on August 1 a 35 percent reduction.

In jack pine, female flowering is stimulated by girdling until July 1, while the male flower stimulation stopped with girdling on May 15.

A timing experiment with pruning and ammonium fertilizer on young red pine gave indications of how one may treat red pine seed orchards. Any kind of pruning inhibits female flowering (as might be expected). Pinching of lower side branches in early May promotes male flowering, but this effect disappears when the trees are fertilized. To reduce growth and increase branching the leader and upper whorls should be pruned between June 9 and July 9. This will triple the number of branches and, as the branches are smaller, should eventually be conducive to female flowering, and later also to male flowering (one only finds male flowers on small branches). The lack of male flowers in seed orchards, and in the tree breeders clone collections could be overcome by pinching of the lower branches in early May.

In white, black and Norway spruce, branch girdling was a complete failure as the incidence of breakage was very high. The timing experiment was therefore repeated using treatment of whole trees (girdling, strangulation and rootpruning). For 16-year-old white spruce and 15-year-old Norway spruce only rootpruning before May 10 was effective. Black spruce reacts to treatment up to June 15 (although early treatments are best) and reacts better to girdling and strangulation than white and Norway spruce.

Six-year-old white spruces were treated with a combination of short day, high lime, and spraying the uracil, xanthine and ethylenechlorhydride did not produce any flowers. Man-high red pines sprayed with uracil and xanthine did not flower either, but 2-year-old larch seedlings sprayed with uracil yielded 10 percent female flowers.

Mr. M.M. Giertych made a comprehensive study of red pine buds, comparing different age classes, different positions within the crown, and ammonium nitrate-fertilized and non-fertilized trees. Three growth promoters and one growth inhibitor were found. Terminal buds had higher levels of growth promoters than side buds indicating a hormone gradient in flowering. The effect of the fertilizer was to increase the content of all growth regulators, particularly the inhibitor which may explain the reduction of leader growth seen on red pine fertilized with ammonium nitrate. DNA concentration was proportional to number of cells and therefore constant per cell, while RNA varied with season and bud position. The ammonium nitrate fertilizer increased the RNA concentration in July. This is a very important study for our understanding of the physiology of flowering - but we still have a long way to go and we need more of these fundamental studies.

VEGETATIVE PROPAGATION

Some of the spruce grafting experiments have been mentioned above.

Red pines grafted on Scots pine rootstocks show incompatibility. Following are typical percentages for red pine grafted out of doors on large Scots pine rootstocks. The first year survival of about 1,000 grafts was 72 percent. Eight years after we had the following:

	Percent of first year survivors
Healthy green	54
Yellow needles	5
Burned needles	5
Dead recently with brown needles	2
Dead (reason suspected to be incompatibility)	34
Total:	100

Thirty-six percent have died. Another 10 percent are unthrifty with yellow or brown needles typical of starved foliage.

A total of 3,788 grafts were made during the two-year period. Of particular interest are the Pinus nigra x resinosa hybrids from Placerville (Table 1).

NURSERY WORK

The nursery has been enlarged, but it will be some time before the new area is uniform and of adequate fertility. Many new Dunnemann beds have been installed. About 125,000 seedlings were transplanted (Table 2).

PLANTATION WORK

Thirty-nine experiments including 73,383 plants covering 39.4 acres were field planted at the Petawawa Forest Experiment Station. About 2,500 of these were grafts (Table 3).

Another 72 experiments were planted by co-operators in Canada and the United States. These included 181,477 plants and covered 163.2 acres (Table 4).

About 29,000 plants were distributed for another 7 experiments to be field planted in 1962 (Table 5).

An increasing amount of time is spent looking after older plantings and in getting new experiments properly established.

Table 1

SUMMARY OF GRAFTING DURING SPRING AND FALL 1960 AND 1961

1. SPRING 1960

	No. Grafts	
P-139 & P-142, Exp. No. 128 17 clones of *P. resinosa* from 3 areas in northern Ontario.	660	
P-133 5 clones of *P. glauca* from Petawawa	240	
P-60, Exp. No. 241a; P-133 4 clones of *P. glauca* from Petawawa (grafting and pruning experiment)	560	
Exp. No. 248 Cold storage of red pine, white spruce & Norway spruce	300	
		1,760

2. FALL 1960

P-139 & P-142, Exp. No. 238 43 clones of *P. resinosa* from Petawawa F.E.S.	422	
P-139 & P-142, Exp. No. 257 15 clones of *P. resinosa* from 14 provenances in Ontario	130	
6 clones of *P. sylvestris* x *P. mugo* F_3	60	
		612
Total grafting 1960		2,372

3. SPRING 1961

P-144 2 clones of *P. nigra* x *resinosa* & the parent trees	14	
P-147 10 clones and 2 mixtures of clones of *P. sylvestris* (Christmas tree selections)	255	
P-133 4 clones of *P. glauca* from Causapscal, P.Q. and Petawawa, Ontario	195	

Table 1 (Cont'd)

P-60, Exp. No. 241b; P-133		
4 clones of P.glauca from Petawawa (grafting and pruning experiment)	480	
		944
P-137		
1 clone and 1 population of exotic spruce species from China	33	
6 clones of P.jezoensis hondoensis x glauca	30	
1 clone of P.glauca x mariana & 8 clones of surrounding white and black spruces	69	
		1,076

4. FALL 1960

P-147		
14 clones of P.sylvestris (Christmas tree selection)	340	
		340
Total grafting 1961		1,416

Table 2

TRANSPLANTING OF TREE BREEDING MATERIAL

1. SPRING 1960

Project or Exp. No.	Material	No. Planted
216	*Pinus resinosa* provenances from Lake States and eastern Canada	26,000
215	*Pinus resinosa*, single tree progenies from Lake States and Grand Bend, Ont.	12,500
P-147	*Pinus sylvestris* crossing for Christmas tree breeding	60
P-147	*Pinus sylvestris* of different origin for Christmas tree selection	3,170
183-E	*P. nigra austriaca* provenances from Yugoslavia	3,000
218	*Picea glauca* provenances from northern Canada (from Labrador to British Columbia)	1,250
	Betula verrucosa, elite tree from Sweden	160
	Pine and spruce rootstocks	6,000
	Total transplanting 1960	52,140

2. SPRING 1961

Project or Exp. No.	Material	No. Planted
194	*Picea glauca* provenance experiment	66,000
263	*Pinus sylvestris* provenances	2,600
264	*Pinus nigra* provenances	700
35B-C	*Larix* species and species hybrids	1,400
	Picea " " " "	1,520
	Betula papyrifera single tree and population collections from Petawawa	1,000
	Total transplanting 1960	73,220

Table 3

SPRING PLANTING 1960 AND 1961 BY THE TREE BREEDING SECTION
PETAWAWA FOREST EXPERIMENT STATION

Exp. No.	Description	No. of Plants	Area Acres	Plantation Area
	Seed Plants 1960			
95-H	Provenance experiment including 14 races of red spruce.	7760	2.85	P.A.114
101-C	Trial of Scandinavian elite birch for future breeding purposes.	637	0.35	P.A.106
139	Comparison of Alaska sitka spruce, white spruce and sitka x white spruce hybrids, Danish white spruce and sitka x white spruce hybrids from plantations in Jutland and from controlled hybrids in Horsholm; Cochrane white x B.C. sitka and local white spruce.	3482	1.28	P.A.114
188-A	Selection of Christmas trees in Schwarzwald, Scottish and southern Ontario Scots pine provenances.	9852	3.62	P.A.120
201-A	Provenance experiment and observation plots including Russian and Siberian Scots pine.	6663	2.45	P.A.121
201-B	Ditto	5400	1.98	P.A.120
202-A	Provenance experiment and observation plots including various larch species.	3999	3.31	P.A.122
202-J	Ditto	5159	4.26	P.A.114
	Total 1960	42,952	20.10	
	Seed Plants 1961			
72 open	One-parent progeny test with red spruce, red x black spruce hybrids and black spruce.	79	0.11	P.A.103

Table 3 (Cont'd)

Exp. No.	Description	No. of Plants	Area Acres	Plantation Area
119 open	Transfer of weevil resistance from white spruce to Norway spruce by means of crossing bridges, white-sitka-Norway spruce, and others.	490	0.40	P.A.104
119 open	Ditto	450	0.76	P.A.116
200-J	Provenance experiment and observation plots including north European and Russian Norway spruce.	3082	1.13	P.A.123
200-K	Ditto	6850	2.51	P.A.114
202-J	Provenance experiment and observation plots including various larch species.	5159	4.26	P.A.114
208 open	Comparison of good and poor genotypes in white spruce.	12	0.04	P.A.104
209-A	Provenance experiments and observation plots including *Larix decidua*, *L. leptolepis*, *L. eurolepis* and *L. occidentalis*.	3793	1.40	P.A.123
209-F	Ditto	1150	0.95	P.A.123
209-F-1	Ditto	1657	0.69	P.A.124
209-F-2	Ditto	836	0.35	P.A.124
209-H	Ditto	164	0.24	P.A.114
217-A	Co-operative study of Canadian, European, Korean and Japanese birches.	990	0.44	P.A.123
217-B	Ditto	105	0.09	P.A.101
217-C	Ditto	1800	1.49	P.A.124
217-D	Ditto	403	0.33	P.A.106
243 open	Interspecific hybridization in *Picea*.	13	0.04	P.A.104

Table 3 (Cont'd)

Exp. No.	Description	No. of Plants	Area Acres	Plantation Area
253-A	*Picea abies* x *asperata* hybrids suitable for warm summers.	119	0.20	P.A.116
253-B	Ditto	780	0.64	P.A.114
254 open	Interspecific hybridization in *Abies*.	23	0.03	P.A.104
	Total 1961	27,955	16.10	
	Total 1960	42,952	20.10	
	Seed Plants, Grand Total 1960-61	70,907	36.20	
	Grafts 1960			
87 open	Investigation of jack pine, lodgepole pine and their hybrids for resistance to sweet fern blister rust.	1278	0.23	P.A.106
128 open	Grafted red pine population samples intended for provenance hybridization.	148	0.12	P.A.104
	Total 1960	1426	0.35	
	Grafts 1961			
86 open	Selection of the perfect Scots pine Christmas tree.	105	0.34	P.A.115
87 open	Investigation of the jack pine, lodgepole pine and their hybrids for resistance to sweet fern blister rust.	5	0.01	P.A.115
212-A	Interspecific grafting of black, Norway, red and white spruce.	320	1.06	P.A.115
212-B	Ditto	160	0.53	P.A.116
212-C	Ditto	80	0.07	Nursery

Table 3 (Cont'd)

Exp. No.	Description	No. of Plants	Area Acres	Plantation Area
212-D	Interspecific grafting of black, Norway, red and white spruce.	80	0.07	Nursery II
242 open	Selection of white spruce plus trees.	126	0.19	P.A.114
242 open	Selection of white spruce plus trees.	160	0.53	P.A.116
256 open	Grafted white spruce population samples.	14	0.05	P.A.116
	Total 1961	1,050	2.85	
	Total 1960	1,426	0.35	
	Grafts Grand Total 1960-61	2,476	3.20	
	Seed Plants Total 1960-61	70,907	36.20	
		73,383	39.40	

Table 4

PLANTATIONS ESTABLISHED IN 1960 AND 1961 BY CO-OPERATING AGENCIES

Exp. No.	Title	No. of Plants	Area Acres	Agency & Location
	Seed Plants 1960			
91-C	Comparison of wood production and growth behaviour of 18 select broad and slender white spruces of various provenances by means of single tree progeny test.	798	0.29	J.Blimkie, Chalk River, Ontario
92-C	Single tree progeny test including 16 P.F.E.S. white spruces.	1102	0.40	J.Blimkie, Chalk River, Ontario
93-G-3-1	Ditto	144	0.12	Mich. State Univ., East Lansing, Mich., U.S.A.
93-G-3-2	Ditto	660	0.54	Mich.State Univ., East Lansing, Mich., U.S.A.
93-M-1	Ditto	708	0.26	J.Blimkie, Chalk River, Ontario
93-M-2	Ditto	405	0.15	J. Blimie, Chalk River, Ontario
95-B	Provenance experiment including 22 races of red spruce.	10,349	3.80	Dept. of Forestry, Acadia F.E.S., N.B.
95-C	Ditto	10,481	3.85	Dept. of Forestry, Fundy National Park, N.B.
95-K	Ditto	700	1.00	Lake States F.E.S., Rhinelander, Wisc., U.S.A.
95-L-1	Ditto	900	0.51	New Hampshire Forest & Recreation Committee, Concord, N.H., U.S.A.

Table 4 (Cont'd)

Exp. No.	Title	No of Plants	Area Acres	Agency & Location
95-L-2	Provenance experiment including 22 races of red spruce.	1,100	0.63	New Hampshire Forest & Recreation Commission, Concord, N.H., U.S.A.
95-N	Ditto	2,019	1.00	Univ. of Toronto, Ranger School, Dorset, Ont.
95-O	Ditto	1,750	2.00	Mr. S. Davis, Eganville, Ontario
95-P	Ditto	1,400	1.15	Ont. Dept. of L. & F., Sault Ste. Marie, Ontario.
95-Q	Ditto	1,669	1.40	Univ. of New Brunswick, Maritime For. Ranger School, New Maryland, N.B.
95-R	Ditto	7,000	5.80	Acadia Univ., Wolfville, N.S.
95-S	Ditto	9,425	8.40	Bowater's Mersey Paper Co., Liverpool, N.S.
95-T	Ditto	336	0.12	Dept. of Forestry, For.Res.Br., Fredericton, N.B.
95-U	Ditto	4,700	5.00	Nova Scotia Dept.of L. & F., Yarmouth, N.S.
183-B-2	Testing of single tree progenies of high resin yielding Austrian pine for shoot moth resistance.	150	0.12	Dept. of Forestry, Forest Insect Lab., Sault Ste. Marie, Ontario.
188-B	Selection of Christmas trees in Schwarzwald, Scottish and southern Ontario Scots pine provenances.	3,820	0.62	Mr. J. Blimkie, Chalk River, Ont.

Table 4 (Cont'd)

Exp. No.	Title	No. of Plants	Area Acres	Agency & Location
200-D	Provenance experiment & observation plots including north European & Russian Norway spruce.	3,298+ local jp	4.00	Spruce Falls Power & Paper Co., Kapuskasing, Ontario
200-G	Ditto	910	0.75	Univ. of Toronto, Faculty of Forestry, Toronto, Ontario.
201-C	Provenance experiment and observation plots including Russian & Siberian Scots pine.	4,096	3.40	The KVP Co., Espanola, Ontario.
201-D	Ditto	4,096	3.40	Kimberly-Clark Pulp & Paper Co., Longlac, Ontario.
201-E	Ditto	3,650	3.75	Univ. of Toronto, Ranger School, Dorset, Ontario.
201-F-1	Ditto	3,185	2.63	Dept. of Forestry, Manitoba.
201-F-2	Ditto	3,185	2.63	Dept. of Forestry, Manitoba.
201-K	Ditto	2,020	2.30	Forest Nursery Station, Indian Head, Sask.
201-H	Ditto	4,088	1.51	Sask.Dept. of Nat. Res., Forestry Br., Prince Albert, Sask.
201-I-1	Ditto	792	3.50	U.S. Forest Service, North.Inst. of For. Genetics, Rhinelander, Wisc., USA.
201-I-2	Ditto	792	3.50	U.S. Forest Service, North.Inst. of For. Genetics, Rhinelander, Wisc., USA.

Table 4 (Cont'd)

Exp. No.	Title	No. of Plants	Area Acres	Agency & Location
201-I-3	Provenance experiment and observation plots including Russian & Siberian Scots pine.	792	3.50	Forest Nursery Sta., Indian Head, Sask.
201-I-4	Ditto	792	3.50	U.S. Forest Service, North.Inst. of For. Genetics, Rhinelander, Wisc., USA.
201-I-5	Ditto	792	3.50	U.S. Forest Service, North.Inst. of For. Genetics, Rhinelander, Wisc., USA.
201-J	Ditto	770	0.20	Univ. of Toronto, Faculty of Forestry
201-K	Ditto	3,102	2.50	Ont.Dept. of Lands & Forests, Maple, Ontario.
201-L	Ditto	200	0.16	Forest Insect Lab., Sault Ste. Marie, Ontario.
202-C	Provenance experiment and observationpplots including various larch species.	3,400	3.00	Bowater's Mersey Paper Co., Darling Fields, N.S.
202-D	Ditto	670	0.55	Univ. of Toronto, Faculty of For., Toronto, Ontario.
202-F	Ditto	120	0.10	Univ. of New Brunswick, Fredericton, N.B.
202-G-1	Ditto	2,400	3.50	Can.Int.Paper Co., Harrington For. Farm, P.Q.
202-G-2	Ditto	8,102	11.84	Can.Int.Paper Co., Harrington For. Farm, P.Q.

Table 4 (Cont'd)

Exp. No.	Title	No. of Plants	Area Acres	Agency & Location
202-I	Provenance experiment and observation plots including various larch species.	650	0.50	S. Davis, Eganville, Ontario.
202-K	Ditto	1,900	1.57	James McLaren Co., Buckingham, P.Q.
209-B-1	Provenance experiments and observation plots incl. *Larix decidua*, *L. leptolepsis*, *L. occidentalis* and *L. eurolepsis*.	2,700	4.00	Can.Int.Paper Co., Harrington For. Farm, P.Q.
209-B-2	Ditto	6,500	9.50	Can. Int. Paper Co., Harrington For. Farm, P.Q.
209-C	Ditto	770	0.28	Univ. of Toronto, Faculty of Forestry, Toronto, Ontario.
	Seed Plants 1960 Total	123,388	116.73	

Seed Plants 1961

Exp. No.	Title	No. of Plants	Area Acres	Agency & Location
183-D	Testing of single tree progenies of high resin yield Austrian pine for shoot moth resistance.	360	0.20	Ontario Dept. of L. & F., Maple, Ont.
200-A	Provenance experiment and observation plots including north European and Russian Norway spruce.	60	0.05	Univ. of New Brunswick, Fredericton, N.B.
200-F	Ditto	3,781	3.12	Sask.Dept. of Nat. Res., Forestry Br., Prince Albert, Sask.
200-L	Ditto	2,000	1.15	La Maison Provincial des Freres Maristes, Levis, P.Q.
200-M	Ditto	2,000	1.15	Leopold Dion, Bellechase, P.Q.

Table 4 (Cont'd)

Exp. No.	Title	No. of Plants	Area Acres	Agency & Location
201-M	Provenance experiment and observation plots including north European and Russian Norway spruce.	3,600+ 400 of local material	3.30	Ontario Dept. of L. & F., Swastika Forest District, Ont.
201-N	Ditto	3,600+ 400 of local material	3.30	Ontario Dept. of L. & F., Swastika Forest District, Ont.
201-O	Ditto	197	0.37	Dept. N.A.& N.R., North. Adm. Branch, For. Exp. Nursery, Fort Smith,,N.W.T.
201-P	Ditto	72	0.11	La Maison Provincial des Freres Maristes, Levis, PQ.
201-Q	Ditto	560	0.50	Mr. S. Davis, Eganville, Ontario.
201-R	Ditto	2,565	0.61	Mr. J. Blimkie, Chalk River, Ont.
201-S	Ditto	60	0.05	Univ. of New Brunswick, Fredericton, N.B.
202-E	Provenance experiment and observation plots including various larch species.	132	0.30	Dept.of Forestry, Acadia F.E.S., N.B.
209-D	Provenance experiments and observation plots incl. _Larix decidua_, _L._ _leptolepsis_, _L._ _eurolepsis_, & _L._ _occidentalis_.	1,150	1.68	Dept. of Forestry, Acadia F.E.S., N.B.
		901	1.33	----- -----
209-G	Ditto	140	0.21	La Maison Provincial des Freres Maristes, Levis, P.Q.
214-A	Trial of Norway spruce provenances & frost hardy and weevil rated Norway spruce selections from Hudson's Place Planted in _Pack_ Forest	441	0.50	N.Y. State Univ. Coll. For., Syracuse, N.Y., USA.

Table 4 (Cont'd)

Exp. No.	Title	No. of Plants	Area Acres	Agency & Location
214-B	Trial of Norway spruce provenances & frost hardy and weevil rated Norway spruce selections from Hudson's Place Planted in Pack Forest	441	0.50	N.Y. State Univ. Coll. For., Syracuse, N.Y., U.S.A.
214-C	Ditto	441	0.50	N.Y. State Univ. Coll. For., Syracuse, N.Y., U.S.A.
214-D	Ditto	25,300	21.0	Ont. Paper Co., Gore Bay, Ontario.
253-C	Suitability of *Picea abies* x *asperata* hybrids for warm summers.	1,200	1.00	Ont. Paper Co., Wanifleet Twp., Ont.
253-D	Ditto	7,000	4.0	R. Wagner, Courtland, Ontario.
253-E	Ditto	1,000	0.68	La Maison Provincial des Freres Maristes, Levis, P.Q.
253-F	Ditto	1,000	0.57	Leopold Dion, Bellechase, P.Q.
	Total 1961	58,001	46.18	
	Total 1960	123,388	116.73	
	Seed Plants 1960-61	181,389	162.91	

Grafts 1961

Exp. No.	Title	No. of Plants	Area Acres	Agency & Location
86-open	Selection of the perfect Scots pine Christmas tree.	88	0.29	W.E. Nodwell, Courtland, Ontario.
		88	0.29	

Total number of plants planted by outside agencies 1960-61	Grafts	88	.29
	Seed Plants	181,389	162.91
		181,477	163.20

DISTRIBUTION OF PLANTS TO OUTSIDE AGENCIES IN 1960 AND 1961

(Probably field planted in 1962)

Exp. No.	Agent and Planting Site	No. of Seedlots	No. of Seedlings
200-B	Dept. of Forestry, Manitoba, Riding Mountain Nursery. (Norway spruce, 2-1 stock)	12	7200
200-C	Dept. of Agriculture Forest Nursery Station, Indian Head, Sask. (Norway spruce, 2-1 stock)	11	6900
200-E	Kimberly-Clark Pulp & Paper Co., Longlac, Ont. (Norway spruce, 2-1 stock)	6	7000
200-H	Northern Institute of Forest Genetics, Rhinelander, Wisc., U.S.A., (Norway spruce, 3-0 stock)	6	3000
200-I	Univ. of Minnesota, St. Paul, Minn. (Norway spruce, 3-0 stock)	5	2500
200-N	Dept. of Northern Affairs & National Resources, Northern Administration Branch, Fort Smith, NWT. (Norway spruce, 2-2 stock)	12	300
201-G	Dept. of Agriculture, Forest Nursery Station, Indian Head, Sask., Scots Pine, 2-1 stock.	11	2200
	Total:	63	29,100

PUBLICATIONS

HOLST, M. J. Seed selection and tree breeding in Canada. Paper prepared for the 8th British Commonwealth Forestry Conference, East Africa, 1962. For. Res. Br. Tech. Note No. 115. pp. 34

MORGENSTERN, E.K. and YEATMAN, C.W., Editors. Proceedings of the 7th Meeting of the Committee on Forest Tree Breeding in Canada, Lake Cowichan, B.C., Aug. 21-23, 1960. Forest Research Branch, Canada Department of Forestry, Ottawa.

REPORTS

HOLST, M. J. Co-operative white spruce provenance experiment for the Great Lakes-St. Lawrence Forest Region. Progress Report prepared for Forestry Committee, Woodlands Section, Canadian Pulp and Paper Association, Montreal, November 21, 1961. pp. 8.

HOLST, M. J. Breeding of men and trees. Lecture. Deep River Science Association.

HOLST, M. J. and SANTON, J.B. Reciprocal scion-rootstock combinations of _Pinus banksiana_ Lamb., _P. resinosa_ Ait., and _P. sylvestris_ L. pp. 30.

MORGENSTERN, E.K. Planting in 1961 by the tree breeding section, Petawawa Forest Experiment Station. pp. 9.

MORGENSTERN, E.K. The origin, early development and possible genetic background of the Hudson's Place Norway spruce. Exp. No. 4. pp. 9

YEATMAN, C.W. Controlled pollination of black spruce in Manitoba, 1961. P-135, Exp. No. 243. pp. 10.

YEATMAN, C.W. Controlled pollination of red pine, 1961. (Petawawa Forest Experiment Station and Watabeag Lake, Swastika) P-139, Exp. No. 128. pp. 15

REPORT ON TREE IMPROVEMENT AT THE ACADIA FOREST EXPERIMENT STATION, April, 1960 - March, 1962

by

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This report deals with tree improvement by the Maritimes District, Department of Forestry, from June 1960 to March 1962. This was concerned mostly with provenance studies of *Abies balsamea* (L.) Mill., *Picea abies* (L.) Karst., *P. rubens* Sarg., and *Pinus resinosa* Ait. Work was also done on *P. sitchensis* (Bong.) Carr., and several exotic *Larix* Mill. and *Abies* Mill.

A provenance test involving 17 seed sources of *Abies balsamea* was established (Fig. 1 and Table 1). Plantations A, B and C were planted by the Department of Forestry, and the others by co-operators. Plantation N, a direct sowing made in 1957 on cultivated land, was a failure.

In co-operation with the Newfoundland District, a study is being made to determine whether heredity is a factor in the (reported) premature loss of vigor of *A. balsamea* growing on the Burin, Avalon, and Bonavista Peninsulas of Newfoundland, here referred to as the "problem area". The planting stock, from seed collected in this and other areas in Newfoundland, and in New Brunswick, was grown in the Acadia Nursery. It was sprayed with insecticide in the autumn of 1960 and spring of 1961 to prevent the carrying of *Adelges piceae* (Ratz.) into uninfested areas of Newfoundland.

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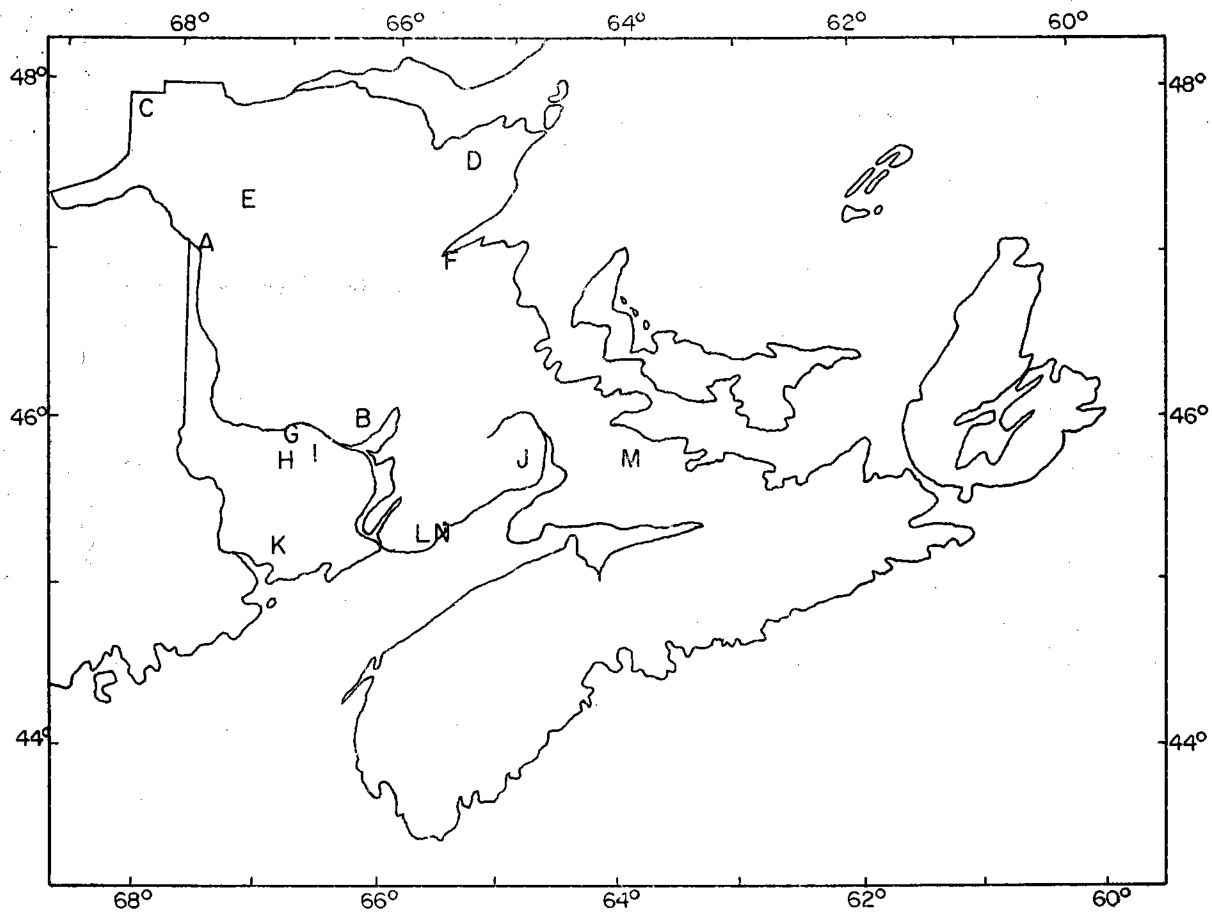
Fig. 1. Locations of plantations in *Abies balsamea* provenance test



Plantation	Place
A	Salmon River Burn, Victoria County, New Brunswick.
B	Acadia Forest Experiment Station, New Brunswick
C	McDonald Brook, Restigouche County, New Brunswick.
D	Haut St. Isidore, Gloucester County, New Brunswick.
E	Riley Brook, Victoria County, New Brunswick.
F	South Nelson, Northumberland County, New Brunswick.
G	Kingsclear, York County, New Brunswick.
H	Lake George, York County, New Brunswick.
I	Nasonworth, York County, New Brunswick.
J	Riverside, Albert County, New Brunswick.
K	Waweig, Charlotte County, New Brunswick.
L	Tynemouth Creek, St. John County, New Brunswick.
M	Near Oxford, Nova Scotia.
N	St. Martins, St. John County, New Brunswick.

Table 1. ABIES BALSAMEA PROVENANCE TEST

Origin of Seed	Number of Trees Planted Spring 1961.						Direct Sowing Spring 1957
	A	B	C	D to L[2]		M	N
Green River, N. B.	300	100	121	300	(J)	100	-
Oromocto, N. B.	1588[3]	100	121	700	(J)	100	½ lb.
Acadia Forest Experiment Station, N. B. (Seed lot MS. 118-56)	300	100	121	1400	(E)	100	½ lb.
Marystown, Burin Peninsula, Nfld.	-	100	-	-	-	100	
Sandy Brook, Nfld.	300	100	121	1000	(F)	140	½ lb.
Valcartier, P. Q.	300	100	121	200	(I)	100	-
Salmonier, Avalon Peninsula, Nfld.	300	100	-	-	-	100	-
Hawke's Bay, Nfld.	300	100	121	800	(I)	350	-
Bonne Bay, Nfld.	300	100	121	400	(L)	100	-
Nutak, Labrador	-	3	-	-	-	-	-
Canada Bay, Nfld.	-	100	121	500	(K)	200	-
Duck Mt., Man.	300	100	121	-	-	350	-
Clear Lake, Man.	300	100	121	900	(L)	350	-
West Canada Bay, Nfld.	-	100	-	-	-	50	-
White Bay, Nfld.	300	100	121	-	-	450	-
Adirondack Mts., N. Y.	300	100	121	600	(K)	100	-
Acadia Forest Experiment Station, N. B. (Seed lot MS. 304-56)	-	100	121	1000 2000 1000	(D) (G) (H)	200	-
TOTAL	4888	1603	1573	10800		2900	
spacing:	6'x6'	4'x4'	6.6x 6.6'	5' x 5' or 6' x 6'			

1/ Design: 3 x 4 rectangular lattice with three replications, and 100 trees per plot.

2/ Letters in brackets indicate plantation.

3/ Three hundred plot trees plus 1288 division and surround trees.

Plantation A on the Avalon Peninsula, within the "problem area", and Plantation B in an area producing good A. balsamea, were planted by personnel of the Newfoundland District under a separate project. Plantations C, D and E were established by the staff of the Maritimes District, and F and G by co-operators (Fig. 2 and Table 2).

A. balsamea, A. ernestii Rehd., A. homolepis Sieb. and Zucc., A. nordanniana (Steven) Spach, A. koreana Wils., A. koreana x veitchii Lindl., and X A. vilmorinii Mast. planted at the Acadia Forest Experiment Station during the second week of June 1959 (1930 trees in all), and A. balsamea, A. koreana, A. grandis (Dougl.) Lindl., A. concolor (Gord. and Glend.) Lindl. and A. alba Mill. planted in the second week of June 1960 (4,150 trees in all), were inspected in 1961. Survival of A. balsamea was only 66 per cent in the 1959 planting and 51 per cent in the 1960 planting. The survival of the exotics was better than the A. balsamea except for the A. homolepis and A. koreana in the 1959 planting and the A. grandis in the 1960 planting. The low survival may have been caused in part by the lateness in the seasons when they were planted.

A provenance test involving 12 seed sources of Picea abies was established in the spring of 1961. An additional plantation was made in 1962 (Fig. 3 and Table 3). Eleven of the seed lots were provided by the Petawawa Seed Bank and originated in some of the best stands in Europe. Plantations A, B, C1 and C2 were planted by the Department of Forestry and the rest by co-operators. P. glauca (Moench) Voss was used in control plots in most plantations. P. abies planted by others at earlier dates in a number of areas in the Maritimes, appears to grow more rapidly than our native Picea. The plantations in this provenance test are located in a wide range of climatic zones and sites. Plantations A, B, G, H, J, K, L and most of the plots in I were visited in the Autumn, 1961. Little mortality was observed.

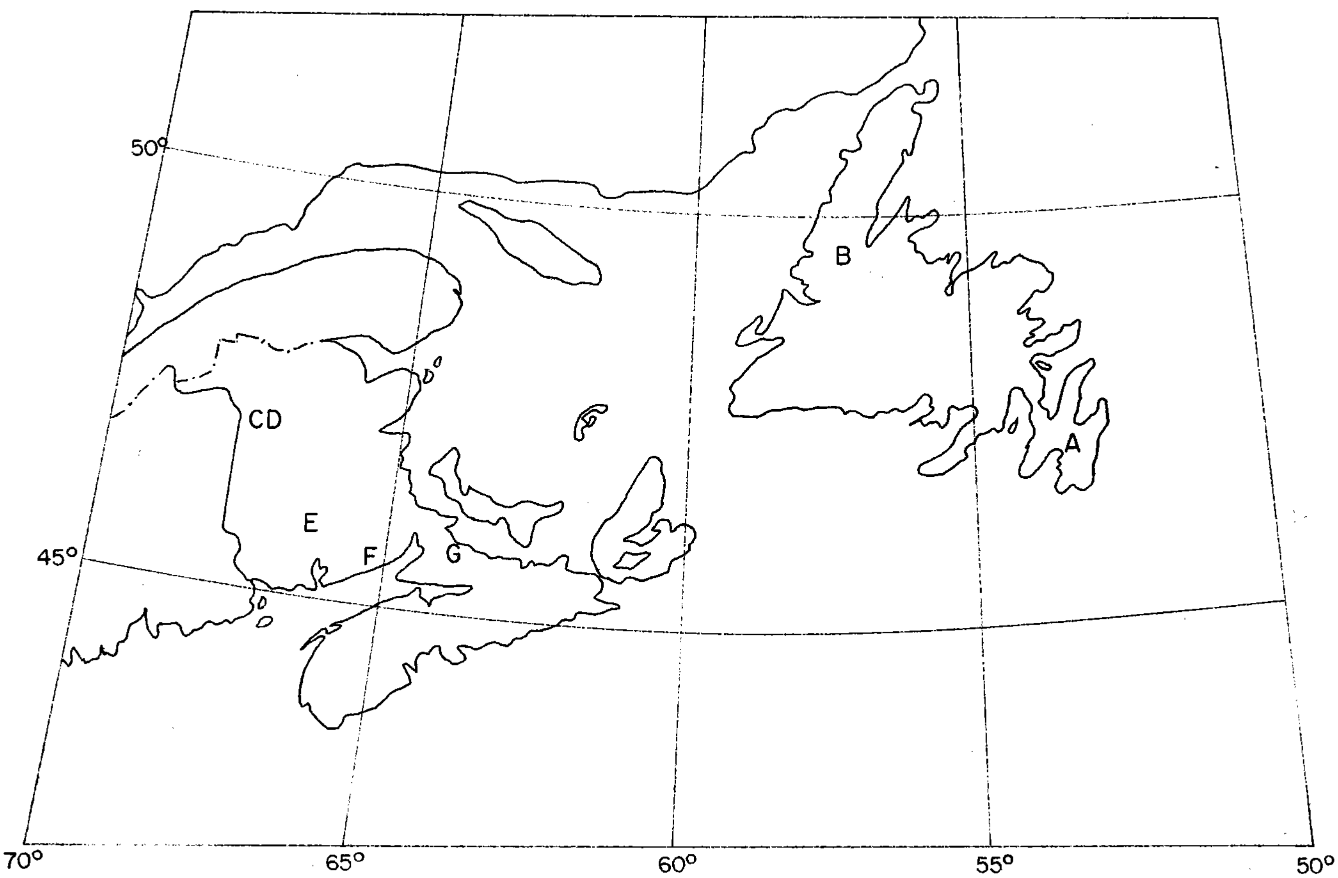
Plantation I consists of a number of plots in the foggy climatic region in the vicinity of Advocate, Nova Scotia. It was intended that these plots would be located on the slopes of the Cobequid Mountains, but some were planted on the outwash soils near the shore. The plots on the slopes appear more vigorous than the latter. Plantation J suffers from severe competition from hay.

The purposes for planting Picea sitchensis, P. glauca and lots likely to contain hybrids of these species, are to grow material, especially P. sitchensis x glauca hybrids, for use in the Picea A. Dietr. breeding at Petawawa, and to see how these lots grow in east-coast areas (Fig.4 and Table 4). Plantations B, C and D were established by co-operators. The direct sowing in 1957, Plantation D, was a failure.

The condition of each tree in Plantations A, B and C of the Picea rubens provenance test planted in 1959 and 1960 was recorded (Table 5). The foliage of trees in Plantations B and C on old fields was not as green as that in Plantation A, on a clear-cut area. Foliage on unreplicated observation plots in New Brunswick and Nova Scotia also showed this relationship.

Examination in June, 1960, of the Pinus resinosa provenance test planted in 1958 (4 x 4 balanced lattice square design with 16 seed sources, five replications, 49 trees per plot, plus division and surround trees, 5609 in all) showed heavy damage by deer; 22 per cent were browsed lightly to moderately, 73 per cent heavily and two per cent so severely that no buds remained to produce new shoots in 1961. Three per cent were dead. In the autumn of 1960 the terminal buds on the leaders which would produce the straightest stems were covered with polyethylene film to protect them from browsing deer, using a method described by McNeel and Kennedy (1959). The polyethylene was removed in the spring.

Figure 2. Locations of plantations in the study of premature loss of vigour of *Abies balsamea*



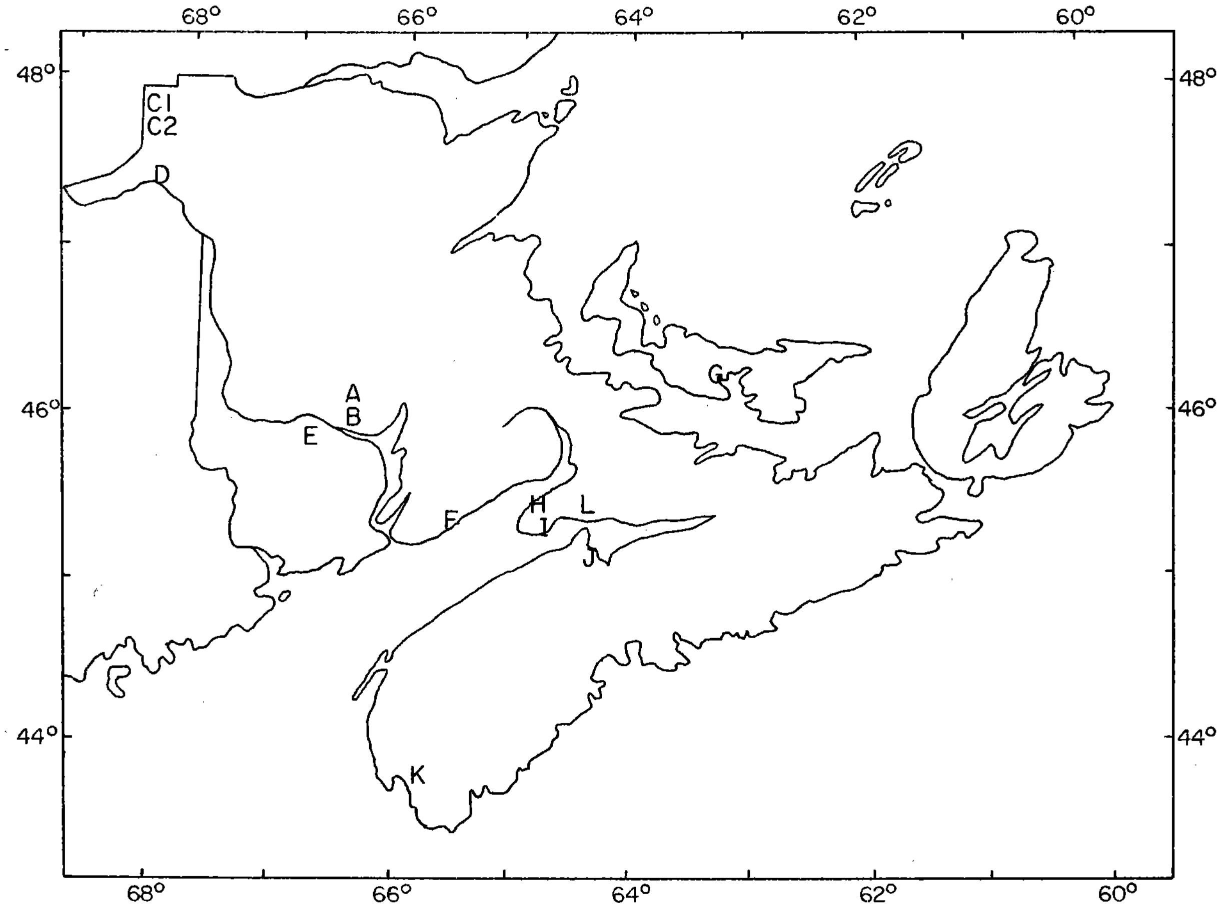
Plantation	Place
A	Near Salmonier Avalon Peninsula, Newfoundland.
B	Near Cormack, Newfoundland.
C & D	Salmon River Burn, Victoria County, New Brunswick.
E	Acadia Forest Experiment Station, Sunbury County, New Brunswick
F	St. Martins, St. John County, New Brunswick.
G	Oxford, Nova Scotia.

Table 2. PLANTATIONS ESTABLISHED IN THE SPRING, 1961, FOR THE STUDY OF PREMATURE LOSS OF VIGOUR OF *ABIES BALSAMEA*

Origin of Seed	Number of 2 + 2 Trees						
	Newfoundland			New Brunswick			Nova Scotia
	A[1]	B[1]	C[1]	D	E	F	G
Acadia Forest Experiment Station, N. B.	576	576	1,297[2]	-	90	-	-
Beaver Harbour, N. B.	-	-	-	-	180	250	90
McGivney, N. B.	-	-	-	-	480[3]	600	60
Chisholm Brook, Green River, N. B.	-	-	-	100	420	2,200	50
Salmon River, St. John Co., N. B.	576	576	576	-	420	400	50
Avalon Peninsula, Nfld. (Seed lot MS.120-57)	-	-	-	-	90	-	-
Burin Peninsula, Nfld.	-	-	-	-	60	-	30
Sandy Brook, Nfld.	576[4]	576[4]	576	-	300	400	-
Avalon Peninsula, Nfld. (Seed lot MS.232-57)	576	576	576	-	-	-	100
Lake Melville, Labrador	-	-	-	-	30	-	-
Millerton District, Nfld.	-	-	-	-	30	-	-
	2,304[4]	2,304[4]	3,025	100	2,100	3,800	380

1/ Randomized blocks with four replications, 12 rows of 12 trees per plot; spacing 6' x 6'
2/ Four plots of 144 trees each (576) plus 721 in double surround and single division rows
3/ One plot of 90 trees plus double end rows and single division rows (390 trees)
4/ Plus division and surround trees.

Fig. 3. Locations of plantations in *Picea abies* provenance test



Plantation	Place
A and B	The Acadia Forest Experiment Station, Sunbury Co., N. B.
C1 and C2	Summit Depot, Green River Watershed, Restigouche Co., N. B.
D	Second Falls Reservoir, Madawaska County N. B.
E	University of New Brunswick, Fredericton, N. B.
F	Saint Martins, St. John County, N. B.
G	North Point, Queens County, Prince Edward Island.
H	East of Apple River, Cumberland County, N. S.
I	Near Advocate, Cumberland County, N. S.
J	Acadia University, Wolfville, N. S.
K	South of South Quinan, Yarmouth County, N. S.
L	Chignecto Game Sanctuary, Cumberland County, N. S.

Table 3. NUMBER OF 2 + 2 TREES PLANTED IN PICEA ABIES PROVENANCE TEST

	New Brunswick							P.E.I.		Nova Scotia			
	A	B	C1 2/	C2 2/	D	E 3/	F	G	H	I	J	K	L
Picea abies													
Istebena, Poland	600	-	200	30	1000	200	400	1000	500	100	500	1000	-
Nagold Schwarzwald, Germany	300	-	200	30	500	200	400	500	-	100	500	100	570
Westerhof, Harzen, Germany	300	-	200	30	1000	200	400	500	500	100	500	500	-
Thuringen, Germany	300	-	200	-	1000	200	400	1000	500	100	500	500	60
Schwabishen Alben, Germany	300	-	200	30	500	200	200	500	370	100	500	-	-
Millstatt, Austria	300	-	200	30	700	200	400	500	500	100	500	500	70
Zwettl, Austria	300	-	200	30	400	200	-	-	400	100	400	-	-
Trieben, Austria	300	-	200	30	1000	200	-	-	400	100	500	-	-
Vopau, Austria	300	-	200	-	-	200	-	400	400	100	400	500	100
Nauders, Austria	300	-	200	30	500	200	-	400	370	100	500	400	40
Kowary, Sudeten Mts., Poland	300	-	200	30	700	200	-	400	-	100	500	400	80
Halifax, N. S.	-	500	200	30	-	200	-	400	300	100	400	400	-
Total P. abies:	3600	500	2400	300	7300	2400	2200	5600	4240	1200	5700	4300	920

Table 3. (cont'd)

	New Brunswick							P.E.I.	Nova Scotia				
	A[1]	B	C1[2]	C2[2]	D	E[3]	F	G	H	I	J	K	L
<u>Picea glauca</u>													
Acadia For. Exp. Sta., N. B.	1288[4]	-	200	-	500	200	200	200	400	100	-	200	-
Green River, N. B. (MS. 51-57)	-	-	200	-	500	200	-	500	500	100	-	400	1000
Green River, N. B. (MS.249-57)	-	-	200	-	400	200	-	400	400	100	-	400	-
Total P. glauca	1288	-	600	-	1400	600	200	1100	1300	300	-	1000	1000
Total trees:	4888	500	3000	300	8700	3000	2400	6700	5540	1500	5700	5300	1900
	6' x6'	6'x6'	6.6'x 6.6'	6.6'x 6.6'	?	6'x6'	6'x6'	8'x8'	6'x6'	8'&6'[5]	8'x8'	8'x8'	8'x8'

1/ Design: 3 x 4 rectangular lattice with three replications and 100 trees per plot

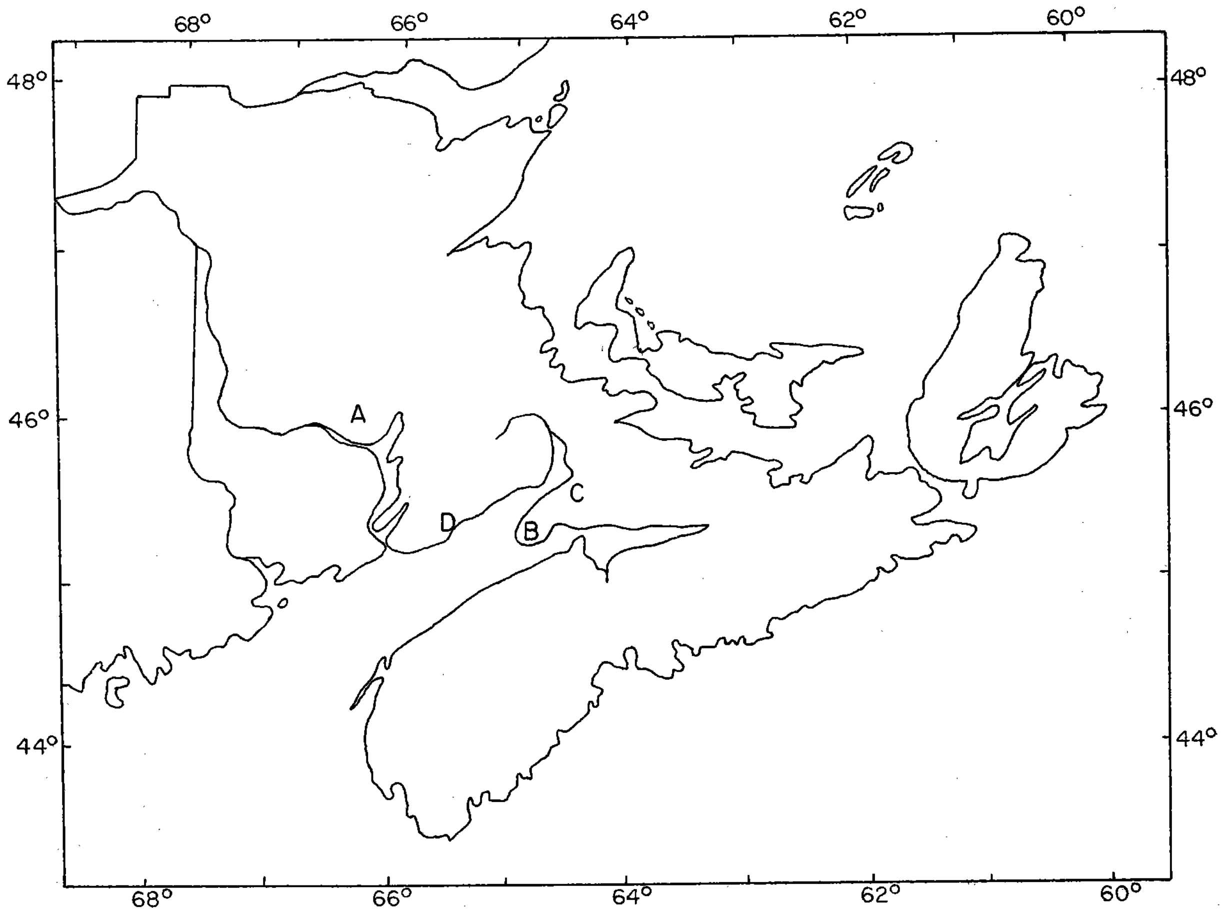
2/ C1 - Established in spring 1961, with two replications of 100 trees per lot
C2 - To be established in spring 1962

3/ Four replications of 50 trees per lot.

4/ Division and surround trees

5/ Spacing: <u>P. abies</u> 8' x 8'; <u>P. glauca</u> 6' x 6'

Fig. 4. Locations of plantations of Picea sitchensis, Picea glauca and hybrids



Plantation	Location
A	The Acadia Forest Experiment Station, New Brunswick
B	Near Advocate, Nova Scotia.
C	Chignecto Game Sanctuary, Cumberland County, Nova Scotia.
D	Direct sowing at St. Martins, St. John County, New Brunswick, in 1957.

Table 4. DISTRIBUTION OF PICEA SITCHENSIS, AND P. GLAUCA MATERIAL

Species	Origin of Seed	Trees Planted in 1961 A	B	C	Seed Lots in Direct Sowing 1957 D	Plants sent to Petawawa 1959	1960
P. sitchensis	Steward, Alaska	50	50	0		200	0
P. sitchensis (and x P. lutzii ?)	Holmer, Alaska	30	50	0		200	
P. sitchensis	Cordova, Alaska	200	100	700	50 g	200	600
P. sitchensis (and P. sitchensis x glauca ?)	Vilsboel Vanned Plantage, Denmark	200	100	380	50 g	0	0
" " " " " "	Lundsgaard, Denmark	200	100	370	50 g	0	0
" " " " " "	Tornby Klit Plantage, Denmark	200	100	2300	50 g	0	0
" " " " " "	ST.1/ 179, Springfield N. S.	5	0	0		0	0
" " " " " "	Springfield, N. S.	5	0	0		0	0
P. glauca (and P. glauca x sitchensis ?)	Springfield, N. S.	10	0	0		0	0
P. glauca	Jutland, Denmark	200	100	2200	50 g	0	0
" "	Green River, N. B. (Seed lot MS.249-57)	200	100	0		0	0
" "	Green River, N. B. (Seed lot MS.51-57)	700	100	0		0	0
		2000	800	5950		600	600

1/ ST - Seed Tree

Few of the terminals had been browsed during the winter of 1960-1961. The terminal buds were again covered in October, 1961. At this time undesirable leaders were pruned, and dead and missing trees and the trees with no buds were replaced. The damage caused by browsing deer may complicate the interpretation of future measurements.

Table 5. SURVIVAL OF PICEA RUBENS

Plantation 1/	Location	Year Established	Percentage survival 2/ 1960	1961
A	Central New Brunswick	1959	98.1 3/	97.6 4/
B	Northern New Brunswick	1960	N/A	98.5
C	Southern New Brunswick	1960	N/A	99.3

1/ Established according to 4 x 4 balanced lattice square designs with 16 seed sources, five replications, 100 trees per plot, division and surround rows and 4' x 4' spacing.

2/ Division and surround trees not included.

3/ No significant difference between survival of provenances (F value = 1.23)

4/ Survival since planting in 1959, dead and missing trees not replaced in 1960.

Plots of 100 trees per lot, from two lots of Larix leptolepis (Sieb. and Zucc.) Gord., five lots of L. decidua Mill. and one lot each of L. decidua sudetica, L. decidua polonica (Racib.) Ostenf. and Syrach, var., X L. eurolepis Henry and L. laricina (Du Roi) K. Koch, along with 50 L. occidentalis Nutt., 1150 trees in all, were planted at the Acadia Forest Experiment Station in the spring of 1961. About 700 trees, some from each lot were planted by the forestry students on the University of New Brunswick Woodlot. All lots, except the L. laricina came from the Petawawa Nursery. The seed source of each lot is known.

An attempt to grow _Cedrus libani_ Loud., _C. deodara_ (Roxb.) Loud., _C. atlantica_ Manetti and _C. atlantica glauca_ Carr., resulted in complete mortality in all lots between sowing in the spring of 1958 and making estimates of nursery stock in 1960. _Larix leptolepis_, _L. decidua_ and _L. laricina_ for provenance studies will be outplanted in the spring of 1962. _Picea rubens_ provenance material, and progenies of selected trees will be outplanted in 1963 and 1964 respectively.

As usual, plant material was exchanged with several research organizations.

REFERENCE

McNEEL, W., Jr., and J. KENNEDY. 1959. Prevention of browsing by deer in a pine plantation. J. Wildlife Mgmt., 23 (4): 450-451

CYTOGENETIC STUDIES IN CARAGANA

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X-Irradiation of Seed

Dry seed of C. arborescens (open-pollinated 1960 seed of several bushes mixed) was exposed to doses of 5,000r, 10,000r, 20,000r and 30,000r of X-irradiation in September 1960. Samples were germinated immediately and grown in greenhouse until the following May, when they were planted in the field.

Germination of seed of each treatment was 100%, of untreated seed, 62%. Irradiated seed began to germinate slightly (1-2 days) earlier than the control seed. There was no significant difference between the germination behaviour of seed of the different dosages.

Growth abnormalities were slight or absent in the seedlings of the 5,000r and 10,000r treatments but leaflets of the first 5-6 leaves of seedlings from the heavier treatments were crinkled, asymmetrical and mottled with yellow spots. Later leaves were normal and it appears that affected tissue did not survive competition with normal tissue. Root tips of the young seedlings were examined cytologically but no chromosome fragments were observed.

Measurements of the height of the plants in June 1961 indicated that seedlings from the 10,000r, 20,000r and 30,000r treatments were taller, by as much as 60%, than the controls but by the end of the growing season the controls equalled the tallest of the treated plants.

Some remaining seed of the 5,000r and 10,000r treatments and untreated seed was sown in October 1961 after storage for 1 year in envelopes under laboratory conditions. Germination was 100% (5,000r), 80% (10,000r), 66%(control). Leaf abnormalities were slight, as was the case in plants grown from seed of these treatments germinated immediately after germination. Storage did not seem to alter the irradiation affect.

Taxonomic Studies

As a result of taxonomic studies 2 papers were published:

Typification of the linnaean species of Caragana- Can. J. Botany 39, 1041-44 (1961). The type specimens of C. arborescens Lam., C. frutex (L.) Koch, C. pygmaea (L.) DC. were designated from those in the Linnaean Herbarium in London. The specimen bearing the epithet "Pygmaea" in Linnaeus' hand is actually C. frutex. It is proposed that another specimen, truly C. pygmaea, be designated as type to avoid renaming the species. It is apparent that Linnaeus understodd the species pygmaea and the error in labelling was merely a slip.

On the origin of Caragana sinica - J. Arnold Arb. 43, 203-214 (1962). Seed is distributed by many botanic gardens under the name C. sinica but it produces several other unrelated species. True C. sinica has been obtained only from the Grootendorst Nursery, Holland. This material is asexually propagated, is completely seed sterile and is triploid (2n-24). Pollen is partially aborted and normal embryo sacs are not formed. Herbarium specimens of the species from China have been examined, all have similar partially aborted pollen. On the basis of general morphology and pollen condition it is postulated that the species is a hybrid between C. rosea and C. microphylla. All available living material of both of the latter species is diploid and it is to be expected that their hybrid will be diploid and at least partially fertile. It is suggested that C. sinica in Asia is hybrid and diploid and that the triploid condition has arisen in cultivation through the formation of an unreduced gamete, the formation of which may have been stimulated by the unusual European environment.

REPORT TO COMMITTEE ON FOREST TREE BREEDING 1962.

by

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Research Division,
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1. General.

A graduate forester was added to the staff in October 1960. This increase in personnel has greatly benefited the research program. A new nursery area has been recently allocated. Deer-proof fences have been erected around the three outplanting areas at Lake Cowichan.

2. Selection.

The main emphasis has been on the selection of Douglas fir throughout Vancouver Island and the Lower Mainland. The objectives of this program are not only to select candidate trees for seed orchards but also to sample the population of coastal Douglas fir over as wide limits of its range as possible. Permanent clone banks of the trees selected are finally established for later breeding work. The number of Douglas fir selected from 1957 to 1961 is now 150; 64 of these trees being rated as plus and the remainder as almost plus trees. These trees are located over fifteen land districts in Vancouver Island and over two on the Lower Mainland. All of the trees selected to date have been propagated. The cruising involved has only been conducted during the summer months when temporary help was available so that progress has been slow and a great deal of the coastal region remains to be cruised. In addition, the work is becoming harder as the areas involved are becoming more and more inaccessible each year. Cooperation by industry is, therefore, of the greatest assistance and is actively encouraged. Fortunately it has been increasing steadily since 1958, and culminated this year in the establishment of clone banks by four of the leading companies on the coast.

The establishment of the first Forest Service seed orchard has been purposely delayed until a sufficient number of suitable trees had been selected. It was considered advisable to have high clone numbers when the genetic quality of the material was completely unknown. The first seed orchard, therefore, is largely an experimental unit. The area for this orchard has now been cleared, fenced and planted to rootstock. The first propagations will be made in 1963.

3. Anatomical Characteristics of the Wood of Selected Trees.

Since 1958 the cores of 225 selected trees and their surrounding dominants have been sent to the Forest Products Laboratory in Vancouver. These cores were extracted with either a 5 mm, 12 mm or 3/4" borer. The

specific gravity has been measured ring by ring from one to ten years on the cores of 64 of these trees and from eleven to thirty-five years at every five rings on 205 trees. Tracheid length has been measured in detail on 30 and spiral grain and compression wood on 205 trees. A complete report on this work is being prepared by the Forest Products Laboratory. It is hoped that this work will be continued as it is not only important that a background of information on the variation in internal characteristics of the Douglas fir be obtained, but that this investigation be extended to the progeny.

4. Progeny Tests.

A problem analysis involving the future of the whole genetic program has been recently written for detailed consideration by the Forest Service. It is essential that the most important aspect of the program, namely progeny testing, receives the necessary support.

The clone banks were all fertilised in the spring of 1961 and some interesting results were obtained. It was found that there was much variation in both cone and pollen production between different ramets of the same clone although all received the same amount of fertiliser. This was probably caused by the heterogeneity of the rootstock which, although from the same seed lot, would be highly variable as regards flowering propensities. Future research, therefore, will be directed towards the development of more uniform rootstock as irregular flowering within the ramets of a clone could have serious consequences in a seed orchard. Another clone was found to have a high proportion of hermaphroditic cones, a very undesirable character.

In general, the clones established from scions collected from the tops of sexually mature trees produced both cones and pollen in equal amounts. It was much more difficult, however, to induce pollen in young trees although cones could be produced in abundance in those as young as seven years. Further research into this problem of pollen induction is urgently needed. In spite of the shortage of pollen, some controlled crosses were possible in 1962.

5. Inbreeding of Douglas Fir.

The additional staff has enabled more time to be given to the breeding part of the program. Clones of some of the trees selected for the first seed orchard were inbred in 1962 to ascertain the degree of incompatibility. In 1961, successful backcrosses were made with four inbred progeny, in 1962 further backcrosses were made on a larger scale with progeny from five inbred lines. Sufficient pollen was also produced for some outcrosses to be made between different inbred lines, while further inbreeding to an S_2 generation was attempted with progeny in two lines.

6. Selection in other Species.

Western hemlock occurs in many of the stands which are cruised and trees are selected from time to time. As there is no great demand for the seed of this species for reforestation on the coast at the present time, the few trees selected have simply been propagated in a clone bank.

7. Plantings of Exotic Conifers for Future Hybridization.

The small breeding arboretum started in 1960 has now been restricted to the genera *Pseudotsuga* and *Tsuga* only. All the known species of these two genera are now represented in the arboretum at Lake Cowichan. Seed of many other species is sent to the recently established arboretum at the University Forest of the University of British Columbia.

"SUMMARY REPORT" 1961-62

par

L. PARROT

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I. Etude de Provenances.

1o Une plantation de 25 provenances de pin rouge a été mise sur pied suivant dispositif statistique avec répétitions, en collaboration avec la station de Recherches Forestières de Petawawa, Ont.

2o Les semences de 95 provenances de pin gris, couvrant l'aire canadienne, ont été ensemencées en mai 1962. Etude effectuée avec l'organisme de recherches ci-haut mentionné.

3o Quelque dix races de pin sylvestre, provenant de tiges sélectionnées et de vergers à graines, ont été ensemencées simultanément avec 2o.

4o Plantation de quelque 115 provenances de pin sylvestre, qui se continuera en 1963, en collaboration avec le professeur J. W. Wright, de l'Université du Michigan, E. U.

5o Une plantation de clones de Populus, sp. a été amorcée et se continuera incessamment.

II. Sélection individuelle.

La sélection d'arbres plus de Pin rouge et d'épinette noire est commencée depuis 1961 et portera sur plusieurs années.

III. Enseignement.

Un cours nouveau et couvrant les différents aspects de la génétique forestière et de l'amélioration des arbres forestiers est donné à la Faculté; ce dernier étant surtout orienté vers un but pratique.

IV. <u>Publications</u>.

1) "L'importance de la sélection en reboisement", Forêt Conservation, mars 1962.

2)"La génétique forestière, une clé pratique au reboisement" Le Laval forestier et géomètre, mai 1962.

V. <u>Travaux en perspective</u>.

1) Etude sur un aspect génétique de l'*Acer saccharum*.

2) Approche sur la floraison de certains conifères d'âge juvénile.

LP/SDV

REPORT TO COMMITTEE ON FOREST TREE BREEDING, AUGUST, 1962.

White Pine Weevil: Tree Resistance Studies

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I. Introduction

The fact that adults of the white pine weevil, Pissodes strobi Peck, have a definite preference for white pine leaders of particular quality led Dr. C. Heimburger to study the resistant qualities of pine stock, selected specifically for good growth, form, and seemingly resistance to weevil attack, under natural conditions. The studies were begun during the spring of 1957, at the Kirkwood Management Unit, Ontario Department of Lands and Forests, Thessalon, Ontario. In co-operation with Dr. Heimburger, the Forest Insect Laboratory, Sault Ste. Marie, has assumed responsibility for inspecting test grafts set out in field experiments to obtain records on the success, growth characteristics, and incidence of weevilling in the selected stock.

II. Experiment No. 1

This experiment involved grafting into pruned Scots pine, 400 scions made up of 20 grafts from each of five clones of resistant P. strobus and five clones of susceptible P. strobus, plus 20 grafts from each of five clones of resistant P. peuce and susceptible P. peuce. Annual surveys during the period 1958 to 1961 revealed considerable variability in their survival and vigor. The P. peuce grafts showed a higher percentage of survival than did the P. strobus grafts, but among the survivors of both species graft vigor has been about equal, with about 60 per cent of the grafts showing good to moderate vigor, and the remaining 40 per cent showing poor vigor.

Analysis of weevilling has been limited to stems of moderate to good vigor, because it is typical of white pine weevil adults to confine their attack to leaders so characterized. Of the resistant P. strobus stock, none of the leaders were killed as a result of weevil attack in 1959, 1960, or 1961, whereas among the susceptible stock, five, three, and 15 per cent of the leaders were killed, respectively. Of the resistant P. peuce stock, one, five, and five per cent of the leaders were killed by the weevil in 1959, 1960, and 1961, respectively, whereas among the susceptible stock, four 16, and 14 per cent were killed respectively. These figures indicate that both P. strobus and P. peuce stock, assumed to be susceptible to weevil attack at the beginning of the experiment, are indeed, more susceptible than the stock classified as capable of resisting weevil attack.

Tests of resistance of the above stock to blister rust were carried out by Dr. Heimburger concurrently with these studies. His results indicate that the P. strobus stock used in this experiment is rust susceptible, but that the P. peuce clones, especially those that seem to be somewhat more resistant to weevil attack, merit further consideration in the future. Examinations of this stock will, therefore, be continued.

III. Experiment No. 2

In 1961, the scope of the project was increased to include an additional 1,050 white pine trees top-grafted with 50 scions of each of 21 clones collected in Canada and United States. Materials grafted include P. strobus, P. peuce, P.

griffithii, and P. monticola, in addition to hybrids of each of the last three species obtained from crossings with P. strobus, and hybrids obtained from crossing P. strobus with P. parviflora. The grafts were selected for resistance to blister rust and resistance or susceptibility to weevil attack. During 1961, chemicals were used to protect the grafts from weevil attack and permit maximum graft success. Eighty-eight per cent of the grafts from the 21 clones (range between clones, 50 to 100 per cent) survived the summer and about 90 per cent of these exhibited good vigor. It is not known at this time whether grafts of the various clones will be fully hardy in the Kirkwood area. Observations on this aspect of the problem are continuing.

REPORT TO THE COMMITTEE ON FOREST TREE BREEDING IN CANADA

by:

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Report on Tree Improvement Work at

The University of British Columbia, Faculty of Forestry

Forest Tree Improvement work at the University of British Columbia is chiefly concerned with Douglas fir, the most important timber species on the Pacific Coast. Western hemlock, western red cedar, lodgepole pine, several native Abies species, black cottonwood, and some hybrid poplars are also under study.

The following projects were active during 1960 and 1961.

1. Studies of Douglas fir provenances, with special reference to British Columbia.

   Investigators: Dr. P. G. Haddock and J. Walters.

   The objective is to supplement studies under way in coastal Douglas fir provenances, by the Oregon Forest Lands Research Center. Thirteen provenances were included, mostly from the Interior regions of the Province. The seedlings were observed in the first two years in the nursery bed. Phenological observation and growth characteristics were recorded and 2+0 seedlings were transplanted to the University Research Forest in the spring of 1961. Further observations on growth characteristics are continuing.

2. The effect of inheritance on germination behavior of seed of Douglas fir.

   Initiated by Dr. G. S. Allen, continued by O. Sziklai.

   The objective is the determination of the physiological basis for dormancy and the relation of this to inheritance.

   Intraspecific reciprocal crosses were carried out on three trees in 1958, 1959 and 1961. Dry and wet pollination methods were tried. The wet pollination method gave double the number of viable seed produced by the dry pollination method. Stratified and unstratified seeds were tested by standard methods for germination. Seedlings were transplanted in 1959 to the University Campus Nursery. Progeny tests will be established at the University Research Forest in 1963 for later work with the F_2 generation and back crosses.