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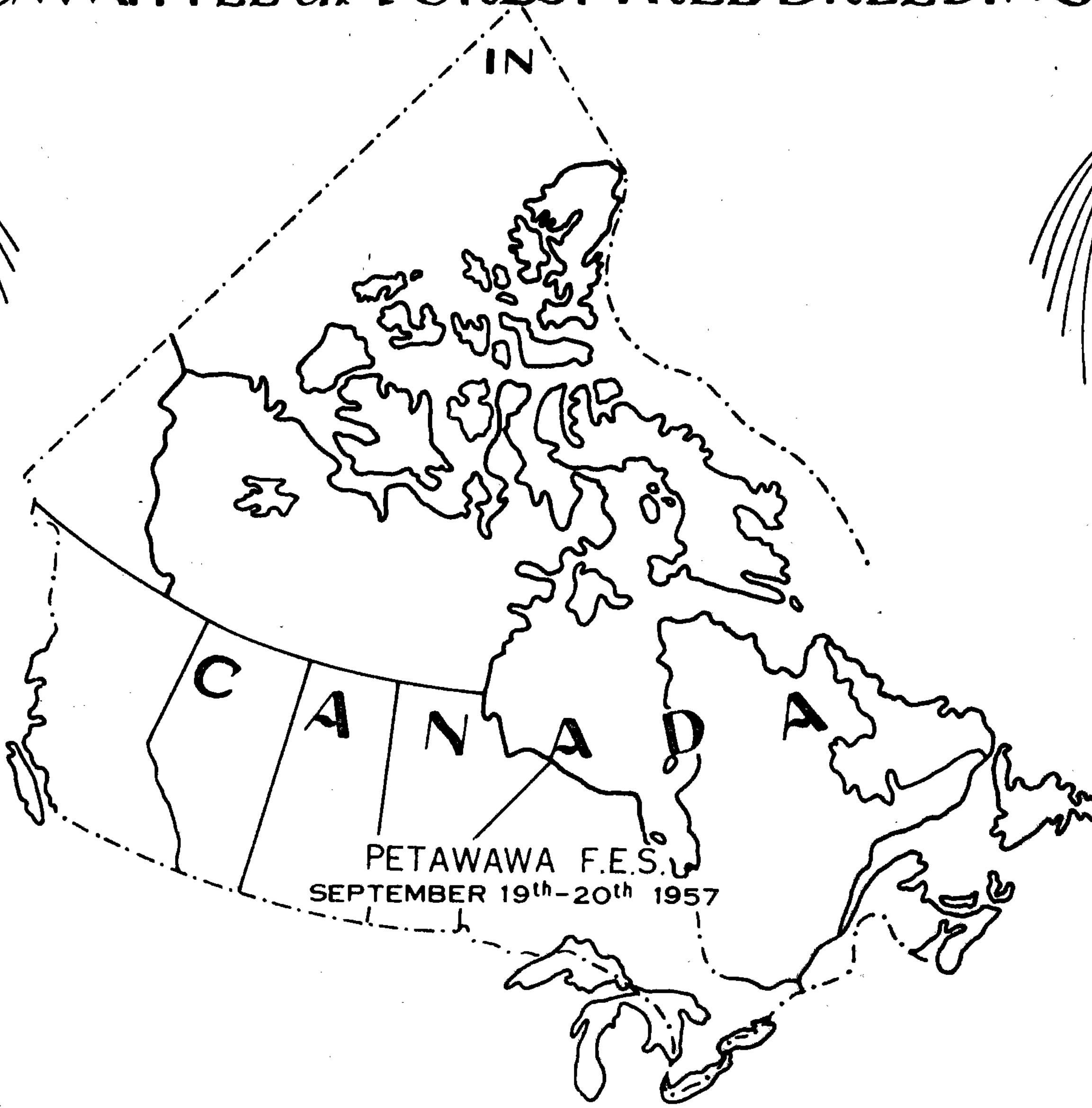
Proceedings of the Fifth Meeting OF THE COMMITTEE on FOREST TREE BREEDING IN



Part II
Reports and Papers

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

Held at Petawawa Forest Experiment Station, Forestry Branch, Department of Northern Affairs and National Resources, Chalk River, Ontario

on

September 19th and 20th

1957

Part I of the Proceedings, which includes the Minutes of the Meeting and Discussion of Reports, received restricted distribution to Committee members only.

Part II is distributed for information to persons and organizations outside of Canada who are actively engaged in forest tree breeding and forest tree improvement.

The Proceedings are prepared and distributed by the

Forest Research Division

Forestry Branch

Canada

Department of Northern Affairs and National Resources

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PART II

PROGRESS REPORTS AND PAPERS SUBMITTED

TO THE COMMITTEE

SEPTEMBER, 1957

BY: - -

APPENDIX

List of Active Members, September, 1957.

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REPORT TO THE COMMITTEE ON FOREST TREE BREEDING

by:

A.J. CARMICHAEL
and
G.B. WITHERS

Ontario Department of Lands and Forests

Ontario Tree Seed Plant

Angus

Ontario

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TEST PLANTING 1956

A. Planting Procedure

The use of a marker to maintain an accurate spacing between furrows has continued to improve the uniformity of hand planting. In order to extend this uniformity to the location of trees in the furrow, a method has been devised whereby the alignment of two pickets designates the location of each tree. A row of pickets is placed at six foot intervals along the edge of a furrow at one side of the planting area. Pickets with two contrasting colours (red and white, blue and yellow) are set alternately in the row. A similar row is placed beside a furrow approximately 240' from the first. A third row is placed between the two by alignment, from one side of the field. When planting, the alignment of two appropriate pickets (red and white, or blue and yellow), will designate the exact location for each tree. The method is simple, gives an accurate spacing and does not delay the planting.

The steel rods, referred to in the March 1956 report, for marking sample blocks, are unsatisfactory. Aluminum stakes are being used but are not sufficiently conspicuous. A 2" x 2" painted, wooden stake seems to be as satisfactory as any except for the replacement problem.

B. 1956 Planting Program

1. General

Each test planting was arranged in four replications with randomized blocks. A sample block of one source contained 100 trees, 10 rows of 10 trees, unless otherwise noted. Whenever possible, a 14" wide ploughed furrow was made and the trees planted by hand using the wedge method, at a spacing of 6' x 6'.

Replacements of each source were lined out in furrows adjacent to the planting sites, for refill planting in spring 1958.

2. White Pine Provenance Test

Cone collections were made in two sections of the Boreal Forest Region (Halliday, B7, B9), and four sections of the Great Lakes--St. Lawrence Forest Region (L1, L2, L4, L 10). Plantings were made, using 2-2 stock, in Hill's Site Regions 4, 5 and 6 as follows:

Seed Source			Planting Site			
Locality	Halliday's Section	Hills' Site Region	Site Region 4 Tp. 11C	Site Region 4 Morse Tp.	Site Region 5 Rose Tp.	Site Region 6 Hope Tp.
Timmins	B7	3	-	-	X	-
Port Arthur	B9	4	X	X	-	X
Angus	L1	6	X	X	X	X
Kemptville	L2	6	X	X	X	-
Massey	L4	5	X	X	X	X
Douglas	L4	5	X	X	X	X
Mattawa	L4	5	-	-	-	X
Blind River	L10	5	X	X	X	X

The planting in Site Region 6 varied from normal in that the block size was reduced to nine rows of nine trees in each row in order to fit the planting to the area available.

3. Red Pine Provenance Test

Cone collections were made in one section of the Boreal Forest Region (Halliday, B9) and six sections of the Great Lakes--St. Lawrence Forest Region (L1, L2, L4, L9, L10, L11), to provide twelve sources of red pine seed. Plantings were made, using 2-2 stock, in Hills' Site Regions 3, 4, 5 and 6 as follows:

Seed Source			Planting Site			
Locality	Halliday's Section	Hills' Site Region	Site Region 3 German Tp.	Site Region 4 Morse Tp.	Site Region 5 Rose Tp.	Site Region 6 Hope Tp.
Port Arthur	B9	4	X	X	X	X
Bruce	L1	5	X	X	X	X
Angus	L1	6	X	X	X	X
Kemptville	L2	6	X	X	X	X
Mattawa	L4	5	X	X	X	X
Douglas	L4	5	X	X	X	X
Golden Lake	L4	5	X	X	X	X
Pembroke	L4	5	X	X	X	X
Barry's Bay	L4	5	X	X	X	X
Temagami	L9	4	X	X	X	X
Thessalon	L10	5	X	X	X	X
Eagle River	L11	4S	X	X	X	X

The planting in Site Region 4 varied from normal in that the trees were planted by the T-Method without furrowing, and the sample block was reduced to five rows of five trees in each row.

4. Scotch Pine Christmas Tree Test

Eight sources of Scotch pine seed were used, seven were obtained from commercial dealers and one was collected in Norfolk County. Plantings were made, using 2-1 stock, in Hills' Site Regions 3, 4, 5 and 6, as follows:

Seed Source		Planting Site			
Place	Dealer	Site Region 3 German Tp.	Site Region 4 Morse Tp.	Site Region 5 Rose Tp.	Site Region 6 Hope Tp.
Norfolk	Ont. L. & F.	X	X	X	X
Cevennes	Est.Versepuy	X	X	X	X
Adirondacks	F. Herbst	X	X	X	X
L.Austria	F.W.Schumacher	X	X	X	X
Denmark	Anton Mielsen	X	X	X	X
Campigne	Est.Versepuy	-	-	X	X
Belgium	R. Firmin	X	-	-	-
Auvergne	Est. Versepuy	-	X	-	-

The planting in Site Region 4 varied from normal in that the trees were planted by the T-method, without furrowing, and the sample block was reduced to five rows of five trees in each row.

C. 1955 Test Plantings

1. Jack Pine Provenance Test

The plantings in Maria Tp., Site Region 5 and Cane Tp., Site Region 4 could not be maintained at full stocking with a sample block size of 400 trees. These were reduced in size from 400 to 100 trees by re-marking a smaller block in the centre.

Replacement plantings were made in both townships, by the Reforestation Supervisors of Pembroke and Swastika Districts, in spring 1957. The large size of the replacement stock (12" - 30"), and the irregularity of spacing due to machine planting complicated the work. In future, hand planting at a uniform spacing will be used.

D. 1954 Test Plantings

1. Red Pine Provenance Test

Replacement plantings could not be arranged as planned for this test, in 1957.

2. Scotch Pine Christmas Tree Test

In the fall of 1956 (late October, early November) observations were made in the Site Region 3, 5 and 6 plantings, of foliage colour change and counts taken of the number of lateral buds surrounding the terminal bud. Most trees are still too small to make comments as to their form.

The varieties received from France have the best coloured foliage in Site Regions 3, 5 and 6, and attain their best colour in Site Region 6 at Cambridge Tp. near Ottawa (the most southerly planting). This source also has the highest numbers of lateral buds in all three Site Regions with the exception of a West Baltic and Adirondacks (Herbst) sources.

All sources produce darker foliage in the Southern plantings than in the Northern Plantings and each produces more lateral buds in the South than in the North. An increase in the number of lateral buds should increase the density of branches and improve the appearance of the trees.

Source	No. Lateral Buds Site Region 3 German Tp.	Site Region 5 Rose Tp.	Site Region 6 Cambridge Tp.
France	3.6	3.9	7.4
W. Baltic	2.9	5.5	7.2
Finland	0.9	1.2	3.3

Rather extensive variation was found in all counts and there would seem to be some relationship between the soil type, the foliage colour and the number of lateral buds.

A small test is being made of the effect of pruning on the formation of buds, to determine which variety will produce an optimum of about 15 lateral buds after pruning.

3. Mugho Pine Christmas Tree Test

An inspection of the sources planted indicates that all are bush types and no single-stemmed habit has been produced.

4. Pine Shoot Moth Test

A comparison of Pinus nigra cebennensis from Cevennes, France, and red pine from Douglas in Site Region 5 is being made on two areas, to determine if there is any difference in the attack of shoot moth on these species. The following information was obtained by the Forest Biology Ranger Staff:

Species	No. Trees Attacked by Shoot Moth 1954		1955		1956	
	S.R.6	S.R.7	S.R.6	S.R.7	S.R.6	S.R.7
Red Pine	16	7	110	245	121	277
P. nigra cebennensis	30	11	21	82	20	45

N.B. Sample Size - Site Region 6 - 400 trees X 4 replications.
Site Region 7 - 200 trees X 4 replications.

A change in the method of examination was made in 1957 to indicate the reaction of the two species to attack by shoot moth. Four rows were selected in a random manner in each sample block and a total count of the number dead and the number attacked by shoot moth was taken for these rows. Three trees were randomly selected in each of these rows and a count made of the number of shoots attacked in each whorl, and the form of the tree described. The average for the four sample blocks of each species is as follows:

Species	Av. per Row of 20 Trees No. Dead	No. Trees Attacked by Shoot Moth	Total Ht. to 1956 inches	1956 Increment	*Form S-D-M	No. Shoots Attacked by Whorls **0	1	2	3	4
Site Region 6										
Red Pine	10.2	5.4	13.0	2.5	7-2-3	0.9	0.8	0.7	0.8	0.1
P. nigra	2.5	2.3	11.2	3.4	9-1-2	0.2	0.2	0.2	0.0	0.0
Site Region 7										
Red Pine	1.0	3.2	13.2	3.7	2-2-5	0.1	0.1	0.0	0.1	0.0
P. nigra	0.9	0.6	13.7	4.8	6-1-2	0.0	0.0	0.0	0.0	0.0

* S-D-M = single, double or multiple stem. The form of twelve trees is given, which is the average of four samples of twelve trees each.

** 0 whorl = This is the terminal shoot of the plant. In the case of double stemmed trees there are two of these and three or more for multiple stemmed trees.

N.B. The high mortality of red pine in Site Region 6 was due to grasshopper damage in the very dry summer of 1955.

The 1957 examination indicates that red pine continue to be attacked more frequently than Austrian pine. The Austrian pine are beginning to show a greater annual height increment and tend to have a single stemmed growth habit even after shoot moth attack. The general infestation, as indicated by this test, in Site Region 6 is four times as heavy, while in Site Region 7 it is the same for red pine and only half as great on Austrian pine as it was in 1956.

SEED PRODUCTION

A. Seed Production Areas

1. Nairn Township

This area will not be treated until the red pine trees recover from a severe attack by a midge insect which resulted in the loss of considerable foliage for several years.

2. Lynn Tract, Drury Forest

The fruit induction tests which were to be planned for this area of red pine, have been delayed until more information can be obtained on the effects of site on flower production. Mr. R.D. Carman carried out a preliminary soil survey of the area and selected 15 sites on the basis of topographic position and growth of the red pine. On each site selected, two replications of eight trees were established with four trees chosen for female flower counts within each replication, and four trees left for later treatment. The eight trees on each site chosen for female flower counts were further marked with zinc tags lettered A to O between sites and numbered 1 to 8 within sites. The eight trees on each site left for later treatment have yet to be numbered 9 to 16 and have flower counts made.

Description of Broad Sites Chosen by Topographic Position and Growth of the Red Pine

Site A - Steep south slope, middle position; fair growth.
B - Gentle west slope, middle position; good growth.
C - Moderate north slope, middle position; good growth.
D - Steep north slope, upper position; poor growth.
E - Ridge; poor growth.
F - Depressed flat; good growth.
G - Flat; good growth.
H - Gentle east slope, middle position; good growth.
I - Steep south slope, middle position; good growth.
J - Steep northeast slope, middle position; poor growth.
K - Steep west slope, upper position; poor growth.
L - Moderate west slope, lower position; fair growth.
M - Moderate west slope, lower position; good growth.
N - Steep south slope, upper position; fair growth.
O - Steep south slope, middle position; good growth.

Counts were made in June 1957 and the number of 1 year old and 2 year old cones per whorl recorded. There were no 1 year old cones on any site. The number of 2 year old cones is as follows:

Site	Number of 2 year old cones per tree								
	Replication 1				Replication 2				
	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7	Tree 8	Avg.
A	54	27	0	54	50	32	45	55	39.6
B	40	7	63	58	13	19	23	55	34.7
C	0	27	10	14	-	-	-	-	12.7
D	28	34	81	36	11	6	13	33	30.2
E	30	6	48	64	170	14	6	29	45.9
F	112	131	0	96	4	0	3	0	43.2
G	0	0	0	0	0	0	2	8	1.2
H	7	0	6	0	0	4	1	0	2.5
I	65	93	114	65	35	26	102	23	65.4
J	0	32	2	1	18	35	7	0	11.9
K	7	16	11	-	0	0	2	0	5.1
L	5	51	55	44	0	1	0	11	21.0
M	0	3	2	1	0	2	0	3	1.4
N	78	3	25	12	27	9	59	32	30.6
O	4	9	2	3	0	1	3	0	2.7

The trees selected will be re-examined to try and determine the cause of variation between trees on the same site. Mr. K. Armson of the University of Toronto plans to carry out foliar analysis tests to correlate cone production with the nutrient uptake of the tree. When fertilizer treatments are applied to individual trees, further foliar analyses would be carried out.

B. Seed Orchard Production

1. White Pine

In the winter of 1956, approximately 2700 grafts of white pine were made for Dr. Heimburger, to preserve various clones at Connaught Ranges. A series of greenhouse difficulties weakened many of the grafts and reduced the normal survival for the species. About 2200 or 80% were delivered to Maple in spring 1956. Another 4% have survived at Angus, although they were originally thought to be dead.

In order to increase the white pine cone production for Site Region 3, 1100 white pine, 2-2 stock, were planted at Maria Township in spring 1957 for later field grafting and 1000 white pine 2-2 stock, were potted for greenhouse grafting in winter 1957-58.

2. Red Pine

Site Region 3

The accumulation of scion materials from northern Ontario has continued. In February 1956 scions were collected by the Reforestation Supervisor at Swastika and shipped to Angus. Two hundred and ninety-six grafts were made in the greenhouse mainly on Scotch Pine. The survival on June 20, 1956 was 65% and on July 26, 1957 was 44%.

In February 1957, scions were collected by the Reforestation Supervisor at Cochrane and shipped to Angus. Eleven hundred grafts were made in the greenhouse mainly on Scotch pine. The growth of these scions has been very irregular and generally slow, so that no survival figure is available. When sufficient scions become available from grafted materials, they will be sent to the Ontario Division of Research, Maple, for clonal testing. While these are being tested, seed orchards will be established to increase the bulk production of seed for Site Region 3.

Site Region 5

Nine hundred and five red pine scions were grafted in Head Township, using materials supplied by the Petawawa Forest Expt. Station, in order to determine the procedure of orchard establishment by field grafting.

Scotch pine established in 1953 as stock plants, were in an area surrounded by native and planted red pines. For this reason Site Region 5 scions were used, although additional cone producing stands are not required for this region. Survival of the grafts seven weeks after grafting shows that 76% of the scions have new growth. The pattern of the failures would seem to indicate that a portion of the loss is due to the poor grafting qualities of one of the clones.

3. Scotch Pine

Timber Types

The propagation of 10 new selections from the Nellie Lake group of trees, in Cochrane District, was carried out in 1957. A two acre field has been prepared for field planting of an orchard in 1958 utilizing the original selections.

Arrangements are to be made to test the timber strengths and pulping properties of some of the parent trees and to compare these with jack pine from the same region. When sufficient seed is available from orchard stock, test plantations will be established to compare the growth of this Scotch pine with jack pine.

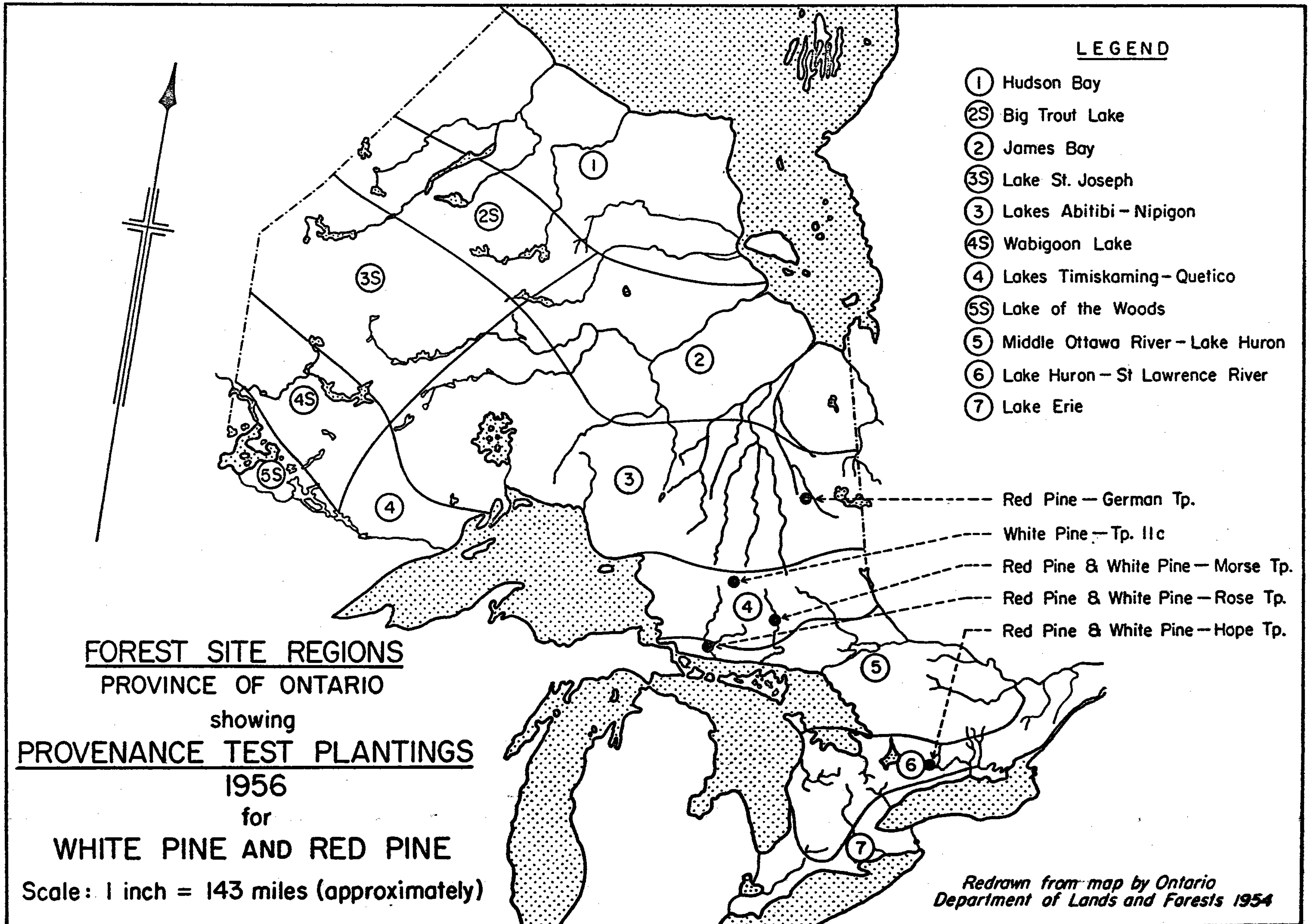
4. Yellow Birch

The grafting of selected veneer quality birch from the Algonquin Highlands has continued. In 1956, 134 grafts were made with a success of only 10%. In 1957, 444 grafts were made, with what appeared to be a high survival. Fungus attacks on the foliage reduced this to 34% by July 20. Bordeau mixture applied weekly is the best treatment available at present.

A survey, by means of aerial photographs, was made by R. D. Carman to locate potential birch seed orchard sites. It covered about 2700 square miles in the Muskoka and Haliburton area. Mr. Carman's report states:

"The specific location had to have a minimum of 2 acres clear with a 20 chain radius which was free or could be freed from yellow birch. A moulded till appears to offer the most advantages as it is a rich material, is usually moderately deep to deep, and has a smooth topography. The dumped till is less rich, is usually shallower and has a rougher topography. The fine sand appears to be the least advantageous as it is poorer in nutrients."

With this basis of suitability, Lots and Concessions were marked on Topographic maps for field checking. When field checking is completed there will be a sound basis for land purchase.



FOREST SITE REGIONS
PROVINCE OF ONTARIO
showing
PROVENANCE TEST PLANTINGS
1956
for
WHITE PINE AND RED PINE
Scale: 1 inch = 143 miles (approximately)

B.

SUMMARY REPORT FOR 1956
SHELTERBELT TREE BREEDING & NURSERY PROBLEMS

by:

W.H. CRAM

Forest Nursery Station

Experimental Farms Service

Canada Department of Agriculture

Indian Head

Saskatchewan

SHELTERBELT TREE BREEDING & NURSERY PROBLEMS

In 1956 the research program was expanded to include:1) Nursery and 2) Seed Viability Problems, in addition to existing breeding and improvement projects for Caragana, Spruce, Pine and Poplar. Services of a third technician and one laborer were made available for the two new phases of work after July. A new headerhouse with office-laboratory space and a new greenhouse are scheduled for construction in 1957. Encouraging progress is reported for 1956, despite increased administrative duties and a serious infestation of spruce seed insects.

Breeding work was confined to plants in the open, while existing greenhouse facilities were utilized for seed studies. An early spring with cold and wet weather prevailed until May 15, but was followed by a clear and dry period favorable to field breeding. A frost-free period of 118 days from April 10 to September 6 was experienced in 1956.

A brief summary of the 1956 results for active research projects follows.

CARAGANA

Cross-and self-compatibility studies in 1955 and 1956 with *Caragana arborescens* demonstrated that seven self-incompatible selections were cross-incompatible. However, three were highly cross-compatible with pollen of 12 vigorous and self-compatible selections. Hybrid seed from the 1955 determinations was sown in the greenhouse in January 1956 and the resulting hybrid progenies planted May 1956 in field vigor tests. The most vigorous progenies should identify the superior cross combinations. Mass production of hybrid seed of these combinations will be possible from Natural Crossing blocks of the two selections forming each superior combination.

Rooting of Softwood Cuttings was found to decrease with maturity of the wood. Results of a 1956 rooting test for two trees have been summarized in Table 1. It was evident that caragana was readily propagated by cuttings, if collected from June 14 to June 28. However, as moisture content of the cuttings at harvest decreased from 77 to 66%, rooting capacity decreased from 74 to 2%. Rooting of basal cuttings was materially increased by the hormones, until moisture content of the cuttings fell below 70%. Maximum rooting of basal cuttings was obtained when the moisture content at harvest was 75% Rooting of tip (or terminal) cuttings was inferior to that of basal cuttings until moisture content of the cuttings had fallen below 68%.

Table 1. Rooting and Moisture Content of Terminal and Basal Cuttings of Caragana at Six weekly Intervals.

(Averages for Two Trees)

date of collection	Moisture Content[1] Tip	Base	Ave.	Tip Cuttings[2] +	-	Basal Cuttings[2] +	-	Mean Rooting
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
June 14	79	75	77	70	50	95	80	74
June 21	79	73	76	50	60	85	50	61
June 28	74	70	72	55	40	55	40	47
July 5	69	68	69	5	5	0	15	6
July 12	68	67	67	0	10	0	10	5
July 26	66	66	66	0	10	0	0	2

[1]Moisture content (wet weight) of cuttings when collected
[2]Rooting with (+) and without (-) Rootone Hormone

SPRUCE

A small Seedcrop of spruce was further reduced by severe insect infestations in 1956. Large numbers of the male flowers were destroyed by larvae of the Owlet moth (Epizeuxis sp.) in late May. Twenty-five percent of the female buds on Colorado spruce (*Picea pungens*) were destroyed by larvae of the spruce budworm (*Choristoneura funferana*) in early June. In addition, 70% of the cones, which were produced from the 1956 Colorado Spruce breeding program, were damaged or destroyed by insects. Larvae of the spruce cone worm (*Dioryctria abietella*) caused most of this damage and larvae of the spruce seedworm (*Laspeyresia Youngana*) a lesser amount. (Note:- the above insects were identified by courtesy of the Forest Biology Laboratory, Science Service, Winnipeg.)

Seven Insecticides were investigated for the control of insects which attack spruce cones and seed. Female cones on two trees of white spruce (*Picea glauca*) were isolated in the bud stage by sausage casing bags. The isolated flowers were cross-pollinated with a pollen mixture to ensure cone set. Five series of seven insecticides were applied a week later to the fertilized cones within 35 bags on the two trees. The mature cones were classified (after extraction of seed) as to insect infestation by Mr. L.O.T. Peterson, Entomologist, Forest Biology Laboratory, with the results listed in Table 2. Insect infestations were not materially reduced by any of the insecticidal treatments. It was evident that insecticides must be applied in the pre-bloom stage to be effective. Reliable techniques were evolved for applying the dust form of insecticides for subsequent studies.

Table 2. Percentage of Insect Infested Cones of White Spruce Following Seven Insecticidal Treatments[1]

Series	D.D.T.	Malathion	Starch	Lindane	Endrin	Benexane	Methoxychlor
(Ranked)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	29.3	40.0	29.6	30.4	33.3	29.4	26.1
2	27.6	28.3	28.1	21.4	22.7	23.8	16.7
3	23.1	24.5	25.0	20.0	15.4	17.9	16.1
4	22.6	7.0	16.0	15.0	12.0	12.1	14.3
5	20.0	0.0?	0.0?	0.0?	0.0?	11.1	11.8
Means							
General	24.5	20.0	19.7	17.4	16.7	18.9	17.0
Weighted	24.5	24.9	24.6	21.7	20.8	18.9	17.0

[1]Insecticides applied as 5% dust with starch (except 2% Endrin preparate)
(Courtesy of L.O.T. Peterson, Forest Biology Laboratory, Indian Head.)

Self - and Cross - Compatibility investigations for Colorado spruce were seriously distorted in 1956 by the above mentioned insects. Only 20 trees with sufficient female flower buds were readily accessible for the 1956 breeding program. Three to six bags of bloom were utilized to determine effectiveness of isolation, self-and cross-compatibility of each tree. The results while incomplete suggest that eight trees were self-incompatible and five were cross-incompatible with two deep blue 'tester' selections. Average self and cross sets were reduced to one-ninth that of open-pollination apparently due to a combination of insect protection and high temperatures within isolation bags. Nevertheless, the 1956 investigations demonstrated the value of sausage casings as isolation bags for spruce breeding. The value of shading, by adding a paper bag during the pollination period, is being determined in 1957. Bagging of male flower buds on the tree hastened pollen dehiscence. Pollen from these bags was more bountiful and viable than that from detached branches.

Survival, Vigor and Coloration data for 8-year-old progenies of 25 Colorado spruce bore no relation to that for the same seedlings four years previously. However, marked differences existed between progenies for all three characteristics. For example, the proportion of blue seedlings ranged from 12 to 97% for the 25 progenies. Nevertheless, the age at which Colorado Spruce seedlings attain maturity of these characteristics has yet to be determined.

Provenance Trials to evaluate spruce species under prairie conditions were initiated in 1956.

Two-year-old seedlings of 15 white spruce provenances (from Quebec, Ont. & U.S.A.) were received from the Petawawa Forest Experimental Station (Courtesy of M. Holst) and planted in the transplant plots.

Seed accessions of nine white, two red and two black spruce (from Sask., Man., Ont. and N.B.) were sown in the seedbeds.

Methods for Grafting selections of Colorado spruce were investigated in 1956. Two-year-old seedlings, which were potted in April 1955, were brought into the greenhouse on April 6, 1956. Cleft, side and bottle grafts were made at four weekly intervals from April 12 to May 2. The average catch for the tree types of grafts was 45, 27 and 9%, respectively.

PINE

Progeny Tests, involving 88 seedtrees from plantations of seven Scotch pine races, were field planted in 1952 and 1953. Records for needle-burn, survival and vigor in 1956 revealed that vigorous progenies and outstanding seedlings were produced by seedtrees of each race. Eighty-five seedlings were selected for vigor and resistance to needle-burn. A slight relationship (r= .55) existed between the height of the 4- and 8- year-old seedlings.

POPLAR

Seventeen poplar clones were selected, from 80 hybrids and 40 species in test plantations on the station, on the basis of performance and rooting ability. A 1951 rooting test of these 17 clones was thinned to 4 x 4 foot spacings for a performance recheck. Records on survival, disease and vigor of these clones in 1956 have been summarized in Table 3. One poplar clone, FNS-52,

Table 3. Rooting in 1951 and subsequent Performance in 1956 of 17 Poplar Clones

Clone	Rooting 1951	Survival 1956	Disease[1] 1956	Height[2] 1956
	(%)	(%)	(rank)	(ft.)
P. X. FNS-#52	78	94	0	25.0
P. X. 38P38	67	75	2	20.6
P. tristis #1	84	87	2	20.0
P. gelrica	73	87	2	18.5
P. X Northwest	59	75	1	17.8
P. X Brooks #4	67	6	1	15.9
P. Sargentii	55	19	4*	15.6
P. X Brooks #7	74	25	4	15.3
P. incrassata	45	6	3*	13.6
P. X Dunlop	92	19	3	12.9
P. X Sask.	74	94	1	12.9
P. X BNW #4	61	100	0	12.2
P. X. Wheeler #4	76	6	5	11.1
P. X Volunteer	91	0	-	- -
P. X Brooks #10	77	0	-	- -
P. X PAS #2	68	0	-	- -
P. angustifolia	59	0	-	- -

[1]Ranking from 0 to 5 for incidence of cankers or die-back*
[2]Average height in feet

(selection of P. deltoides) was outstanding for survival, freedom from disease and vigor. Three other clones, 38P38, P. tristis and P. gelrica, demonstrated superior vigor to the standard Northwest clone.

SEED VIABILITY

Maturity of White Spruce cones and seed was further investigated in 1956. Specific gravity and/or moisture content proved reliable and accurate indices of cone maturity. A positive correlation (r= 0.98) existed between the respective values of the two indices. Specific gravity of the cones decreased from 1.04 to 0.77 and moisture content decreased from 60.7 to 48.2% in the four weeks just prior to natural seed-shed. Date of seed-shed for white spruce was directly related to the date of pollen-shed, and occurred on the average 98 days after pollen shed. Development of white spruce seed continued to within 15 days of natural seed-shed. Maximum yield of seedlings per cone (i.e. yield + germination) was obtained only when harvesting was delayed until 3 to 6 days before natural seed dispersal. It is recommended that cone collections of white spruce be delayed until 90% of the cones float in turpentine or 80% in kerosene.

Spruce Seed Viability was investigated under greenhouse and seed-bed conditions in 1956. Under greenhouse conditions following stratification for 60 days, germination was 92% for black spruce seed, and 80% for red and white spruce seed. Under-seedbed conditions following stratification for 90 days, germination was 70% for red spruce seed but only 50% for black and white spruce seed.

Seed from 9 white spruce accessions was stratified for 0, 60- and 90-days prior to seedbed sowing in 1956. Some dormancy was exhibited by seed of all accessions. On the average, germination was 9, 36 and 40%; and stand of seedlings was 7, 21 and 22%, respectively.

Maturity of Caragana Seed is clearly indicated by the moisture content of freshly harvested pods. Natural seed shed has been found to occur within a day or two of maturity when the moisture content falls below 20%, some 70 days after first flower. Results to date suggest that Caragana should not be harvested until moisture content of the pods falls below 50%, which is usually a week prior to natural seed-shed. Stratification in moist sand at 41°F for 15 days increased the average germination of mature and immature seed from 74 to 90%.

Viability of Caragana Seed was retained for at least five years under normal room storage, but only if mature when harvested. Immature and mature seed, as harvested annually from 1951 to 1955, was sown as non-stratified seed in the greenhouse. Germination of the immature seed averaged44% for the five years, but decreased from 76 to 20% with age. On the other hand, germination of mature seed averaged 90% and decreased with freshness from 99 to 78%. Immature seed had a tendency to decompose after sowing and the proportion increased with age. One-year-old seed exhibited a high degree of dormancy, which decreased from 48 to 22% when allowed to mature on the tree.

PHOTOPERIOD

Four Light Chambers were sown to stratified seed of three tree species. Growth records, as taken 60 days later, are summarized in Table 4. It would appear that the 16-hour photoperiod produced the greatest growth for all tree species, and was decidedly favorable for conifers. These results suggest the value of photoperiodic responses as a tool in tree breeding programs.

Table 4. Flush Growth and Weight of Seedlings for Three Tree Species under Four Photoperiods.

Photoperiod	Flush Growth[1]			Weight of Seedlings[2]		
	Spruce	Pine	Caragana	Spruce	Pine	Caragana
	(%)	(%)	(%)	(mg)	(mg)	(mg)
Natural	0	9.0	100	3.2	3.1	46.0
8 hours	0	25.0	100	3.1	3.5	41.0
8 + 2 Hours	79.9	54.0	100	3.7	3.8	50.8
16 hours	100	80.0	100	5.6	5.1	89.7

[1]Flush growth is % of seedlings with growth instead of terminal buds.
[2]Weight of oven-dry seedlings 60 days after sowing of seed.

RECENT PUBLICATIONS

'Self-compatibility of Caragana arborescens Lam.' W.H. Cram., Cdn. Jour. Bot. 33: 49-155. 1955.

'Toxicity of eight pesticides to spruce and Caragana seed.' Cram W.H. and O. Vaartaja., for. Chron. 31:247-249. 1955.

'Maturity of Colorado Spruce Cones.' W.H. Cram., For. Sci. 2:26-30. 1956.

'Damping-off pathogens of conifers and caragana in Saskatchewan.' O. Vaartaja and W.H. Cram Phytopath. 46:391-397. 1956.

'Rate and timing of fungicidal soil treatments.' Cram, W.H. and O. Vaartaja., Phytopath. 47:169-172. 1957.

'Maturity of white spruce cones and seed.' Cram, W.H. and H.A. Worden., For. Sci. 3: 1957.

C.

SUMMARY REPORT FOR 1956
DISEASES OF POPLAR

by:

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Southern Research Station

Maple

Ontario

DISEASES OF POPLAR

1. Orange Leaf Blight of Hybrid Aspen

For several years naturally-occurring hybrids of *Populus alba* x *P. grandidentata* have suffered from a prevalent and conspicuous leaf blight which appears in late summer. In trees affected the foliage on the higher branches turns bright yellow or orange changing, later, to brown. Eventually the underdeveloped, curled leaves die. Successive years of injury by this disease results in a stag-headed condition or in dead trees.

Investigation has shown that diseased leaves are infested by an intracellular fungus identified as a *Gloeosporium* species. A perfect stage, probably a *Gnomonia*, develops within the dead leaf tissue during the winter and spring. Spore discharge occurs some time after May 1.

Different clones exhibit varying degrees of resistance. Some appear to be immune; others are very susceptible and may die. Consequently, the prospect of suppressing this blight appears favourable.

2. Fungous Flora of Poplar

Cultures were made from 385 diseased leaves, twigs and stems of native, exotic and hybrid poplars at the Petawawa Forest Experiment Station. Most of these cultures yielded fungi; frequently 2, 3 and occasionally 4 different fungi were recovered from a single sample.

Trees from which fungi were isolated were: *Populus tremuloides*, *P. grandidentata*, *P. tremula*, *P. alba*, *P. balsamifera*, *P. trichocarpa*, *P. deltoides*, *P. koreana*, *P. rasumowskyana*, *P. nigra* var. *italica*, *P. nigra* x *laurifolia*, *P. balsamifera* x *laurifolia*, *P. deltoides* x *balsamifera*, *P. vernirubens* x *angulata*, *P. maximowiczii* x *berolinensis*, and *P. grandidentata* x *alba*.

Most of the fungi isolated fell into eight large groups, the largest being *Cytospora* and *Alternaria*. In addition, 20 smaller groups and sporadic cultures of individual species occurred.

The pathogenicity of fungi in the larger groups will be assessed in 1957 and, where their life histories are unknown, efforts will be made to secure the missing information. In this regard, cultures maintained at low temperatures are examined periodically for evidence of ascomycetous stages. To date, no such stage has developed although numerous imperfect stage fructifications have appeared. Consequently, monoconidial cultures have been obtained.

Isolates of the following destructive and well-known poplar pathogens also were secured preparatory to resistance studies:

Hypoxylon pruinatum (Klotzsch) Cooke
Dothichiza populea Sacc. & Briard

Cytospora chrysosperma (Pers.) Fries
Fusicladium tremulae Frank; and,
Septoria musiva Peck

A rapid and simple method was found for isolating single spores of H. pruinatum: Pieces of bark bearing mature perithecia, brought directly from the field, were immersed in distilled water and placed on the base of an inverted petri plate containing malt agar. Heavy ascospore discharge occurred within two hours. Dense, black masses of spores formed on the agar surface. Monospore isolations were readily made from the periphery of these areas.

3. Germination Tests

Closely controlled tests were made to ascertain the cardinal temperatures for the germination and development of conidia of Fusicladium tremulae. The tests were conducted on malt agar substrate and by the hanging drop method: Beginning at 35°F. the germination rate increased to an optimum of 74°F., decreased slightly to 76°F., then quickly reverted to zero.

This information should be of value in securing infections with F. tremulae under controlled greenhouse conditions. An estimate of the disease resistance of poplars, presently available, should be feasible by comparing that of each individual with that of the other varieties.

D.

ANNUAL REPORT 1956 - 57

FOREST TREE BREEDING, UNIVERSITY OF TORONTO

by:

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Toronto

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FOREST TREE BREEDING, UNIVERSITY OF TORONTO

Work is continuing with the seed lots of Norway spruce obtained from Mr. M.J. Holst and from other sources. Most trees are now in transplant lines. Several hundred trees from five selected strains (G-1, G-2, G-7, G-8, and G-11) have been potted for use in experiments to determine the variation in the pattern of annual height growth. The growing period was artificially lengthened for certain groups of trees by bringing them into a warm greenhouse with a 20-hour photoperiod, at intervals beginning November 1956. Under these treatments some trees behaved normally, i.e. the pre-formed leaf initials expanded, and then height growth ceased. In others a second or third flush was produced. In still others growth was continuous for some weeks after the pre-formed leaf initials had expanded. There was great variation within a treatment group, so the nature of the growth pattern may be due to inherited characters or to some feature of the plant or the environment not taken into account in the experiment.

In a second experiment the growth period is being shortened for certain groups of trees by subjecting them to heavy shade for 5 weeks during the growing season. If the growth this year or next year is not influenced by a period of shading, it will suggest that the period is being wasted by the plant.

In a further experiment the growth period is being shortened by shortening the normal photoperiod to 12, 10, and 8 hours.

The experiment to determine the response of white spruce to release from shade at different ages is continuing. Growth is reduced in proportion to the time that the seedlings have been shaded. Shaded seedlings have a bluish cast, the needles are finer, and the angle with the stem is not far from 90°. The Saskatchewan strain is inferior to the Ontario strain. A group of black spruce is equal to the best of the white spruce.

A graduate student, W.D. McJannet, was successful in air layering white pine following the technique used by Mergen of Yale University on other species. The work was done in the greenhouse on potted specimens from 4 to 15 years of age.

E.

SUMMARY REPORT

September 1957

A STUDY OF PHYSIOLOGICAL FACTORS INFLUENCING FLOWERING IN SPRUCE

P.-385

by:

D.A. FRASER

Petawawa Forest Experiment Station

Forestry Branch

Canada, Department of Northern Affairs and National Resources

Chalk River

Ontario

A Study of Physiological Factors Influencing Flowering in Spruce
P-385

MATURE TREES: the study of growth and flower production in mature trees in relation to site and weather was continued on an eight acre experimental plot. Twig samples were taken periodically for anatomical investigation to determine the time of initiation of flower primordia. A paper entitled "Relation of Environmental Factors to Flowering in Spruce" which includes the 1955-56 data, was presented at the Tree Physiology Symposium, Harvard University, April, 1957. The conclusions in this paper were as follows: "The contentions of earlier workers that an abundant seed year in the temperate region follows an excessively hot, dry summer was substantiated. Anatomical investigations indicated that the flower primordia which produced the 1956 seed crop were initiated during the 1955 growing season. The conditions which appeared to favour flower primorida initiation included a summer mean day temperature of 80 deg. F. and a night temperature of 56 deg. F. with an average daily sunshine of over 9 hours. Though radial growth was reduced on the drier sites during 1955, flower primordia appeared on all trees, indicating that soil moisture is probably of secondary importance in this area. These data are being used to design experiments for growth chamber investigations of young trees.

YOUNG TREES: experiments were initiated on the effect of photoperiod, day and night temperatures and the application of auxins and auxin antagonists on growth and flowering of young spruce trees. Although certain phases of this work will not be completed until growth chamber facilities and a complete range in age and growth cycles of experimental trees are available, yet two observations are of interest:

(a) Radioactive phosphorus sprayed on the leader and young needles of an 18-inch white spruce tree was absorbed and translocated to lateral branches. It is assumed that auxins and anti-auxins sprayed on young trees will also be absorbed.

(b) The application of one auxin antagonist (2, 4, dichloroanisole) was accompanied by the production of 63 female cones in a seven year old black spruce.

F.

OUTLINE OF PROGRAM IN FOREST TREE BREEDING

by:

C. HEIMBURGER

Southern Research Station
Ontario Department of Lands and Forests
Maple
Ontario

OUTLINE OF PROGRAM IN FOREST TREE BREEDING
SOUTHERN RESEARCH STATION, MAPLE, ONTARIO

The work at the Southern Research Station, Maple, Ont. is carried out under the direction of the Division of Research, Ontario Department of Lands and Forests. Breeding work with white pine, aspen poplars and two-needled pines are the main projects. Some work with chestnut was started in 1955 and with Thuja in 1956.

The main object of the white pine work is to develop trees resistant to the white pine blister rust, in addition to adaptation to climate, good growth form and growth rate, and possible resistance to weevil attack. The work is mainly concerned with *Pinus strobus* but includes related exotic white pine species.

The work with poplars is aimed at the production of aspen-like hybrids with rapid growth, good growth form, resistance to several important diseases, and capability of producing high yields in forest plantations in southern Ontario. Ease of vegetative propagation by means of stem cuttings is also one of the long-range objectives. The main species concerned are the two native aspens, *Populus grandidentata* and *P. tremuloides*, as well as related old-world species.

The work with two-needled pines is carried out in cooperation with the Petawawa Forest Experiment Station of the Forestry Branch, with the aim of developing strains of 2-needled pines with resistance to the European pine shoot moth and suitable for growing in southern Ontario, in areas with heavy shoot moth infestation. Several Asiatic 2-needled pines and species of the *Pinus nigra*-group show resistance to the shoot moth and the procedure is to incorporate the resistance of these species into the more commonly planted red and Scots pine.

The aim of the chestnut breeding work is to produce hardy dwarf chestnuts resistant to blight, for use as dwarfing stocks to induce early flowering in any breeding program with timber type chestnuts. *Castanea pumila* is the main species used in this work.

The work with *Thuja* is directed towards the production of timber types with good growth form and rapid growth rate, fully hardy and suitable for planting in southern Ontario. *Thuja occidentalis* and *T.plicata* are the main species involved.

The tree breeding work at Maple has been summarized three times and the summaries published as follows:

Heimburger, C. 1953 The present status of forest tree breeding in Canada. Proc. Lake States Forest Genetics Conf. Lake States Forest Exp. Sta. Misc. Report 22:33-41

1954 Forest Tree Breeding in Canada. Journal of Forestry 52(9):682-684

Holst, M.J. 1955 Forest Tree Breeding in Canada. Proc. Lake States Forest Tree Improvement Conf. Aug. 30-31, 1955. Lake States Forest Exp. Sta. Misc. Report 40:41-42

Annual reports on current work are submitted to the Division of Research, Ontario Department of Lands and Forests and are published in the Annual Research Reports of this Department.

G.

ANNUAL REPORT 1956-57
FOREST TREE BREEDING AND GENETICS
AT
PETAWAWA FOREST EXPERIMENT STATION

by:

M.J. HOLST

Petawawa Forest Experiment Station

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Canada, Department of Northern Affairs and National Resources

Chalk River

Ontario

FOREST TREE BREEDING AND GENETICS

AT

PETAWAWA FOREST EXPERIMENT STATION

General

No changes in personnel have taken place. Mr. Yeatman was on educational leave from September 1956 to June 1957. We have still been short of labour and some of the work of preparing plantation sites had to be postponed.

A greenhouse was built during the fall of 1956.

White Spruce

Cone collection was nearly completed for the large white spruce provenance experiment (Exp. No. 194) which is to be planted in the Great Lakes--St. Lawrence Forest Region.

In most parts of Canada a bumper crop in the spruces was predicted for 1956, the prediction being based on the very hot and dry summer in 1955. We therefore, had time to organize and obtain help from the many co-operators.

We had originally contemplated the collection of cones from 74 areas in Eastern Canada. However, we later reduced this figure to 60 and instead included areas in New York State, the Lake States and British Columbia.

The collections are summarized below:

Agency	Number of Collections			
	White Spruce		Red Spruce	Incomplete
	Requested	Fulfilled		
Member companies of C.P.P.A.	30	22	1	2
Ontario Dept. of Lands and Forests	17	15	-	-
Forestry Branch	9	9	-	-
Lake States F.E.S.	6	3	-	-
B.C. Forest Service	5	1	-	-
Quebec Dept. of Lands and Forests	4	2	1	-
New York State	1	1	-	-
Totals	72	53	2	2

We had some difficulty in obtaining collections from northern areas and will ask for these again in 1957. However, as 1957 most likely will be a very poor seed year, we may have to wait until 1958 before the collections are complete.

We are also short of three Lake States and four British Columbian collections which will be attempted during 1957.

The experiment, therefore, will most likely be sown during the fall of 1958 - a few years behind schedule.

The Lake States Forest Experiment Station is also conducting seed collections for white spruce provenance experiments to be planted in the Lake States. For this experiment we were requested to make sixteen collections of which we managed to make thirteen; of these six were within the Great Lakes--St. Lawrence Forest Region and presented no serious problems; the rest were in remote corners of Canada where both personnel and cones were scarce.

During the spring of 1956 we distributed 206,400 2-0 white spruce seedlings for a provenance experiment which included races from the middle part of the Great Lakes--St. Lawrence Forest Region (Exp. No. 93). The details of the seedling distribution are shown in Table 3. In the nursery at Petawawa Forest Experiment Station we planted a nursery provenance experiment which included 25 races of the same material. This experiment will be followed with detailed observations.

We were busy with cone collection in the autumn, and consequently we managed to select only one white spruce plus tree.

In the spring a number of white spruce crosses were made (see later under Spruce Breeding).

A provenance experiment (Exp. No. 144) including northern and northeastern white spruce was sown during the fall of 1955, but was lost due to pregermination and subsequent frost damage.

<u>Norway Spruce</u>

Fifteen selections were made of apparently weevil resistant Norway spruce trees from plantations in the Province of Quebec. These and earlier selections will form a basis for making a well formed, frost hardy, and weevil resistant type of Norway spruce suitable for the middle part of the Great Lakes--St. Lawrence Forest Region. If it is impossible to make such a type by selection within Norway spruce, we may be able to transfer weevil resistance from white spruce and Colorado blue spruce to Norway spruce by species hybridization. As white spruce and Norway spruce do not cross readily, we are attempting to establish an intermediate hybrid (see later under Spruce Breeding).

The details of planting are given in Tables 1 and 2. We planted in the field 350 grafts from selected weevil resistant trees for observation and seed orchard purposes. An Experiment (Exp. No. 76) including eight provenances was planted at Petawawa Forest Experiment Station. Similar experiments were planted at Harrington Forest Farm (Exp. No. 177), at Lorne, N.S. (Exp. No. 178), and Mersey Paper Company limits near Liverpool, N.S. (Exp. No. 179).

Red and Black Spruce

Considerable time was spent analyzing the various red and black spruce material in the Petawawa plantations for introgression. As the material flowered abundantly, it was relatively easy to decide on a method of scoring, and introgressive hybridization could be demonstrated. Also, population samples collected during trips in Ontario, Quebec, New Brunswick and the New England States were scored, although these were composed of dry herbarium material. The results of this investigation will be published.

The red spruce provenance experiment is progressing satisfactorily and will be ready for planting in the Maritime provinces in the spring of 1959.

One fall sown black spruce provenance experiment (Exp. No. 143) was a complete failure due to pre-germination.

Spruce Breeding

The cool and wet spring of 1956 prolonged and delayed the flowering season for both spruce and pine beyond the normal dates. There was also an abundance of flowers for all species of all ages, no doubt due to the hot dry summer of 1955. These two factors were of great advantage to the breeding program as a record number of flowers were isolated and pollinated.

The use of a locally constructed pollination tent facilitated the breeding work and showed promise of having further practical application. The white spruce we used as a test tree gave 2,962 cones which produced 80 grams of seed. In a good flowering year such a tent would be valuable for the large scale production of controlled hybrid seed and for selfing studies. It seemed to work well in the early summer (on spruce) while it was too hot and cooked both needles and flowers of the Scots pine which flowered later in the season. On the spruce, the tent was set over the exposed crown apex, 85 feet above the ground. The pine was only 10 feet high and protected from cooling breezes by surrounding forest. Further tests are to be made to determine conditions which limit the application of this method of isolation.

The presence of the many mixed plantations, and plantations which flowered for the first time (predominantly female), made it possible to remove the male flowers and to allow the female flowers to be wind pollinated by the surrounding species or by brushing or blowing selected pollen onto the female flowers.

In order to produce the crossing bridge between Norway spruce and white spruce mentioned above, the following crosses were made:

P. abies x	P. pungens P. koyamai P. jezoensis P. sitchensis	controlled hybrids 235 bags

P. glauca x	P. pungens P. koyamai P. jezoensis P. sitchensis	controlled hybrids 205 bags

P. asperata x (rubens + mariana) P. abies x asperata P. asperata x glauca P. obovata x glauca	made on open flowers

To investigate some peculiar, nearly fastigate, white spruce types which occur at Petawawa, and to demonstrate the probable heritability of this poor phenotypic characteristic, three trees were selected and crossed in all combinations, using 95 bags.

In order to study the black x red spruce hybrids further, we crossed and back crossed red and black spruce and their hybrids using about 500 bags.

To check whether Dr. Wright at the Northeastern Forest Experiment Station is correct in his assumption that the red and black spruce has some affinity with Picea omorica, we made the following crosses:

P. omorica x (rubens x omorica) P. mariana x omorica P. rubens x omorica	Controlled hybrids 70 bags

Red Pine

A red pine nursery provenance experiment (Exp. No. 74-A) was followed with phenological observations in an attempt to learn more of the physiological responses of the various provenances.

Seeds from a number of single trees of Austrian pines selected for high resin production in Austria were sown in the nursery. This material is intended for breeding shoot moth resistant types in the hard pines, as it appears that trees high in resin drown the attacking insect.

For the same purpose, a number of crosses were made on red pine. An attempt was made to transfer shoot moth resistance directly from P. nigra and P. thunbergii. The second approach was an effort to break down the apparent crossing barrier between red pine and the other hard pines by crossing it with the primitive P. densiflora. The following crosses were made:

P. resinosa (Petawawa) x	P. nigra (Maple) P. thunbergii (Rochester) P. densiflora (Rochester)	)	300 bags

In order to produce pine hybrids which in turn might hybridize more readily with red pine, and to produce some P. densiflora and P. thunbergii derivates which might prove more hardy and thus become of direct value in the Ontario breeding program, the following crosses were made on open flowers in an isolated Riga pine plantation:

P. sylvestris (Riga) x	P. densiflora (Rochester) P. thunbergii (Rochester)	)	4,200 flowers

Two red pine provenance experiments were planted at the Station. The one includes 25 provenances (Exp. No. 74-B) and the other 16 provenances (Exp. No. 74-E). Of the same material, one experiment including eight provenances was planted at the Harrington Forest Farm (Exp. No. 177), and one experiment including 10 provenances was planted on the limits of Mersey Paper Co., Liverpool, N.S. (Exp. No. 180).

Scots Pine

A number of new selections were made of Scots pine suitable for Christmas trees. A provenance experiment (Exp. No. 188) including Ontario, Belgian, French, German and Scots Highland Scots pine was sown for future selection of suitable Christmas tree types.

A number of provenance hybrids (Some 300 bags) of selected Scots pine Christmas trees were performed in one of the I.U.F.R.O. Scots pine provenance experiments which is located at Petawawa. It is still an open question whether provenance hybrids will be of any direct value for seed orchard purposes.

Earlier selections of elite Scots pine Christmas trees were planted in the pine graft arboretum. Small demonstration seed orchards were established in the fuel wood area (Exp. No. 190) and in Southern Ontario (Exp. No. 186). One thousand heavily graded single stem French Mugo pine (Exp. No. 184) were planted in the fuel wood area for the later selection of suitable Christmas tree types.

Other Tree Species

Finnish and Swedish elite birch was sown in the nursery and is intended for use in future work in birch breeding.

About 4,200, 2-0 Polish larch were sent to the nursery at Harrington Forest Farm for transplanting (Exp. No. 183).

Large seed lots of fir hybrids were obtained from Denmark for use in the Maritimes District.

Various larch, birch and red pine seed lots were sent on request to overseas co-operators.

Vegetative Propagation

About 1,500 grafts of selected material and 1,500 experimental grafts were made during 1956. An experiment to investigate a means of rooting pine needle fascicles was initiated.

Nursery Work

About 152,000 seedlings were transplanted in the Petawawa nursery and about 210,000 2-0 stock were distributed to various co-operators for the later planting of provenance experiments and observation plots. Twelve thousand 2-2 plants were distributed for field planting.

The warm fall of 1955 brought about much troublesome pre-germination, and several fall sown experiments were lost. The June beetle took a heavy toll in seed beds established directly after lifting transplants.

To improve on our seed bed technique, an experiment was initiated using various litters and compost for the improvement of soil fertility and structure, together with steam sterilisation and "Cemesan" application for the control of damping off. Cemesan proved ineffective, whilst the steam sterilisation resulted in a greatly increased seedling survival. This experiment will be followed in 1957 and the results published in due course.

Plantation Work

The details of the plantations established are shown in Tables 1, 2 and 4.

The new area at Turkey Point in Southern Ontario, where plants too tender for the Petawawa climate can be planted, has proved very useful.

The provision of land suitable for experimental planting, both at the Station and with co-operators, has been satisfactory.

The advance clearing of land for planting at Petawawa has lagged owing to a shortage of labour, and lack of markets for low quality wood.

Table 1
Spring Planting 1956, Petawawa F.E.S.

Experiment Number	Description		No. of Plants	Area (Acres)	Plantation Area
10 (108,185)	Selection and breeding of weevil resistant Norway spruce.	Grafts	350	1.2	P.A. 117
74-B	Red pine provenance test. 25 Seed lots.	Experiment Div. and surround	7,500 2,045	3.5	P.A. 106
74-C	Red pine provenance test. 16 Seed lots.	Experiment Div. and surround	3,920 1,361	1.9	P.A. 106
76	Observation of Norway spruce in general reforestation work. 8 Seed lots.	Experiment Div. red pine	8,150 400	2.8	P.A. 114
184	Selection of single stem French Mugo pine. 2 Seed lots.	Experiment Div. red pine	1,000 20	.3	P.A. 114
120	Scots pine Christmas tree seed plantation. (9 clones)	Grafts	38	.2	P.A. 114
86	General collection and Exp. No. 86	"	733	2.4	P.A. 115
		Total	25,517	12.3	
93-A	Nursery white spruce provenance test.		4,266	4266 sq.ft.	Lower Nursery

Table 2
Grafts and 2-2 Transplants Shipped to Outside Agents, Spring 1956

Experiment Number	Title	No. of Plants	Agent
--	Tender Lariciones and Insignes Grafts for Southern Planting.	50 (grafts)	C.C. Heimburger, Ontario Dept. of Lands and Forests, Maple, Ontario.
--	Tender Lariciones Transplants for Southern Planting.	210	" " " "
66	Trials of Larix Species in Eastern Canada.	440	E. Bonner, Spruce Falls Power and Paper Company, Kapuskasing, Ontario.
177	8 Provenance Red Pine Experiment at Harrington Forest Farm.	1,000	J.C. Anspach, Harrington Forest Farm, Calumet, P.Q.
178	4 Provenance Norway Spruce Experiment at Lorne, N.S.	4,000	Gordon Mackay, Lorne, Pictou County, Nova Scotia.
179	4 Provenance Norway Spruce Experiment at Liverpool, N.S.	4,000	Leif Holt, Mersey Paper Company Limited, Liverpool, Nova Scotia.
180	10 Provenance Red Pine Experiment at Liverpool, N.S.	2,300	" " " "
186	Seed orchard of grafted elite Scots pine Christmas trees planted near Courtland, Ontario.	97	C.W. Nodwell, Courtland, Ontario.
	Total	12,097	

Experiment No. 93B-J

Table 3

White Spruce Provenance Experiments. Distribution of 2-0 Seedlings, Spring 1956.

Experiment Number	Agent	Number of Provenances	Number of Seedlings
93-B*	Forestry Branch, Petawawa F.E.S.	25	30,000
93-C*	Ontario Department of Lands and Forests, Midhurst, Ontario.	25	29,400
93-D*	Spruce Falls Nursery, Moonbeam, Ontario.	24 (+1)	23,500
93-E*	Southern Canada Power Company, Drummondville, P.Q.	25	29,400
93-F*	Harrington Forest Farm, Calumet, P.Q.	25	29,100
93-G**	Lake States Forest Experiment Station, Rhinelander Nursery, Wisconsin	19	9,500
93-H**	Canada, Dept. of Agriculture, Indian Head, Saskatchewan.	14	14,000
93-I**	Forestry Branch, Winnipeg, Manitoba.	17	8,500
93-J**	Harrington Forest Farm, Calumet, P.Q.	12	33,000
		Total	206,400

* Designed experiments
** Observation experiments

Table 4
Plantations established 1955-1956 with material provided at an earlier date from Petawawa

Experiment Number	Title	No. of Plants	Agent
57-A	Provenance experiment planted Spring 1955 including five races of Norway spruce.	2,500	Southern Canada Power Company, Drummondville, P.Q.
57-B	" " planted Spring 1956	2,269	Saguenay Power Company, (Taillon Plantations)
57-C	" "	3,000	Consolidated Paper Corp., Grand'Mere, P.Q.
57-D	" "	1,200	Dominion Experimental Farm, Ste. Anne de la Pocatiere, P.Q.
59-A	" "		Harrington Forest Farm, Calumet, P.Q.
165	Observation plots of various white spruce and Norway spruce provenances, planted Spring 1955.	8,000	Harrington Forest Farm, Calumet, P.Q.
	Total	16,969	

Table 5
Summary of Grafting During 1956

Spring 1956	No. Grafted
German population of Picea sitchensis x abies	60
Danish Picea jezoensis x glauca (3 clones)	150
Danish Picea koyamai (2 clones)	50
Russian Scots pine and Norway spruce	17
Population sample of jack pine from Fort Smith, N.W.T.	100
Swedish coastal Scots pine selected for Christmas trees (3 clones)	60
Norfolk County Scots pine selected for Christmas trees.	20
Population sample of Red pine from Raco, Michigan.	100
Picea koyamai from Maple, Ontario.	39
Suspected P. Abies x pungens hybrids from Rochester, N.Y.	130
Scots pine of Scots Highland origin selected for Christmas trees in Thetford Chase Forest, Suffolk, England. (12 clones)	300
Fifteen Norway spruce trees selected for weevil resistance.	750
One elite white spruce from Manitoba.	20
Red pine experimental grafts.	900
Norway Spruce experimental grafts.	600
Total	3,296

Table 6

Transplanting Spring 1956

Larix species	10,000
Betula species	2,000
Red pine provenances	47,700
Various pine species	5,000
Various pine hybrids	1,200
Various spruce hybrids	450
White spruce provenances	28,000
Slender and broad spruce	30,000
Norway spruce provenances	15,000
Black spruce provenances	3,000
Red spruce provenances	10,000
Total	152,350

Reports

Holst, M.J. Distribution during 1956 of 2-0 white spruce seedlings for provenance experiments. File report, Exp. No. 93, P-132. 4pp.

----------. Notes on a nursery provenance experiment in white spruce. File report, Exp. No. 93-A, P-132. 4pp.

----------. Provenance experiment planted spring 1955, including five races of Norway spruce planted by Southern Canada Power Co., Ltd., Drummondville, P.Q. Establishment report, Exp. No. 57-A, P-136. 6pp.

----------. Provenance experiment planted spring 1956, including five races of Norway spruce planted at the Point Taillon plantations of the Saguenay Power Co. Establishment report, Exp. No. 57-B, P-136. 8 pp.

----------. Provenance experiment planted spring 1956, including five (plus two) races of Norway spruce planted by Consolidated Paper Corporation, Grand'Mere, P.Q. Establishment report, Exp. No. 57-C, P-136. 7pp.

----------. Provenance experiment planted spring 1956, including six provenances of Norway spruce planted at the Dominion Experimental Farm at Ste. Anne de la Pocatiere, P.Q. Establishment report, Exp. No. 57-D, P-136. 6pp.

----------. Provenance experiment planted spring 1956 on the Harrington Forest Farm, including five races of Norway spruce, planted by Canadian International Paper Co., Grenville Division. Establishment report, Exp. No. 59-A, P-136. 6pp.

----------. Observation plots of various white spruce and Norway spruce provenances planted at Harrington Forest Farm during the spring of 1955, planted by Canadian International Paper Co., Grenville Division. Establishment report, Exp. No. 165, P-132 and P-136. 5pp.

----------. Observation plots including four provenances of Norway spruce, planted near Lorne, N.S. Establishment report, Exp. No. 178, P-136. 5pp.

----------. Provenance experiment, including four provenances of Norway spruce, planted by Mersey Paper Co., Liverpool, N.S. Establishment report, Exp. No. 179, P-136. 8pp.

----------. Provenance experiment, including eight provenances of red pine planted at Harrington Forest Farm, spring 1956, by Canadian International Paper Co., Grenville Division. Establishment report, Exp. No. 177, P-139. 10pp.

----------. Observation plots, including eleven red pine provenances planted by Mersey Paper Co., Liverpool, N.S. Establishment report, Exp. No. 180, P-139. 10pp.

Reports - (Cont'd)

Holst, M.J. Review of Maritime Tree Breeding Project, December 1956. File report. 5pp.

----------. Review of C. Syrach Larsen's "Genetics in Silviculture". File report. 11 pp.

Yeatman, C.W. Pollination, spring 1956. File report, P-60. 14pp.

----------. Report on spring planting, 1956. File report, P-61. 10pp.

Publications

Holst, M.J. 1956. Scion storage and graft protection in the spring grafting of red pine. Forestry Branch, Tech. Note No. 29. 11pp.

----------. 1956. Phenology of rootstocks and grafts in a timing experiment with autumn and winter grafting of Norway and white spruce. Forestry Branch, Tech. Note No. 44. 17pp.

----------., J.A. Santon and C.W. Yeatman. 1956. Greenhouse grafting of spruce and hard pine at the Petawawa Forest Experiment Station, Chalk River, Ontario. Forestry Branch, Tech. Note No. 33. 24pp.

H.

FOREST GENETICS AND FOREST TREE IMPROVEMENT
UNIVERSITY OF BRITISH COLUMBIA

A Statement of Projects Initiated During 1956-57 and Proposed for Development During 1957-58 under a Grant from the National Research Council to the Faculty of Forestry and the Department of Biology and Botany.

by:

A.H. HUTCHINSON

July 9, 1957

Department of Biology and Botany
University of British Columbia
Vancouver
British Columbia

PART A

ABSTRACT

1. An analysis of the hybrid (wind pollinated) population of Douglas fir including a comparison of the coastal and interior races and the progeny of seeds from twenty sources.

   - The establishment of a plantation at the University of British Columbia.
   - Evaluation as a basis of selection of seed source sites (provenances).
   - Emphasis on growth rates and frost resistance.
   - Conclusions -

     (1) The greatest variability is associated with optimum ecological conditions.

     (2) Natural selection has developed many local ecotypes. Selection of superior progenitors is essential for the re-establishment of effective forests.

     (3) Natural selection on a basis of frost tolerance has established many local ecotypes. Survivors may be deficient in other desirable characters. Controlled selections of advantageous combinations is genetically feasible.

     (4) Analysis of the population on a genetic basis makes possible the prediction of the progeny class frequencies when the progenitors are known. The converse also is valid. Height inheritance in coastal Douglas fir seedlings may be evaluated on the basis of three pairs of genes which are cumulative in their effect. Progeny tests make genetic selections feasible.

2. Genetic evaluation of progeny from individual seed trees and wind distributed pollen - progeny tests.

   (1) Douglas fir seeds have been obtained from four coastal logging areas and are now planted. In each case, a superior, inferior and intermediate tree was selected on a basis of economic characteristics.

   (2) White spruce seeds from seven bearing trees in a row of 36, grown in the Thunder Bay nursery, Ontario, have been planted for progeny tests.

   (3) Yellow birch seeds from ten trees selected for high lumber quality are being used for progeny tests. With a view to establishment in British Columbia soil samples are being studied.

3. (1) Genetic formulae for the estimation for class frequencies of progeny resulting from phenotypically known crosses have been devised. Conversely when the frequency distribution curve of the

progeny is known the genetic complements of the progenitors may be evaluated. This applies particularly to quantitative characters which are expressions of multiple factors such as growth rates, frost tolerance and disease resistance. Skewness is the result of two or more pollen progenitors acting with a single seed progenitor and may be evaluated by comparison with the progeny of two completely heterozygous progenitors.

(2) Mass pollination experiments are in process, using electrically operated vacuum and air pressure equipment and specially devised collecting and dispensing nozzles.

(3) Pollen storage methods are being tested.

4. As in #2.

5. Histological and cytological studies of leaves and buds give evidence of the inheritance of genetic, growth and metabolic cycles. The development and activity of plastids, originating in the nuclear area, is interpreted as indicating genetic relationships.

6. A survey of natural spruce hybrids as a source of superior combinations of characters is planned. Progeny tests will follow.

7. Four species of Abies were selfed and crossed each with the other in 1956 and again in 1957. The progeny test is being applied.

8. To date many of these projects are in the initial stages of development; in most cases reasonable promise of definite conclusions is in view. Papers are in process of preparation as follows:

(1) The relative roles of genetics and environment as related to forest tree breeding.

(2) An analysis of the polyzygous population of Douglas fir with a view to selection of progenitors.

(3) The role of the nuclei in the histogenesis of leaf tissue plastids.

(4) New schedules for the preparation of mounted and stained sections of conifers.

PART B

Forest Tree Improvement - General Statement

1. The General Problem - Basic Requirements.

Forest tree improvement is attained by the selection, establishment, and perpetuation of favorable or desirable variants. Selection is primary and to be effective must be directed toward establishment and perpetuation. Establishment involves the selection of forms which are genetically adapted to the particular environmental site. In some cases the environment may be modified to fit the tree requirements especially in the nursery during the early period of three years, but ordinarily the great variation in individual trees or groups of trees facilitates the suitable selection of saplings. Perpetuation of the desirable species, race, or ecotype necessitates the selection of true breeding lines, that is, observance of the laws of heredity and the selection of phenotypically desirable homozygous genotypes.

Natural selection is ecologically adaptive and the resultant of the survival of adapted progenitors; in nature, test conditions are cyclic over a period of years and the non-adaptive may survive during the early years when and where noncritical conditions hold. The slow progress of natural selection and the polyzygous or heterogeneous features of the population follow directly. In the nursery and the greenhouse there is opportunity for controlled adaptive selection as well as mitigation of certain harmful conditions which are not serious during the later periods of growth. In order to be fully effective, selection must be planned and controlled.

2. The Evaluation of Variants of Douglas Fir Representing Regional Ecotypes.

(1) Two thousand seedlings, - two hundred from each of twenty provenances or ecotypes,- have been planted at the two or three years of age, in the University Botanical Gardens. Twelve of the seed sources are from coastal B.C.; five are from the interior; one from each of Washington State, Colorado, and New Zealand. Records and measurements of height, diameter, bud activity, branching, root development, leaf size and colour, form and symmetry, disease resistance and ecological tolerance, especially frost resistance, have been tabulated at various stages. There is abundant evidence of independent inheritance of many of these characters. The seedling height from a single seed source may vary as one is to twelve; the stem diameter as one is to six, that is, the sectional area may be as one is to thirty-six and the volume as one is to 432. Frequency distribution curves show marked characteristics for the different seed sources, and provide information applicable for seed selection.

(2) A table for the analysis and evaluation of a "Polyzygous Population" has been devised, copies of which are attached. A paper is in course of preparation.

(3) Frost tolerance has been amply tested by two successive years of low temperature in the coastal area, that is two successive nights of 10 degrees F. in early November, 1955, and seven nights at 10 degrees F. in January, 1957. The progeny of New Zealand seeds which originated in California suffered over 95+percent of mortality when grown at Vancouver while comparable plants from central British Columbia showed no apparent effect. There are marked differences between the frequency of killed seedlings from one-thousand-foot altitude as compared with those from near sea level. In addition, varying degrees of frost injury are apparent in seedling survivors, such as bud injury, leaf depletion, and hypocotyl scaling. These characteristics also are independently inherited; defoliation is related to mid-winter low temperatures, bud injury to frost at the last of the growing season, while hypocotyl stem injury is greatest during the period of day-and-night thawing and freezing in the spring. Graphs of the frequency distribution of frost-injury data demonstrate definite seed-source relationships.

(4) Conclusions reached are that natural selection has resulted in the establishment of regional ecotypes. The frost tolerance of individual plants of Douglas fir has been shown to vary greatly. This basic factor in tree establishment and the distribution of ecotypes should be recognized in the use and distribution of seeds. Progeny tests give early evidence of desirable seed sources for particular plantation areas.

3. The Significance of Variable Growth Cycles.

The hybrid or polyzygous nature of the Douglas fir is expressed in variation of growth cycles which are specific to individual plants. In one case the terminal bud may open early and the lateral buds later or the reverse may be the case. Again, the buds may be synchronous. Differences also occur in the closing period. Some Douglas firs show several cycles per year and others one only while growing under identical conditions. The trees which attain maximum growth with minimum frost exposure may be selected. A selection of 64 plants from 64,000 has been obtained and established in parallel with others from the same source which are smaller and in many cases show decided frost injury.

4. The Relative Roles of Heredity and Environment in Forest Tree Improvement.

(1) The nutrition experiments conducted by Dr. V. Krajina and observations of nursery stock give abundant evidence that optimum environment is accompanied by the maximum hereditary variation in growth rates, symmetry of form, growth cycles, viability, and general metabolic activity.

(2) Cytogenetic studies provide evidence that the range of tolerance to mineral and other deficiencies or excesses varies greatly in progeny of a common seed progenitor. Extreme deficiencies, as well as excesses of nutrients lead to physiological abnormalities such as etiolation, necrosis, barring, spotting, discoloration, die back,

and defoliation of leaves. Cytometabolic analysis is in progress with Douglas fir, sitka spruce, western hemlock, cedar, and poplar.* A paper on this subject is being presented to the American Institute of Biological Science at Stanford University, August, 1957. Another has been prepared on micro-technique for conifers (Zeitschrift fur Forstgenetik und Forstpflanzensuchtung).

5. Progeny Testing of Seeds from Selected Trees.

Members of the forest industry have donated seeds from superior trees of Douglas fir, spruce, and yellow birch. Nursery sowings are checked with seeds from intermediate and inferior trees from the same environment in each case.

6. Progeny Tests of Self- and Cross-Pollination of Abies.

Four species, resulting in twelve genetypic groups, are being evaluated. The experiment has been repeated in 1957.

7. Development of Equipment for Mass Pollination.

Exhaust and blower instruments with a generator and pollen-collecting and dispensing devices have been tested successfully. Suitable trees are being selected for pollination experiments in 1958. Pollen storage experiments are formulated.

8. Plans are made for a survey of superior seed sources to be undertaken during the summer of 1957 and for later collections, particularly from Douglas fir, hemlock, Abies and spruce hybrids.

9. Last year's preliminary report on "Forest Genetics and Tree Improvement" outlined a five-year programme. This year's report concedes that certain phases of the investigation are in their initial stages and in other phases preliminary conclusions, although in accord with evidence collected to date may require modifications to cover new data from further investigation. However, general agreement with other investigators on points covered warrants an advance with confidence.

The high degree of co-operation which has been attained is a matter of gratification. The writer is pleased to be associated in this joint project toward the goal of Forest Tree Improvement.

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*Nutrition experiments by H. Smith, Faculty of Forestry, The University of British Columbia.

PART C

SPECIAL PROBLEMS OF EVALUATION IN FOREST GENETICS WITH A VIEW TO SELECTION FOR FOREST TREE IMPROVEMENT

A Report to the National Research Council,
to the Faculty of Forestry
and the Department of Biology and Botany
of the University of British Columbia

1. General Problems in Forest Genetics

The arrangement of a plan of operation in Forest Genetics, in order to be effective, must take care of particular problems arising from the primary characteristics of the species, race, ecotype or individual and from the special ecological conditions of growth. In this two way interaction the tree is more flexible and more selectively adaptive and consequently of major concern. The essence of the problem is the selection of tree progenitors which produce progeny adapted to the conditions available in its particular reforestation area.

2. The Problem of Sampling: planned or orderly sampling in contrast to random sampling.

Selective sampling is necessary for three primary reasons:

(1) There is evidence that the virgin forest was the produce of cross pollination through indefinite time and the result is that the secondary forest is neither homogeneous or homozygous. Random pollination tends to maintain the current polyzygous status, according to Hardy's Law, provided that the variety of progenitors is undistrubed by mutation or selection. Ordinarily, selective logging removes the best progenitors and the resultant forest is the product of the inferior residue of progenitors. Natural reproduction approaches the virgin forest only where high quality trees are preserved, that is where the sampling has been genetically selective.

(2) The genetic process of reduction division (meiosis) and the subsequent production of gametes is ordered and therefore predictable and subject to effective utilization on a selective basis.

(3) Ordered sampling of female and male progenitors, combined with controlled pollination, takes advantage of the ordered genetic products of known genotypes and obviates chance combinations of gametes. There is no 'chance' in naturally self-pollinated peas and Mendel controlled pollination in making his crosses. Insect-pollination is regulated by the condition that the bee, or other pollinator, moves from flower to flower within the same species and the same race, flowering on the same day in a limited ecological area. However most commercial trees, particularly conifers, are wind-pollinated in nature, hence control is essential in order to attain the objective of tree improvement through selection and the subsequent maintenance of the superior types. Both male and female progenitor sources must be selected and utilized in seed production.

3. The Relative Roles of Genetical and Environmental Factors of Growth and Development.

The evaluation of these factors poses the problem of analyzing the variability of forest trees in nature and under control.

Douglas fir trees are distributed in the Rocky Mountain areas from California to Stuart Lake of northern British Columbia. They grow where the precipitation is 15 inches annually and where it attains 150 inches; there is a wide range of tolerance to temperature from sea level to 5,000 feet, in California; yet over all this ecological range the tree characteristics are sufficiently common that only one species is recognized. At the same time there is wide variation structurally, ecologically, physiologically and genetically. During the exceptional winters of 1955-56 and 1956-57 seedlings from warmer coastal areas were killed to the maximum extent of 90 percent -/- in nurseries of the same region; the reaction of individuals varied from death to complete normality. Natural selection of genotypes, incomplete despite the action of thousands of years, proceeded at an excessive rate. In contrast, seedlings from the interior of British Columbia and from higher elevations, showed a frost tolerance of greater than 95 percent under the same conditions.

Seedlings from a common seed source, grown in the same nursery and situated side by side in a plot show remarkable variation in growth rates of stem, roots and leaves; variability is notable in periodicities of bud activity, particularly in the terminal bud, in form and axial symmetry and lateral branching, in wood structure and in histological development of leaves, colour of leaves, disease resistance and in tolerance of ecological conditions. Multiple combinations of these features indicate independent inheritance. The question of the relative roles of heredity and environment is primary. Secondarily, of the hereditary quota, what part is evident in the phenotype and what part is hidden to reappear in later progeny? Of the ecological quota, how much is due to natural selection of genotypes and how much is the expression of temporary response to environment? Completely controlled conditions and completely homozygotic seeds could lead to a solution of the problem. Neither of these is feasible for conifers under forest or nursery conditions. Nursery records and green-house experiments combine to provide confirmatory evidence on a number of significant relationships: V. Krajina* has conducted a nutrition experiment with complete and deficient culture solutions and soils which demonstrate that <u>the more favorable the conditions, as judged by the average growth, the greater is the degree of variability</u>. This applies to Douglas fir, sitka spruce, western hemlock and western red cedar. Moreover comparing genera, species and individuals of a common species, race or ecotype, notable specific variabilities characterize each group. Previously, our observations of nursery seedlings gave evidence that seeds from a common regional source are most variable under the better growing conditions. Since variability was being studied, the better part of a seedbed was selected as the source of plants to be used in the University plantation. Following the confirmatory green-house evidence it appears reasonable to conclude that the <u>genetic</u>

*Department of Biology and Botany and the Faculty of Forestry, University of B.C.

contribution is properly represented by readings of characteristics taken under optimum ecological conditions. Furthermore V. Krajina's experiments show that there is minimal variation with magnesium and phosphorus deficiency, that is where the total growth is at a minimum. The genes gain full expression only under optimal growth conditions. *H. Smith has conducted a nutritional experiment, using variable nutrient combinations as growth media for cuttings from a common poplar stump. Analysis in this case will yield additional relationship.

4. The Problem of the Evaluation of Quantitative Characters in a Polyzygous Population, Frequency Distribution Formulae and Curves.

Mendel began his experiments with homozygous 'parents'; the first 'filial' generation was entirely heterozygous and the second 'filial' generation was an aggregate of homozygous and heterozygous progeny, the frequency of the genotypes being in greater proportion in accord with the degree of heterozygosity. In wind-pollinated trees, continued crossing has produced many generations which are genetically comparable to the second 'filial' generation; the homozygous individuals are comparatively infrequent. In addition, several independently inherited alleles may contribute to a common characteristic, in additive manner. The genes of each allele may be active (A) or inactive (a) in homozygous (AA) or (aa) or heterozygous (Aa) condition, thereby contributing two, one or zero active factors toward a characteristic such as growth rate. In this case each of the three genotypes is expressed as a phenotype, the genotypes are readily recognized, and selection is relatively simple. There is evidence that height growth in western yellow pine has this type of inheritance. The situation is much more complex in Douglas fir and three alleles are required to account for the height-growth variation complex. "The multiple factor hypothesis" for additive alleles was introduced by Nilsson-Ehle to satisfy his study of the inheritance of color in wheat. In certain cases he described the population as consisting of seven classes with color ranging from extreme red to white, that is, 7 classes; 6 'Red', 5,4,3,2,1,0 'Red' having the frequency distribution 1,6,15, 20, 15,6,1, respectively, in the second filial and succeeding generations. Galton's biostatistical interpretation of Pascal normal distribution curve or binomial extension was accepted previously. At that time the fact was not known that the power of the binomial is genetically limited by the number of contributing alleles and this number, in turn, is limited by the number of chromosome pairs, that is by specific and reasonably low numbers. Recently, the specificity of quantitative genes has been confirmed by physiological genetics. Cameron and Teas in "Genetics and Metabolism" quotes Wagner's and Mitchell's analysis of inheritance of endosperm components in corn, particularly starch, sugar, nicotinic acid, thiamine and biotin. In each case these variables are expressed very closely as multiples of basic numbers. These series, in turn, suggest the chemical law of 'Definite Proportions' and the quantum of energy ascribed to genes by Schrodinger.** Moreover the multiple-factor hypothesis has the advantage that when the genotypes of the progenitors are known the progeny are predictable;

*Faculty of Forestry, University of British Columbia.
** "What is Life?" - University of Dublin Lectures.

in addition, the genotypes of the progenitors may be determined from the class frequency of the progeny. The tables presented in "Analysis of a Polyzygous Population - Three Additive Alleles" (ref. appendix) presents simplified formulae for the determination of any term in the genetic equation, including the class frequency distribution, all on a basis of (N) the number of alleles involved and (n) the combined heterozygocity of the progenitors. The result of selfing and all possible crosses of effective genotypes are tabulated in abbreviated form. Seven hundred and twenty-nine possible crosses are fully represented by twenty-eight types of crosses. A paper is in preparation including class-frequency distribution curves, for a single seed and a single pollen parent in each case. Skewness is shown to stem from the interaction of three or more progenitors, for instance the presence of pollen from more than one progenitor, as in wind pollination.

5. The Problem of the Metabolic Control of the Cytoplasmic Differentiation by Genetic Activity.

Photographs of leaf sections from each of four conifers demonstrate the streaming of mitochondria and protoplastids from orifices in active nuclei and give evidence of their metabolic activity. The degree of nuclear and cytoplasmic activity may be limited by nutritional deficiencies as shown by sections from Dr. Krajina's experimental material. The phenotypic variability is paralleled by cytometabolic differentiation. There is evidence of the genetic control of physiological features.

Papers are in process of preparation dealing with each of the genetic problems outlined in this preliminary statement.

July 10, 1957.

A.H. Hutchinson

The University of British Columbia,
Vancouver.

ANALYSIS-POLYZYGOUS POPULATION - THREE ADDITIVE ALLELES

PROGENITORS						PROGENY							
PHENOTYPES		GENOTYPES				PHENOTYPES							
CLASS	RATIOS	RATIOS	ALLELES			HETEROZYGOCITY	FACTOR-CLASS RATIOS CLASSES						
			11	22	33		6	5	4	3	2	1	0
6A 6A	1/64 1/64	1	AA AA	AA AA	AA AA	0 0 0	64						
6A 4A	1/64 3/64	3	AA AA	AA AA	AA aa	0 0 0		64					
4A 4A	3/64 3/64	9	AA AA	AA AA	aa aa	0 0 0			64				
4A 2A	3/64 3/64	9	AA AA	AA aa	aa aa	0 0 0				64			
2A 2A	3/64 3/64	9	AA AA	aa aa	aa aa	0 0 0					64		
2A 0A	3/64 1/64	3	AA aa	aa aa	aa aa	0 0 0						64	
0A 0A	1/64 1/64	1	aa aa	aa aa	aa aa	0 0 0							64
		35											
			11	22	33		6	5	4	3	2	1	0
6A 5A	1/64 6/64	6	AA AA	AA AA	AA Aa	0 1 1	32	32					
4A 5A	3/64 6/64	18	AA AA	AA AA	aa Aa	0 1 1		32	32				
2A 5A	3/64 6/64	18	AA AA	aa AA	aa Aa	0 1 1			32	32			
0A 5A	1/64 6/64	6	aa AA	aa AA	aa Aa	0 1 1				32	32		
2A 1A	3/64 6/64	18	AA Aa	aa aa	aa aa	0 1 1					32	32	
0A 1A	1/64 6/64	6	aa Aa	aa aa	aa aa	0 1 1						32	32
		72											

ANALYSIS-POLYZYGOUS POPULATION - THREE ADDITIVE ALLELES

PROGENITORS						PROGENY							
PHENOTYPES		GENOTYPES				PHENOTYPES							
CLASS	RATIOS	RATIOS	ALLELES			HETEROZYGOCITY	FACTOR-CLASS RATIOS CLASSES						
			11	22	33		6	5	4	3	2	1	0
5A	6/64	36	AA	AA	Aa	1	16	32	16				
5A	6/64		AA	AA	Aa	1^2							
4A	3/64	36	AA	AA	aa	0		16	32	16			
4A	12/64		AA	Aa	Aa	2^2							
1A	6/64	36	Aa	aa	aa	1			16	32	16		
5A	6/64		AA	AA	Aa	1^2							
0A	1/64	12	aa	aa	aa	0				16	32	16	
4A	12/64		AA	Aa	Aa	2^2							
1A	6/64	36	Aa	aa	aa	1					16	32	16
1A	6/64		Aa	aa	aa	1^2							
		156											
			11	22	33		6	5	4	3	2	1	0
5A	6/64	72	AA	AA	Aa	1	8	24	24	8			
4A	12/64		AA	Aa	Aa	2^3							
4A	12/64	144	AA	Aa	Aa	2		8	24	24	8		
3A	12/64		AA	Aa	aa	1^3							
4A	12/64	72	AA	Aa	Aa	2			8	24	24	8	
1A	6/64		Aa	aa	aa	1^3							
3A	8/64	8	Aa	Aa	Aa	3				8	24	24	8
0A	1/64		aa	aa	aa	0^3							
		296											
			11	22	33		6	5	4	3	2	1	0
4A	12/64	144	AA	Aa	Aa	2	4	16	24	16	4		
4A	12/64		AA	Aa	Aa	2^4							
3A	8/64	96	Aa	Aa	Aa	3		4	16	24	16	4	
3A	12/64		AA	Aa	aa	1^4							
3A	8/64	48	Aa	Aa	Aa	3			4	16	24	16	4
1A	6/64		Aa	aa	aa	1^4							
		288											
			11	22	33		6	5	4	3	2	1	0
4A	12/64	96	AA	Aa	Aa	2	2	10	20	20	10	2	
3A	8/64		Aa	Aa	Aa	3^5							
2A	12/64	96	Aa	Aa	aa	2		2	10	20	20	10	2
3A	8/64		Aa	Aa	Aa	3^5							
		192											
			11	22	33		6	5	4	3	2	1	0
3A	8/64	64	Aa	Aa	Aa	3	1	6	15	20	15	6	1
3A	8/64		Aa	Aa	Aa	3^6							
		1103											

7 Phenotypes
10 Effective Genotypes

28 Crosses represent all possible classes in ratios as indicated

Progeny Represented -- 1103 x 64 = 70952
Progeny used -- 28 x 64 = 1792

ANALYSIS-POLYZYGOUS POPULATION - THREE ADDITIVE ALLELES

DATA AND FORMULAE FOR HETEROZYGOUS POPULATION -- THREE ADDITIVE ALLELES PROGENITORS

Reference - Table for Analysis of Heterozygous Population

PROGENITORS					PROGENY		PROGENY		PROGENY
Number of Alleles	Number of Genes	Number of Heterozygotes	Number of Classes in Series	Number of Series Places	First Phenotype	Last Phenotype of Series	Coefficients of Classes in Series Frequency on basis of 64 (2^{2N})	Genetic Base #	Formulae for Coefficients of Series Classes
					GAS	LAS			
3	6	0	1	7	6-0	6-0	64	64	$(1 + 0)^0 \times 64$
3	6	1	2	6	6-1	5-0	32 32	64	$(1 + 1)^1 \times 32$
3	6	2	3	5	6-2	4-0	16 32 16	64	$(1 + 1)^2 \times 16$
3	6	3	4	4	6-3	3-0	8 24 24 8	64	$(1 + 1)^3 \times 8$
3	6	4	5	3	6-4	2-0	4 16 24 16 4	64	$(1 + 1)^4 \times 4$
3	6	5	6	2	6-5	1-0	2 10 20 20 10 2	64	$(1 + 1)^5 \times 2$
3	6	6	7	1	6-6	0-0	1 6 15 20 15 6 1	64	$(1 + 1)^6 \times 1$
N	2N	n	n+1	2N+1 -n	GAS	LAS		2^{2N}	$(1 + 1)^n \times 2^{2N-n}$

Legend

N - Number of Genotypic Alleles

n - Number of Genotypic Heterozygous Alleles of Projenitor Genotypes (Combined)

GAS - Greatest Sum of A's from Two Progenitors

LAS - Least Sum of A's from Two Progenitors

I.

SUMMARY REPORT ON TREE IMPROVEMENT WORK AT THE ACADIA FOREST EXPERIMENT STATION, 1956-57

by:

H.G. MACGILLIVRAY

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New Brunswick

SUMMARY OF REPORT ON TREE IMPROVEMENT WORK AT THE ACADIA FOREST EXPERIMENT STATION, 1956-'57

Forest tree improvement work in the Maritime Provinces was chiefly concerned with (1) the selection of superior red spruce and balsam fir phenotypes; (2) the collection of tree-breeding material; (3) general nursery work; and (4) attempts at hybridization.

Most of the balsam fir trees, previously selected because of their suspected resistance to spruce budworm attack, were discarded. Superior red spruce were selected in Nova Scotia and New Brunswick. Tree-breeding material being grown from seed in the nursery included (1) twenty red spruce seed lots from Canada and the United States; (2) several balsam fir lots from Newfoundland, New Brunswick, and Manitoba; (3) eleven Norway spruce seed lots from superior stands in Europe; (4) white spruce and sitka spruce seed lots suspected of containing hybrids of these species; as well as (5) exotic fir seed lots suspected of containing various hybrids. The plants from these lots will be used for provenance experiments and for observation plots.

Several small experiments in grafting were made. It was shown in one experiment that white, red and black spruce scions could be grafted to white spruce; that fall grafts wintered better in the greenhouse than in cold frames and that mortality was lower for winter grafts than for fall grafts. Balsam fir is believed to be a suitable rootstock for a large number of fir species. Two experiments with exotic fir scions and balsam fir rootstocks showed that larger scions and rootstocks produce better results than smaller material. The result of the first of these two experiments showed little difference between side grafting and veneer grafting or between grafts bound with rubber bands and those bound with raffia. The second experiment indicated that summer grafting may be possible.

Storing fall-collected scions in deep freeze (10°F) was found to be too severe for fall-collected balsam fir and red spruce scions. Cold storage (about 32°F) was better than deep freeze storage for some exotic fir scions collected in March 1956.

Attempts to force the ripening of various species of exotic fir pollen from branches bearing male flowers were not very successful. The branches were collected in February and half subjected to a long day, and the remainder to a short-day treatment under humid conditions with the temperature about 55°F.

Attempts to make crosses with balsam fir using the artificially-matured pollen, as well as naturally-matured pollen, were probably failures. Better results were obtained in a small experiment dealing with the making of hybrid larches.

REPORT ON TREE IMPROVEMENT WORK AT THE ACADIA FOREST EXPERIMENT STATION 1956- '57

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Fredericton, New Brunswick

This report deals with the work conducted at the Acadia Forest Experiment Station from the spring of 1956 until the summer of 1957. The work was mainly directed towards the development of improved races and strains of spruce and fir and included (1) selecting superior spruce and fir phenotypes, (2) growing material for provenance experiments and for future tree-breeding work (3) collecting future tree-breeding material, and (4) hybridization.

Selecting Individual Trees

Fir

The object of this is to select balsam fir trees which show resistance to spruce budworm attack. This material will be used in an attempt to breed a spruce budworm resistant strain of fir. The balsam fir that had been selected previously were reclassified in August, 1956. This reclassification was critical as progress can only be expected if the standards used in making the initial selection are high. As a result, only three of the previously selected trees on the Green River watershed were retained as tree-breeding material.

Red spruce

The work on the improvement of red spruce through the use of superior trees was initiated in 1956. The best stands in the Sheet Harbour and Chignecto areas of Nova Scotia and the more easterly part of the Bay of Fundy area in New Brunswick were located by local foresters. Seven stands were chosen during 1956.

Within each of these stands the best two, and one of the poorer phenotypes, were selected by ocular appraisal. Progeny tests will be made using the seed from each selected tree. It was necessary to choose one of the poorer dominant or co-dominant trees as the poor phenotype, because the poorest trees were often suppressed and therefore not capable of producing seed. Height, diameter and age measurements were taken from the selected trees and also 25 neighbouring trees.

To obtain some idea of the growth performance of the selected trees in each stand, the height over age of these trees were compared to a height over age curve that had been drawn for their neighbouring trees. This method will probably be of limited use in dealing with red spruce because red spruce is tolerant to suppression. Cones were collected from all the selected trees in 1956.

The work of selecting superior red spruce trees is being continued in 1957 in stands along the south shore area of Nova Scotia.

Growing Provenance and Future
Tree-Breeding Material from Seed

Observation plots established during 1957

Small samples from nine balsam fir, six white spruce, 17 red spruce and seven black spruce seed lots were sown at Acadia in 1953. Cotyledon counts, estimates of winter damage, phenological observations and measurements, as well as height growth measurements, were made on the plants produced from these seed lots in the nursery between 1953 and the spring of 1957. These data, although not completely analysed, are interesting especially since some of the seed lots of different species have the same geographic origin.

Red spruce

About 100,000 2-0 red spruce from 20 provenances were transplanted in 1957. The winter of 1956-57 was extremely hard on these seedlings. Winter damage to the 2-0 seedlings appeared to be related to the density of the seedlings in the bed. The seedlings in the central part of densely-stocked beds died back from the top. The roots in many cases were still healthy. The seedlings along the edges of these beds were healthier than those in the center. Apparently the seedlings in the center of the seed-beds did not harden properly before the cold weather came. Heaving occurred in beds where the stocking was very light.

Observations made on the 2-2 trees mentioned in the preceding section indicate that red spruce was more susceptible to winter damage than black and white spruce or balsam fir. Observations made on 2-0 seedlings also showed that it was more susceptible to winter injury than balsam fir.

Balsam fir

Seed lots from various provenances in Newfoundland, New Brunswick and and Manitoba were sown in 1956. The main object of this was to obtain material with which to study the genetic influence on the slow growth after a certain age of some Newfoundland firs. The germination of some of the Newfoundland seed lots was poor. This will reduce the value of the experiment. A decision will be made as to what action will be taken with the material after the 1957 nursery inventory is complete.

Seed lots from Newfoundland and New Brunswick were again sown in 1957. Germination was better than in 1956.

Exotic fir

Some exotic fir have been sown each year to provide seedlings for the establishment of observation plots. These exotic fir plots will vary in size from small plots to about two acres per species. These will be exposed to the natural selection factors and in time these plantations will be cleaned leaving only the best specimens as future tree-breeding material.

Several lots of 'arboretum type' exotic fir seed, each containing several possible hybrids, were sown this spring. Cutting tests indicated a considerably higher viability than was actually obtained in the seed-bed.

A start was made in obtaining some fairly large exotic firs when three balled *Abies koreana* and three balled *A. Veitchii* were planted at Acadia in 1957. More specimens will be added each year. These trees, because of their size (three to four-feet tall) and root pruning caused by transplanting, will probably flower sooner than the grafts and the trees being grown from seed. This may make it possible to attempt crosses, using *A. balsamea* pollen, sooner than would otherwise be possible.

Exotic spruce

Eleven lots of Norway spruce seed from superior stands in Europe were supplied by Mark Holst. These were sown in 1957 along with some local white spruce from a good stand on the Green River watershed. If all goes well, these Norway spruce provenances will be tested under Maritime conditions using the white spruce for comparison.

In co-operation with Mr. Holst, in his work on breeding for weevil resistance in Norway spruce, several lots of sitka spruce, white spruce and hybrids of these species were sown at Acadia. These lots were: (1) sitka spruce from

Alaska; (2) sitka spruce with possible sitka x white spruce hybrids, and (3) white spruce from Denmark; (4) sitka spruce with possible sitka x white spruce hybrids, and (5) white spruce with possible white x sitka spruce hybrids from Nova Scotia. Besides this, scions from several promising sitka spruce trees from Nova Scotia were grafted at Acadia.

Vegetative Propagation

White, red and black spruce grafted to white spruce

The results of a small experiment where white, red and black spruce were grafted to white spruce indicate that white spruce was a suitable rootstock for these species. These grafts were made in the fall and in the winter. Half of those made in the fall were wintered in the greenhouse and half in a cold frame. The results showed that winter grafting was more successful than fall grafting, and that wintering fall grafts in the greenhouse was more successful than wintering them out-of-doors in a cold frame.

Exotic firs grafted in 1956

In February 1956, a trip was made to the Arnold Arboretum and the Hunnewell Arboretum, Massachusetts, and to the University of Maine to collect exotic fir scions and branches bearing male flowers. More will be said about the branches bearing the male flowers later.

The results of grafting a few scions of each of the exotic fir species in March, 1956, indicated that balsam fir will be a good rootstock for most and probably all these exotics (Table 1). The grafted plants were plunged in sand under an overstory of fir during the winter of 1956-57. This was exposed to the wind and better results could probably have been obtained using cold frames for protection.

The remaining scions were stored (1) half in cold storage, about 32°F, and (2) the remainder in deep freeze, about 10°F, from early March until early June. Those stored at 32°F were treated with a 'Cemesan' solution to help prevent damage from mildew. In June, these scions were field grafted to balsam fir under an overstory of spruce and fir. The grafts were protected at first by polythene bags shaded by kraft paper bags. This work was done too late in the season for the best results from field grafting.

Table 1

EXOTIC FIRS GRAFTED TO BALSAM FIR, MARCH, 1956

Species	No. of Grafted Plants		
	Original No.	No. Surviving	
	March 1956	August 1956	June 1957
Abies alba	4	3	0
A. amabilis	3	3	1
A. cephalonica	8	8	8
A. cilicica	3	2	2
A. concolor	9	7	5
A. Fargesii	4	3	0
A. Fraseri	2	0	0
A. holophylla	9	6	3
A. homolepis	9	4	3
A. koreana	8	6	4
A. nephrolepis	4	2	2
A. Nordmanniana	6	4	3
A. sachalinensis	5	5	4
A. sibirica	2	2	2
A. Veitchii	16	13	11
A. cilicica x *Nordmanniana*	2	1	0
	94	69	48
Percentage		73%	51%

A tally at the end of July, 1956, indicated that much better results were obtained from scions stored in cold storage than were obtained with scions stored in deep freeze storage. Unfortunately the winter of 1956-57 was extremely hard on these grafts and only a few of the scions survived. These incidentally were ones that had been stored during the spring of 1956 at 32°F.

Fall grafting, 1956

Scions were collected during the fall of 1956 from the balsam fir selected for budworm resistance and from several of the selected red spruce trees. These trees were mentioned earlier. The scions were shipped in moist sphagnum and on arrival in Fredericton were placed in deep freeze storage. Later, when grafted, all the scions turned brown and died.

The scions were probably not completely dormant when collected during the fall and the sudden shock of placing them in deep freeze storage probably killed them.

Winter grafting, 1957

Scions from flowering *A. cephalonica*, *A. concolor*, *A. homolepis*, *A. Nordmanniana*, *A. Veitchii* and *A. Fargesii*, were obtained from the Highland Park, Rochester, New York, and from the Arnold Arboretum in February, 1957. These were stored in polyethelene at about 34°F until they were grafted to balsam fir during March and June.

In March, the smaller scions from each species were grafted to 2-0-1 balsam fir rootstocks and the remainder to 2-1-1 rootstocks. Roughly half of each group of scions were side grafted and the remainder veneer grafted. Of these, half of each were bound with raffia and half with rubber bands. All grafts were waxed. The grafts made using the larger scions and rootstocks were slightly more successful than those made using the smaller scions and rootstocks (Table 2). There appears to be little difference in the survival of scions grafted by either the veneer or side graft methods or those bound with raffia or rubber bands.

The improvement in the grafting done in 1957 compared to that of previous attempts is believed to be due to better experience in making the grafts and to better care of the plants after grafting. In 1956-57, the humidity was kept higher and more constant than previously through the use of intermittent mist in the greenhouse. The misting equipment was quite simple and consisted of an electric timer that opened a solonoid valve three times an hour for a period of two minutes each time. The mist was made by running the water through oil burner nozzles of various sizes.

Better shade was provided in the greenhouse by tinting the paint, used on the glass, a deeper green than usual. The paint was a mixture of white lead and naphtha.

When rootstocks were brought into the greenhouse the temperature was reduced to about 50°F. The rootstocks were placed in the shade under a center bench, away from the heat pipes, until they had thawed. The intermittent mist was continued until June when the grafts were moved outside and plunged in cold frames.

Summer grafting, 1957

It was quite hot and dry out-of-doors, and still cool and moist in the greenhouse in June owing to the mist and extra shade. Because of these factors, and the lateness of the season, it was decided to do the grafting in the greenhouse instead of out-of-doors as planned. Two methods of grafting were used--side and veneer. All grafts were bound with rubber bands. Half the grafts were waxed and the remainder were not waxed. The grafts were planted in a cold frame at the end of July. Better results were obtained using the larger scions and rootstocks than the smaller material (Table 3). Surprisingly, better results were obtained when the grafts were not waxed. However, it is too early to draw conclusions from this work. Mortality may be high after the new plants have been exposed to the out-door conditions.

Table 2

PERCENTAGE SURVIVAL OF EXOTIC FIR GRAPHS
MADE IN MARCH, 1957*

A. Small scions and small rootstocks (2-0-1 balsam fir)
Total grafts--306

Binding	Method		Total
	Side	Veneer	
Raffia	92	89	90
Rubber bands	89	86	88
TOTAL	91	88	89

B. Large scions and large rootstocks (2-1-1 balsam fir)
Total grafts--748

Binding	Method		Total
	Side	Veneer	
Raffia	88	94	91
Rubber bands	95	93	94
TOTAL	91	94	92

* Checked in June, 1957

Table 3

PERCENTAGE SURVIVAL OF EXOTIC FIR GRAFTS
MADE IN JUNE, 1957*

A. Small scions and small rootstocks (2-0-1 balsam fir)
Total grafts--197

Protection	Method		Total
	Side	Veneer	
With wax	43	58	49
Without wax	54	50	52
TOTAL	48	54	51

B. Large scions and large rootstocks (2-1-1 and some 2-0-1 balsam fir) Total grafts--139

Protection	Method		Total
	Side	Veneer	
With wax	85	68	76
Without wax	84	94	89
TOTAL	85	81	83

* Grafted during first part of June and checked at end of July before being moved from greenhouse

Tree Breeding

Forcing exotic fir pollen

An attempt was made to force pollen production on excised fir branches. As mentioned earlier, branches of several exotic firs were collected in New England during February, 1956. Some of these branches, each bearing male flower buds, were placed in jars of water and taken to the greenhouse on 1 March. 'Fermate' was added to the water in the jars to reduce algal growth. The butts of the branches were cut when necessary to help ensure free intake of water.

These branches were placed in a humidity chamber where they were sprayed with a fine mist of water for three two-minute periods each hour. The temperature was generally between 55° and 60°F. Half of the branches were exposed to a long day of 16 hours under fluorescent and natural light. The remainder were exposed to a short day as determined by natural light only. A Branch was removed from the humidity chamber when it appeared that no more flowers would elongate on it. It was then placed on a greenhouse bench for about three days and then transferred to a warm, dry room where pollen was shed and collected. The branches remained in the jars until pollen was shed or the branches discarded.

The pollen was stored in a desiccator at temperatures which ranged between 32° and 38°F.

This experiment was not too successful (Table 4). Few of the flowers had the plump and healthy appearance associated with naturally-matured male flowers. Pollen viewed under a microscope appeared rather pale. Some flowers elongated and shed their pollen; others elongated but failed to shed their pollen; still others were empty. Many flower buds did not break dormancy. Flower buds on the same branch often reacted differently.

Pollination

Pollination was done at the time the balsam fir pollen was being shed naturally. The results from the crosses attempted with the artificially-forced exotic fir pollen on 77 bags (Table 4) were:

Abies balsamea x cephalonica	1 seedling
" " x koreana	6 "

Table 4. FORCING EXOTIC FIR POLLEN PRODUCTION IN THE GREENHOUSE

A. Long-Day Treatment

Tree No.	Species of *Abies* pollen	Male Flowers: No. days to Elongate	Male Flowers: No. days to Shed pollen[1]	Male Flowers: Per cent elongated	Male Flowers: Colour[2]	Male Flowers: Fullness[3]	No. of pollen bags
S.T. 80	A. amabilis	34	(44)	100	R to Y-R	e-F	1
83	A. cephalonica	43	47	60	G-Y	F	24
84	A. cilicica	28	(40)	100	Y-G	F	1
85	A. concolor	--	--	--	--	--	--
87	" "	47	(51)	100	B	F	1
88	A. Fargesii	47	--	20	G	e-F	--
90	A. Fraseri	--	--	--	--	--	--
94	A. holophylla	44	--	30	B	e	--
95	A. homolepis	--	--	--	--	--	--
96	" "	--	--	20	B	e	--
97	" "	32	--	80	R-Y	e	--
98	A. koreana	47	(51)	70	Y-G	F-e	1
99	" "	--	--	--	--	--	--
100	" "	42	(47)	40	G-Y	F-e	2
105	A. Nordmanniana	28	40	95	Y	F	5
106	A. sachalinensis	--	--	--	--	--	--
107	" "	28	--	80	B	e	--
109	A. Veitchii	--	--	--	--	--	--
110	" "	--	--	--	--	--	--
112	" "	36	42	80	R-Y	F	11
113	" "	42	--	40	R-G	e	--
117	" "	42	--	10	Y-G	e	--
118	" "	--	--	--	--	--	--
							46

[1] Total number of days under treatment. Parentheses indicate that pollen was not shed but was obtained by crushing the flowers.

[2] Colour of elongated flowers: R--red or reddish; B--blue or bluish; G-green or greenish; Y--yellow or yellowish

[3] Fullness of male flowers: F--full of pollen; e--empty.

Table 4 (Continued)

B. Short-Day Treatment

Tree No.	Species of Abies pollen	Male Flowers: No. days to Elongate	Male Flowers: No. days to Shed pollen[1]	Male Flowers: Per cent elongated	Male Flowers: Colour[2]	Male Flowers: Fullness[3]	No. of pollen bags
S.T. 80	A. amabilis	34	40	100	Y-R	F	10
83	A. cephalonica	47	(54)	10	G	F	1
84	A. cilicica	42	--	40	G-Y	F	0
85	A. concolor	--	--	--	--	--	--
87	" "	42	(51)	100	R	F	1
88	A. Fargesii	--	--	--	--	--	--
90	A. Fraseri	--	--	--	--	--	--
94	A. holophylla	47	(53)	10	Y-G	e	1
95	A. homolepis	--	--	--	--	--	--
96	" "	--	--	--	--	--	--
97	" "	40	--	50	Y-R	e	--
98	A. koreana	49	--	50	G-Y	e	--
99	" "	47	--	20	G	e	--
100	" "	42	47	60	G	F-e	7
105	A. Nordmanniana	49	--	5	G	e-F	-
106	A. Sachalinensis	36	--	95	B	e	-
107	" "	--	--	--	--	--	--
109	A. Veitchii	--	--	--	--	--	--
110	" "	--	--	--	--	--	--
112	" "	36	42	40	R-G-Y	F	11
113	" "	--	--	--	--	--	--
117	" "	--	--	--	--	--	--
118	" "	44	--	50	B-G	e	--
							31

The results of the crosses attempted using naturally-matured fir pollen were:

Abies balsamea x nobilis	26 bags	0 seedlings
" " x Nordmanniana	50 "	10 "
" " x balsamea	2 "	1 "

The seed from 25 unpollinated control bags yielded no seedlings. It is doubtful if any of the above seedlings are hybrids, as they appear to be remarkably like ordinary balsam fir seedlings.

The results of some casual work with Larix laricina and L. leptolepis growing near each area at Acadia were:

	No. of bags	No. seed-lings	Av. No. cotyledons
1. Larix laricina x laricina (selfed)	2	15	5.3
2. " " open pollinated		28	5.3
3. " " x leptolepis	3	8	5.9
4. " " x 0 (control)	1	-	-
5. " leptolepis x laricina	2	-	-
6. " " open pollinated		4	6.0
7. " " x leptolepis	4	3	6.9

The seedlings resulting from the self pollination of L. laricina (1) were small, those from the open pollination (2) intermediate and those resulting from the cross L. laricina x leptolepis (3) were large. It is quite possible that the seed resulting from open pollination contained some hybrids.

Cotyledon counts were made on some seedlings from two L. decidua and one L. leptolepis growing adjacent to each other. These averages:

1. L. decidua	5.3 cotyledon
2. " "	5.5 "
3. " leptolepis	5.8 "

J.

CYTOGENETIC STUDIES IN CARAGANA

1957

by:

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CYTOGENETIC STUDIES IN CARAGANA, 1957

Colchicine Treatments

The technique and early results of treating branches of 2 trees of Caragana arborescens with agar-colchicine capsules in 1954 were described in the 1956 report. Only one branch has held out hope of successful treatment and this year it has produced tetraploid flowers for the first time. During the summer of 1956 the foliage on this branch appeared to revert to the normal diploid type and it seemed that the tetraploid tissue had died or had been overgrown by the diploid tissue, as has happened many times before. Lateral branches were removed to force growth of the treated terminal area. The leaves that emerged in May, 1957 again showed the greater size and pubescence characteristic of colchicine treatment. For the first time, flowers that differed from those of the untreated branches were borne. The limit of colchicine treatment on the branch is marked by a swelling of the stem: all foliage and flowers (30) apical to the swelling showed polyploid characters. The flowers were 10% larger in length and width and the calyx was more pubescent than normal flowers. The pollen was normal in appearance and 30 microns in diameter; that of normal flowers is 20 microns. The flowers were bagged with cheesecloth and tripped by hand. The ovaries of only 5 of the 30 flowers showed enlargement: two fell and the remaining 3 are developing into normal full pods.

Squashes of the styles of fallen flowers showed that pollen had germinated but the tubes were short and had penetrated less than one-fourth the length of the style. Sections were made of the ovaries. These showed that the structure of the ovules and embryo sacs was normal but that no pollen tubes had entered the ovary. As soon as it was apparent that the tetraploid flowers were falling, the peduncles and pedicels of half the remaining flowers were painted with 1 ppm indoleacetic acid in carbowax. It was hoped that the hormone might delay the drop sufficiently to allow the pollen tubes to reach the ovary. All of the flowers so treated fell. The 5 flowers that did show pod development were all near the base of the tetraploid zone, but were not treated with hormone. The above will indicate a fertility of 10% for the tripped self-pollinated tetraploid flowers. Fertility of the normal flowers of this tree was measured in 1956: 11% of bagged flowers set fruit without tripping, 64% formed pods after tripping. A small number of cross-pollinations between the tetraploid and diploid flowers of the same and of other trees was made. In almost all of these, the diploid was the female. None of these pollinations set fruit.

Taxonomy

Observations of the variability of C. arborescens and of plants grown from seed received under the names of the closely related species C. boisi C.K. Schn. and C. fruticosa Bess. have led to the decision to formally reduce the species C. boisi to a form of C. arborescens Lam. The species C. boisi was described from a seedling raised in the botanic garden of Vilmorin in France. It represents a selection of C. arborescens with unusually long (1 cm.) spreading woody stipules and with a lower (to 7 ft.) bushy habit. Usually the new growth and stipules are pigmented. The form seems to be less winter hardy at Ottawa than the taller typical forms of C. arborescens.

Interspecific crosses between the species arborescens, spinosa, frutex, maximowicziana and aurantica have again been unsuccessful. The genetic barriers to hybridization seem impenetrable. The great variability seen among plants of C. arborescens, some plants approaching C. microphylla, raises the speculation as to whether these, and related species, are one large species-complex. They have always been recognized as distinct species. It may be that barriers to crossing these species is less rigid than that experienced in other sections of the genus. It would be necessary to have seed collections from the wild, rather than material that has been circulating through botanic gardens for generations, to answer this question.

Pod Development

A comparison was made of the rate of pod development of open-pollinated and of tripped, self-pollinated flowers of two trees of C. arborescens. The ovaries of 5 flowers for each treatment were measured regularly until the pod had reached a constant mature length. Some representative averaged measurements are given in the following table.

Rate of Pod Development in Caragana arborescens

Tree No.	Treatment	Length of Pod (mm.) June 15	20	25	July 3 (mature)	Av. no. seeds per pod
34-2-56	selfed	26	35	36	38	1.68
34-2-56	open-poll.	30	39	41	43	4.20
96-147-80	selfed	32	46	51	54	1.71
96-147-80	open-poll.	35	47	53	57	3.80

It was found that the open-pollinated, possibly cross-pollinated pods were longer than the self-pollinated pods at all stages. The number of seeds per pod was higher in the open-pollinated pod and this is doubtless related to the pod size.

Pollen Germination Tests

Some pollen germination tests, as described in 1956, were made, extending the range of sucrose concentrations beyond the 5% previously used. Mixtures of 2% agar plus 4%, 5%, 6%, 8%, 10%, 15% and 20% sucrose were used to test pollen of one tree of C. arborescens and one of C. frutex.

It appears that fresh pollen of both species will germinate satisfactorily on concentrations of 2-8% sucrose. Beyond this, the germination percentage decreased and the tubes of germinated grains were short.

K.

ANNUAL REPORT

1956

by:

A.L. ORR EWING

Research Division

B.C. Forest Service

Victoria

British Columbia

ANNUAL REPORT FOR 1956

1) GENERAL

One technical assistant has been added to the staff and he will be permanently attached to Duncan nursery where a greenhouse complete with potting shed and lathe house together with a seed testing laboratory and cone extraction plant are being built.

All seed requests from other countries to the Forest Service are now being directed to this section and in the course of the year seed samples of various species were sent to Iceland, India, South Korea, Sweden and the United States. The increasing demands for seed, pollen and scions of many species are becoming difficult to satisfy.

The Annual field meeting of the north west Genetics Association in Idaho was attended in September.

A talk on some applications of forest genetics to forestry practice in B. C. was given to members of the Vancouver section of the Canadian Institute of Forestry in March, 1957.

The various forest genetic projects were shown to several visitors and organizations during the year among whom was Dr. Arnborg, Director for the Society of Practical Forestry Improvement in Sweden.

2) SEED CLASSIFICATION AND REGISTRATION

A new system of seed classification which is based on that outlined by the Royal Board of Private Forestry of Sweden[1] has recently been introduced. It will be used for all seed collected by the Forest Service which will be properly registered and given a permanent identification number. The system briefly entails dividing up suitable forest stands into three seed collection classes, namely plus, normal and minus stands. The criteria for classifying these stands will be mainly based on such characters as straightness of stem, slender branching and self pruning. Maps will then be prepared showing the location of these stands and a start has already been made with the Douglas fir.

All seed is next classified according to the type of stand or tree from which the collections are made and the seed classes are divided into two main groups. Group A includes seed from individual trees and seed orchards. It is divided into five sections A_1 to A_5 which include seed from controlled crosses, elite trees, seed orchards, plus trees and type trees. Group B includes all seed collected from stands and is again divided into five sections B_1 to B_5. The first

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[1]Directions for seed collecting and trading in forest seed and plants. Published 1950 by the Royal Board of Private Forestry of Sweden.

section B_1 includes all seed from cleaned and registered plus stands from which all badly shaped trees have been removed from the stand and its immediate surroundings. B_2 includes seed from other plus stands and seed from the better trees in a normal stand collected under control. B_3 includes seed from normal stands collected without any special selection of the mother tree while B_4 includes seed from minus stands and from stands about which there is no information. B_5 includes all seed collected from plantations.

Special cone collection forms have been made up in order to ensure that this new system will operate smoothly. These forms provide for all the necessary information concerning the location, stand type and site from which any cone collections are made and full instructions for their use are printed on the back of each form. The supervisors in charge of cone collecting complete these forms and forward them with the cones from that particular lot to the seed extraction plant where they are carefully checked. The individual lots of cones are then given permanent identification numbers and all the pertinent particulars are entered in a seed register. The system of numbering is as follows: the first number shows the seed classification, the second the number of the collection (all numbers run consecutively irrespective of species), the third number gives the year of collection. B_1/25/56, for example, would show that seed lot number 25 was collected from a cleaned and registered plus stand in 1956. All the pertinent information relative to this seed lot could then be found by referring to that number in the seed register.

It is hoped that this new system of seed classification will not only lead to improved control of individual seed lots but will provide a real incentive for collecting seed of the highest possible quality.

3) <u>SELECTION OF PLUS TREES FOR SEED ORCHARDS</u>

There is a severe shortage of high elevation Douglas fir seed at the present time and the first seed orchard will, therefore, be established from selected plus trees growing at elevations of from fifteen hundred to twenty three hundred feet. A general survey of suitable stands was made in 1956 and four of these stands will be intensively cruised for plus trees in 1957. This seed orchard will be established in the vicinity of Duncan nursery.

4) <u>THE EFFECTS OF SELF POLLINATION ON THE DOUGLAS FIR</u>

The results of the cytological study will be published in Silvae Genetica. It has been found that the effects of self-pollination vary widely in individual trees and that the inbred seedlings are usually less vigorous than those resulting from either open or controlled cross-pollination of the same parent tree. A few inbred seedlings with good form and rapid growth occasionally develop; such seedlings may be of considerable value. Several inbred lines have either been planted out on an experimental area or are in the transplant beds at the nursery at the present time. These lines will be carefully retained.

5) PHENOTYPIC SELECTION IN YOUNG OPEN GROWN DOUGLAS FIR

This study was initiated to demonstrate the need for careful selection of parent trees in cone collecting. Cones and scions have been collected from a number of the best and poorest phenotypes in an open grown stand. The development of the seedlings resulting from open pollination of the parent trees has already proved interesting and detailed measurements will be taken of both the parent trees and the progenies this year. The scions from the selected trees were veneer grafted in the spring of 1956 and the grafts planted out in 1957. Grafting has presented no particular problems and bud grafting has been found most satisfactory for outside use.

6) A COMPARISON OF THE PROGENY FROM POOR AND GOOD STANDS

A study has been initiated to compare the progeny from two high elevation Douglas fir stands in order to determine the significance of site and exposure in relation to seed quality. This is particularly important as the poorer stand has been used for cone collections in the past and some evidence is required in order to decide whether such collections should or should not continue. The seedlings from the two stands will be planted on selected areas in 1957.

7) A CO-OPERATIVE SEED PROVENANCE STUDY OF DOUGLAS FIR

This study which was mentioned in the 1955 report is continuing and fourteen seed sources will be represented. Four collections have been made in British Columbia, three of which have been made by private companies and one by the Forest Service. The seed from the fourteen sources will be sown in Oregon in 1957.

SUMMARY REPORT - 1956
TO COMMITTEE ON FOREST TREE BREEDING

by:

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Forest Biology Laboratory
Canada Department of Agriculture
c/o Forestry School, Laval University
Quebec
Que.

POPLAR HYBRID DISEASE RESISTANCE TESTS

Only exploratory work was carried out on this project during 1956. A small number of hybrids and varieties were obtained from the Harrington Forest Farm, the Maple Experiment Station, and from the Northeastern Forest Experiment Station in the United States, and planted at the Quebec Laboratory. Preliminary observations in natural stands and in plantations on poplar diseases were made during summer 1956 at Berthierville and the Harrington Forest Farm. No interesting result can be reported at this stage.

DUTCH ELM DISEASE RESISTANCE

Initiated in 1951, this co-operative project was actively carried out at the l'Assomption Experiment Station. The collection of seeds from selected American elms and the raising of seedlings in nursery was the responsibility of the station, whereas the inoculation tests were made by the Quebec Laboratory. The task of selecting uninfected seedlings was shared by both agencies.

More than 43,000 seedlings were tested for resistance to the Dutch elm disease organism from 1952 to 1956 inclusive. A number of them were inoculated twice the same year and a few were reinoculated once each year afterwards. In the fall of 1956, 2 seedlings without mutagenic treatment have not shown any disease symptoms after three or four annual inoculations, 19 after two inoculations and 53 after one inoculation. Since 1955 some 20,000 seedlings from X-rayed seeds were inoculated once or twice. Six seedlings have escaped infection after two inoculations and 1,265 after one inoculation. In spite of the apparent tolerance of a few seedlings no definite indication of the existence of some degree of resistance to the Dutch elm disease have been found yet.

In the Quebec Laboratory, some preparatory work was made to import and propagate resistant or tolerant elm hybrids from Europe, in view of testing their relative susceptibility to native disease organisms in this country and to the Dutch elm disease under our conditions.

M.

REPORT - 1956

TO COMMITTEE ON FOREST TREE BREEDING

by:

W.A. PORTER

Forest Pathology Laboratory

Canada Department of Agriculture

Victoria

British Columbia

M.

REPORT - 1956

TO COMMITTEE ON FOREST TREE BREEDING

by:

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REPORT TO COMMITTEE ON FOREST TREE BREEDING

Blister Rust

Search is continuing for a second suitable area for field planting of white pines from the Duncan disease garden. Because of their size and the space requirements at Duncan, it is necessary to move scions which have shown resistance. A forested area with maximum protection from trespass, as well as uniform soil conditions, is required.

Artificial inoculations continued in the disease garden. No additional grafts were made nor was reconnaissance extended for additional selections suitable for resistance testing. White pine rootstock for future grafting was imported and potted.

All of the white pine control grafts and seedlings are cankered and some have died. Among the 1952 grafts from coastal British Columbia selections, 4 remain canker free, 11 have 1-2 cankers, and 6 are heavily infected.

Results of the Disease Garden inoculations on British Columbia Interior and the imported pines (Idaho, Wisconsin and Ontario) should be available next year.

A permanent research greenhouse with facilities for grafting and preliminary inoculations will soon be available.

Western Red Cedar

A study on the cause of variation in symptom expression of cedar needle blight caused by the fungus *Keithia thujina* Durand on western red cedar, *Thuja plicata* Donn., has been completed. The microclimate factors of temperature and moisture favouring spore discharge were examined and defined. Differences between stands, trees, and parts of the same tree were investigated.

Rooted scions from selected clones as well as wildlings were interchanged between locations for field cross inoculation and for uniform greenhouse inoculation. Apparent disease resistance in scions at field locations where the microclimate was favourable for infection was generally not maintained under greenhouse conditions. One clone showed a moderate degree of resistance and is worthy of further testing and consideration in a breeding program.

The symptomology variation observed in the field is primarily due to environment. Variation from the physiology of the host is secondary. Variation in the fungus has not been shown. This study has been completed and will be published.

Other Activities

Abies grandis pollen has been supplied to Mr. MacGillivray at Fredericton.

The forest genetics short course given by the Northwest Forest Genetics Association was attended at Corvallis, Oregon. The field meeting of this association was held on Vancouver Island. A field demonstration of the studies in testing for blister rust resistance was shown by W. A. Porter to about 45 attending members from California, Oregon, Washington, and British Columbia.

N.

THE LAKE STATES FOREST TREE IMPROVEMENT COMMITTEE
ITS PURPOSE AND ACTIVITIES

by:

PAUL O. RUDOLF

Executive Secretary

Lake States Forest Tree Improvement Committee

Lake States Forest Experiment Station*

St. Paul 1.

Minnesota

U.S.A.

September 4, 1957.

* Maintained by the Forest Service, U.S. Department of Agriculture, at St. Paul 1., Minnesota, with the University of Minnesota.

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THE LAKE STATES FOREST TREE IMPROVEMENT COMMITTEE

ITS PURPOSE AND ACTIVITIES

The Lake States Forest Tree Improvement Committee is one of some half-a-dozen similar groups developed to encourage and co-ordinate forest tree improvement activities in the United States and Canada. It was formed as a 9-man committee in April 1953 at the Lake States Forest Genetics Conference. It was enlarged in 1955 to include 14 members representing the following agencies: (1) Michigan Conservation Department, (2) Minnesota Conservation Department, (3) Wisconsin Conservation Department, (4) University of Michigan, (5) Michigan State University, (6) University of Minnesota, (7) University of Wisconsin, (8) Lake States Industrial Foresters Council, (9) Institute of Paper Chemistry, (10) Lake States Forest Experiment Station, (11) North Central Region, U. S. Forest Service, (12) Forest Products Laboratory, and (13) the International Committee on Forest Insects and Diseases (2 members - one entomologist and one pathologist). These members represent not only their agencies but also the subject-matter fields of silviculture, genetics, pathology, entomology, and wood technology. Committee members serve 4-year overlapping terms; half of the group is appointed every 2 years.

The Committee has three officers. The chairman and vice-chairman are elected for 2-year terms. The executive secretary is a permanent officer.

The Committee's work is accomplished through four types of activity: (1) subcommittee activities, (2) regional tree improvement conferences, (3) Committee meetings, and (4) a newsletter.

SUBCOMMITTEE ACTIVITIES

Shortly after the Lake States Forest Tree Improvement Committee was established in 1953 the following four subcommittees were appointed: bibliography and directory, tree and stand selections, seed collection zones, and projects for study. The general purpose of these subcommittees was to develop recommendations and prepare reports in their specific fields for the information and guidance of workers in those fields.

The subcommittee on bibliography compiled an annotated list of forest tree improvement references published by authors or agencies in the Lake States, or by others if pertaining to forest tree species growing in the Lake States. This report was published by the University of Michigan in 1956.* A second original function of this subcommittee - to prepare a directory of workers and agencies engaged in forest tree improvement work in the region - was dropped when it was learned that an S.A.F. committee was developing a national directory of this nature.

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*See list of references at end of this report.

The subcommittee on tree and stand selections had as its objective to assemble and make available the best-known criteria for selecting superior forest trees and stands in the Lake States. The purpose of the final report was to put this information into clear and simple language so that fieldmen unacquainted with technical genetics terms could follow and use the descriptions. This report was published by the Lake States Forest Experiment Station in 1956.

The seed collection zones subcommittee was charged with developing seed collection zones for the Lake States upon the basis of some readily available climatic data. This was considered a first step toward forest tree seed certification for the region. A report outlining proposed seed collection zones was published during 1957 by the Michigan Conservation Department.

The subcommittee on projects for study attempted to assemble a list of forest tree improvement projects needing study and to rate them on a scale of priority and costs or funds required. After the subcommittee started to function, however, several collegiate institutions in the region began forest genetics instruction and research and other agencies also added or expanded programs. It was decided, therefore, to discharge the subcommittee and reconstitute it upon a different basis.

Since the appointment of the original four subcommittees (all of which will have been discharged by the close of 1957), three additional subcommittees have been established and are currently active. Two of these were appointed only this summer.

The subcommittee for research evaluation, co-ordination, and planning (RECAP) was appointed in 1956. Its purpose is to consider proposals and make recommendations to the Committee concerning projects under way or recommended for study in the field of forest tree improvement. This subcommittee is the successor of the projects for study group. Currently the subcommittee is concerned with developing and assembling brief summaries of forest tree improvement research projects under way in the region. This probably will be done in co-operation with the Forest Genetics Research Foundation.

The forest tree seed certification subcommittee, recently appointed, has as its object to explore needs for and suggest and recommend means of meeting the needs in tree seed certification. It represents a further step in the work carried out by the seed collection zone subcommittee.

The subcommittee for registration and marking of selections, also recently appointed, has as its purpose to explore the needs for and methods of registering and marking tree and stand selections and to suggest and recommend procedures.

REGIONAL TREE IMPROVEMENT CONFERENCES

The Lake States Forest Tree Improvement Committee was brought into being in April 1953 at the Lake States Forest Genetics Conference held in Eagle River, Wis. One of the mandates to the committee was to conduct "annual or periodic" regional conferences.

These conferences provide an opportunity (1) for those engaged in forest tree improvement research to report briefly on what they have done and what they have learned, (2) for those interested to learn the status of such research in the Lake States and in other regions, (3) for interested people to point out problems needing study, and (4) for demonstrations and examinations of forest tree improvement work in the field.

Committee sentiment favoured biennial conferences. Accordingly, the Second Lake States Forest Tree Improvement Conference was conducted at Wisconsin Rapids, Wis., in August 1955. Registered attendance was 72 as compared to 57 at the first conference. Now the Third Lake States Forest Tree Improvement Conference is scheduled for September 17 and 18, 1957, at the University of Minnesota's North Central School of Agriculture at Grand Rapids, Minn. A record attendance is anticipated.

COMMITTEE MEETINGS

Much of the Committee's work is done by correspondence and through the subcommittees. However, two or three meetings usually are held between the regional conferences. At these times the Committee (1) reviews and approves activities and reports of the subcommittees and plans for regional conferences, (2) considers suggestions for new lines of work, and (3) conducts other necessary business.

NEWSLETTER

Once or twice a year, between Committee meetings and regional conferences, the Committee publishes a newsletter, Trebredinews. It contains current, brief reports on subcommittee activities, work of the member organizations, and tree improvement activities in other regions and countries, and announcements of meetings. Preparation of the newsletter is rotated among the Committee members.

PUBLICATIONS

So far, five publications have been issued by member agencies for the Lake States Forest Tree Improvement Committee. Two are proceedings of regional conferences, and three are subcommittee reports. A list of these publications appears at the end of this paper.

CONCLUSION

The various Committee activities all contribute to the fulfillment of its major purpose - to encourage and co-ordinate forest tree improvement activities in the Lake States. The work of the Committee has been characterized by an excellent spirit of co-operation and goodwill among its members. Apparently all realize that the most rapid, yet sound progress possible is needed in this relatively new and important field, and that by pulling together this can be achieved with mutual benefit.

PUBLICATIONS ISSUED FOR THE LAKE STATES FOREST TREE IMPROVEMENT COMMITTEE

(1) Proceedings of the Lake States Forest Genetics Conference.
1953. Lake States Forest Expt. Sta. Misc. Rpt. 22, 83 pp. (processed.)

(2) Proceedings of the Lake States Forest Tree Improvement Conference.
1955. Lake States Forest Expt. Sta. Misc. Rpt. 40, 108 pp. (processed.)

(3) Forest Genetics in the Lake States, an Annotated Bibliography, by William J. Libby, Burton V. Barnes, and Stephen H. Spurr.
1956. Univ. of Mich., School of Natural Resources (no series), 74 pp. (processed.)

(4) Guide for Selecting Superior Forest Trees and Stands in the Lake States, by Paul O. Rudolf.
1956. Lake States Forest Expt. Sta., Sta. Paper 40, 32 pp., illus. (processed.)

(5) Forest Tree Seed Collection Zones for the Lake States, by Paul O. Rudolf.
1957. Mich. Dept. Conservation, Forestry Div. (no series), 14 pp., illus. (processed.)

REPORT TO COMMITTEE ON FOREST TREE BREEDING

SOME EFFECTS OF LIGHT ON THE GROWTH OF CERTAIN WOOD SPECIES

by:

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SOME EFFECTS OF LIGHT ON THE GROWTH OF CERTAIN WOOD SPECIES

1. Effect of photoperiod on growth of Caragana arborescens seedlings.

Caragana arborescens seed was planted in the greenhouse under natural daylight and daylength on December 19, 1956. On January 19, 1957 seedlings were transferred to five different photoperiods at a constant temperature of 20°C. The photoperiod conditions were as follows:

A - Natural daylight and daylength, mean photoperiod 12.5 hours (excluding twilight).

B - 8 hours natural daylight of low intensity, approximately 800-1000 f/c, 16 hours dark.

C - 8 hours daylight as in B, plus 4 hours of 25 f/c of incandescent light, 12 hours dark.

D - 8 hours daylight as in B, plus 8 hours of 25 f/c of incandescent light, 8 hours dark.

E - 8 hours daylight as in B, plus 16 hours of 25 f/c of incandescent light, no dark period.

Height of the shoots was measured periodically and the data are presented in the following table.

Height in cm. ($\overline{X}$ per plant)
Treatment (137 days)

Date	Age (days)	A	B	C	D	E
*19 Jan.		1.5	1.8	2.0	1.4	1.9
12 Feb.	53	3.3	5.7	7.5	10.6	11.6
16 Mar.	85	2.4	6.2	10.7	13.6	23.0
20 Apr.	120	2.9	8.9	12.9	21.2	39.0
20 May	150	3.4	9.8	12.7	32.1	52.8
5 June	168	8.8	10.0	14.0	32.7	57.2

*Beginning of treatment

At the end of the treatment period plants were harvested and dry weights determined as follows.

Dry Weight in grams ($\overline{X}$ per plant)
Treatment

	A	B	C	D	E
Shoots	0.58	0.86	1.29	1.76	2.64
Roots	0.79	0.88	1.13	0.84	1.08
Total	1.37	1.74	2.42	2.60	3.72

Long photoperiods definitely increase both stem elongation and total production of dry matter. Continuous light of low intensity produced no obvious growth abnormalities.

2. Effect of continuous light on growth of woody plant seedlings.

Plants were grown in the greenhouse under the following light conditions.

A - Natural daylight and daylength.

B - Natural daylight plus continuous illumination of 25 f/c of incandescent light (minimum continuous light 25 f/c.)

C - Natural daylight plus continuous illumination 950 f/c of standard cool white fluorescent light plus 50 f/c of incandescent light (minimum continuous light 1000 f/c).

During most of the year the temperature was held at 20°C continuous but during midsummer this temperature was exceeded for part of some days.

1. Caragana arborescens

Plant Height in cm. ($\overline{X}$ per plant)

Date	Age (days)	Treatment A	Treatment B	Treatment C
5 May 56	0	Seed sown		
16 June	42	9.1	7.7	6.7
9 Sept.	127	40.8	31.2	42.6
9 Jan. 57	249	52.3	104.4	125.2
24 Feb.	295	55.4	133.9	147.7
9 June	400	63.9	143.4	152.8

Plants under treatment B and C became too tall for the space available under light panels and suffered tip damage in some instances. One plant under Treatment C flowered April 14 and another under the same treatment May 9.

2. Betula lutea

Plant height in cm. ($\bar{X}$ per plant)

Date	Age (days)	Treatment A	Treatment B	Treatment C
5 May 56	0		Seed sown	
6 Sept.	124	29.9	18.7	33.9
12 Jan. 57	252	27.3	62.7	86.5
2 Mar.	301	30.0	97.7	89.6
9 June	400	30.0	116.5	94.3

Plants in Treatments B and C suffered some mechanical damage from light panels.

3. Betula papyrifera

Plant height in cm. ($\bar{X}$ per plant)

Date	Age (days)	Treatment A	Treatment B	Treatment C
5 May 56	0		Seed sown	
23 Sept.	141	59.3	55.6	46.2
13 Jan. 57	253	91.6	123.9	97.2
2 Mar.	301	93.0	157.5	102.9
15 June	406	100.1	162.5	105.0

4. Picea glauca

Plant height in cm. ($\bar{X}$ per plant)

Date	Age (days)	Treatment A	Treatment B	Treatment C
9 May 56	0		Seed sown	
15 Oct.	159	4.4	2.1	1.0
13 Jan. 57	249	5.4	3.7	1.8
3 Mar.	298	5.3	4.4	3.9
7 Apr.	333	5.4	5.8	6.0
20 May	376	5.5	8.6	8.8
17 June	414	5.6	10.6	11.0
11 July	438	6.2	10.9	13.3

Dry weight in gm. ($\bar{X}$ per plant)

Date	Age (days)	A Shoots	A Roots	A Total	B Shoots	B Roots	B Total	C Shoots	C Roots	C Total
9 May 56	0				Seed sown					
15 Oct.	159	--	--	--	0.07	0.04	0.11	--	--	--
21 June 57	418	--	--	--	0.99	0.35	1.34	3.39	1.98	5.37

5. <u>Picea mariana</u>

Plant height in cm. ($\bar{X}$ per plant)

Date	Age (days)	Treatment A	Treatment B	Treatment C
9 May 56	0		Seed sown	
17 Oct.	161	4.8	--	--
26 Oct.	170	--	1.7	--
27 Oct.	171	--	--	1.4
19 Jan. 57	245	7.1	--	--
20 Jan.	246	--	3.8	7.1
9 Mar.	304	7.3	7.7	13.5
7 Apr.	333	7.2	11.6	16.4
20 May	376	7.3	19.2	22.6
22 June	419	9.0	26.4	35.3

Dry weight in gm. ($\bar{X}$ per plant)

Date	Age (days)	A Shoots	A Roots	A Total	B Shoots	B Roots	B Total	C Shoots	C Roots	C Total
9 May 56	0				Seed sown					
17 Oct.	161	0.04	0.02	0.06	--	--	--	--	--	--
26 Oct.	170	--	--	--	0.03	0.02	0.05	0.02	0.03	0.05
22 June 57	419	0.32	0.31	0.63	1.11	0.36	1.47	11.30	7.85	19.15

6. Picea abies

Plant height in cm. ($\overline{X}$ per plant)

Date	Age (days)	Treatment A	Treatment B	Treatment C
19 May 56	0		Seed sown	
28 Oct.	162	1.8	2.6	--
1 Nov.	166	--	--	0.7
20 Jan. 57	246	1.8	4.7	1.4
10 Mar.	316	2.0	7.6	3.4
20 Apr.	357	2.0	11.6	6.1
20 May	387	2.1	16.0	7.6
25 June	423	2.1	19.7	8.8

Dry weight in gm. ($\overline{X}$ per plant)

Date	Age (days)	Treatment A			B			C		
		Shoots	Roots	Total	Shoots	Roots	Total	Shoots	Roots	Total
19 May 56	0					Seed sown				
28 Oct.	162	0.04	0.05	0.09	0.06	0.04	0.10	--	--	--
1 Nov.	166	--	--	--	--	--	--	0.05	0.04	0.09
25 June 57	423	0.08	0.14	0.22	1.49	0.73	2.22	--	--	--

Continuous light at the higher intensity produced no obvious abnormalities although it appears to have inhibited stem elongation in Betula and possibly in Picea abies and P. glauca. All the Picea species show more branching under the higher intensity continuous light. Where data are available it is obvious the dry matter accumulation was greatly increased under high intensity continuous light. Continuous light of even low intensity might be a valuable tool in producing rapid growth of potentially valuable stock.

P.

FOREST TREE IMPROVEMENT RESEARCH IN WISCONSIN

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FOREST TREE IMPROVEMENT RESEARCH IN WISCONSIN

The University of Wisconsin in co-operation with the Wisconsin Conservation Department undertook a program in forest tree improvement in July of 1948. The general objective of the program was for the improvement of the genetic quality of the forest tree planting stock used in Wisconsin reforestation. The program has been developed along three general lines. They are:

1. Selections and testing of superior forest tree species

2. Hybridization studies

3. Specialized studies on such problems as vegetative propagation, flower induction, establishment and maintenance of forest tree seed orchards, etc.

To date, over 360 individual tree selections have been made, however, not all of these represent plus tree selections. Many of the individual tree selections have been used to provide stock for progeny tests and as parent stock for forest tree seed orchards to be established.

Species of interest include red, white, and jack pine, white and black spruce, and some balsam fir. In addition, some individual tree selections have been made for trembling and large-toothed aspen, and several birch population collections have been acquired.

An attempt has been made to build up a collection of breeding material for future research. Included in the collection are some twenty species of _Pinus_, five species of _Larix_, six species of _Picea_, three species of _Abies_, and three species of _Betula_. Representative samples of all this material are being grown in breeding collection areas in several locations throughout the state.

Approximately 100,000 trees from open-pollinated seed from individual trees or selected areas are now involved in progeny and provenance tests. The trials are composed of 36 and 64 tree plots replicated 2 or 3 times within a trial. The trials are then replicated on 2 or 3 different sites in central and northern Wisconsin. Periodic survival counts, growth records, and other observations will be made on the areas. Certain provenances or individual tree selections which prove to be superior to others in the test will be used as seed sources for future reforestation work and as parent stock for seed orchards.

Controlled pollinations have been performed during the years as time, personnel and flowering on the pines permitted. The majority of these pollinations have been made on red pine. Although some work has also been done with jack pine, Austria pine, and white and Norway spruce. Both intra- and inter-specific crosses have been attempted. Results to date have been rather poor. Many cones have been lost due to insect damage. No inter-specific crosses have to date yielded seed. A small scale self-compatibility test with red pine has been in progress for several years.

The object of several of the specialized studies is to provide information of value for the systematic development and management of a network of forest tree seed orchards. In addition, a number of the studies