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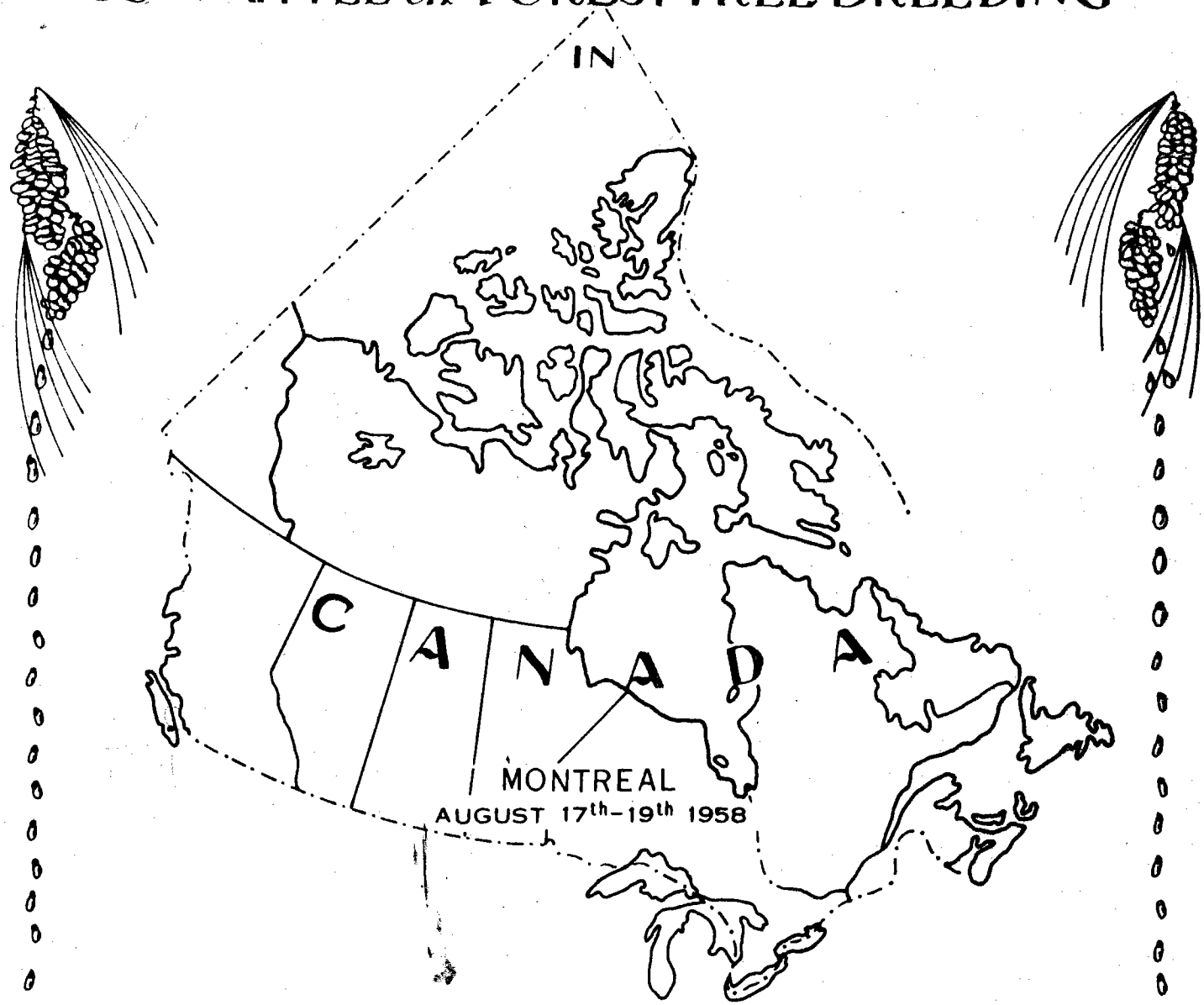
Proceedings of the Sixth Meeting OF THE COMMITTEE on FOREST TREE BREEDING IN CANADA



Part II
Reports and Papers

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

Held at Macdonald College, Ste. Anne de Bellevue, Que., on August 17th, 18th and 19th, 1958.

PART II

PROGRESS REPORTS, PROGRAMME REVIEWS AND PAPERS PRESENTED AT THE MEETING

Part I of the Proceedings, including Minutes of the Business Meeting and the Discussions of Reports and Papers, received restricted distribution to Committee Members only.

Part II, in addition, 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

Ottawa

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List of Active Members of

The Committee on Forest Tree Breeding
in Canada.

August, 1958

Mr. A. Beckwith.	Dept. of Lands and Forests, Southern Research Station, Maple, Ontario.
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Mr. A.J. Carmichael.	Dept. of Lands and Forests, Tree Seed Plant, Angus, Ontario.
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Mr. W.A. Porter.	Dept. of Agriculture, Forest Biology Division, Victoria, British Columbia.
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1. MEMBER PROGRESS REPORTS

REPORT TO COMMITTEE ON FOREST TREE BREEDING
July, 1958

A. J. Carmichael
Ontario Tree Seed Plant, Angus

I General

A change in the program for seed production has resulted in the full time employment of A. J. Carmichael and G. B. Withers on a Seed Production and Improvement Project. This project will be concerned with the verification of the seed zone system in use in Ontario and with the development of improved seed collection methods, to include the thinning of selected natural stands and the establishment of seed orchards. The work will be designed not as a research project but as a production unit to improve the quality and quantity of seed available. This will be done by adopting the practices and principles made available by research organizations. Headquarters for this work will remain for the present at Angus, Ontario.

II Provenance Tests

Routine maintenance and refill planting was carried out for existing test plantings. No growth measurements were made of test trees.

Red pine and white spruce provenance tests were established for the Dominion Forest Service in three locations. In each case the wedge method of hand planting in furrows was used and trees were placed at a spacing of 4' x 4'.

III Seed Orchards and Seed Production Areas

A. General

An analysis has been made of the size, number and general location of seed orchards and seed production areas required for each species in each seed zone for an annual production of 100,000,000 trees. This has been used to develop a work program co-ordinating the efforts of five nurseries in the production of grafted seed orchard materials.

The majority of the work will be concerned with the northern part of the province where the emphasis will be on spruce and red pine. The 1959 seed orchard grafting program will include 2500 white spruce, 2000 black spruce, 4000 red pine and 2000 white pine.

B. Red Pine Seed Production Area - Lynn Tract

The test area of red pine at Lynn Tract, Simcoe County (13 yr. age, 12' x 12' spacing), has been re-examined for flower production. A detailed description of the 15 sites selected was given in the August 1957 report to the committee.

There were no 2 year old cones present in 1958, but a small crop of 1 year old cones was found. This crop is described in Table 1.

A comparison of the 1957 and 1958 cone counts, indicates that a few trees had a higher production in both years. These trees possibly differ genetically in their flowering pattern. They are found in general on those sites where the red pine have good growth rather than on those sites supporting slower growing trees. The counts would indicate that several cone crops must be examined before individual tree differences became definite.

The great variation in cone production between individual trees on the same site would indicate that there are great differences in the inherent capacity of the trees to produce cones, or that some trees are at their low ebb in the cycle of cone production while others are at their peak, or that the sites as selected are not uniform. When further counts are available, these factors might be resolved. Until then no attempt will be made to increase flower production by means of fertilizer treatments.

Foliar analysis tests were carried out for three trees in site F, a depressed flat with good growth (Table 2) samples were taken in September 1957 from each whorl on the trees, air-dried and analysed for nitrogen, phosphorous and potassium, by Donald Inspection Ltd., Toronto. Plotting of these values singly and in ratio did not show a correlation with the production of 2 year old cones.

Grafts of trees F2 and F9 were made and will be observed to determine whether variations in cone production are genotypic. When tests in the induction of buds in needle fascicles have been completed for red pine, plants might be reared and used on various sites, to explain further the variation in cone production between these trees. This is of interest since the two trees have a similar phenotype.

Table I Red Pine - Lynn Tract - 1958

Average of 1 Year Cones - Trees 1 - 16, Site A - O

Tree #	Site A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	TOTAL
1	12	8	1	1	2	67	3	14	3	0	0	0	0	0	0	111
2	5	11	20	1	3	25	5	6	14	1	0	0	5	0	1	97
3	19	1	5	37	1	7	17	34	2	10	0	33	0	2	0	168
4	40	29	9	28	2	53	1	6	4	0	4	28	0	4	6	214
5	21	2	38	1	20	13	45	0	9	2	0	0	6	2	0	159
6	37	34	27	0	9	2	31	105	5	10	0	13	18	0	0	291
7	31	3	48	0	1	30	9	40	8	2	3	0	0	11	0	186
8	1	9	17	8	1	0	95	0	4	0	1	1	0	6	0	143
Total	166	97	165	76	39	197	206	205	49	25	8	75	29	25	7	1369
Avg.	20.7	12.1	20.6	9.5	4.8	24.6	25.7	25.6	6.1	3.1	1.0	9.6	3.7	3.1	.8	171.1
9	2	6	35	5	0	15	2	8	8	16	3	6	3	7	1	117
10	4	8	20	0	0	17	14	0	17	0	2	1	1	11	0	95
11	2	0	17	0	5	6	37	2	0	13	0	8	0	0	0	90
12	3	3	85	0	21	35	6	6	20	25	0	25	5	24	0	256
13	59	15	138	6	0	0	5	3	0	0	1	6	7	0	20	260
14	1	56	1	0	1	0	14	215	10	0	3	5	7	0	29	342
15	0	12	0	5	1	0	9	15	0	5	40	18	3	11	0	119
16	0	3	0	37	2	10	24	13	0	0	0	2	11	2	0	104
Total	71	103	296	53	30	83	111	262	55	59	49	71	35	55	50	1383
Avg.	8.8	12.8	37.0	6.6	3.7	10.3	13.8	32.7	6.8	7.3	6.1	8.8	4.3	6.8	6.2	172.8
Grand total	237	200	461	129	69	280	317	467	104	84	57	146	64	80	57	2752
Avg.	14.8	12.5	28.8	8.0	4.3	17.5	19.8	29.1	6.5	5.2	3.5	9.1	4.0	5.0	3.5	172.0

Table II

Foliar Analysis for N. P. K. for Red Pine Trees F2 and F9, Lynn Tract

Whorl No.*	No. 2 Yr. Cones		N.% Oven Dry Wt.		P.% Oven Dry Wt.		K.% Oven Dry Wt.	
	F 2	F.9	F 2	F 9	F 2	F 9	F 2	F 9
0	-	-	-	-	-	-	-	-
1	-	-	1.67	1.67	0.17	0.18	0.62	0.62
2	14	0	1.56	1.67	0.14	0.16	0.43	0.56
3	31	0	1.59	1.55	0.15	0.15	0.48	0.72
4	43	2	1.67	1.73	0.16	0.15	0.59	0.37
5	27	2	1.78	1.62	0.15	0.15	0.44	0.46
6	15	3	1.43	1.67	0.15	0.15	0.50	0.51
7	1	2	1.55	1.67	0.16	0.14	0.37	0.68
8	0	0	1.50	1.40	0.15	0.16	0.18	0.41
9	0	0	1.55	1.51	0.14	0.14	0.40	0.41
10	0	0	1.40	1.67	0.14	0.15	0.52	0.37
Total	131	9						

* The current seasons growth at the top of the tree is designated as whorl 0.

IV Scotch Pine Christmas Tree Test

It is common practice to prune the branches of Scotch Pine to develop a denser and better formed tree. Since the sources of Scotch pine planted in test plantations differ in the number of lateral buds surrounding the terminal bud, it was necessary to determine what number of buds would be produced in the needle fascicles after pruning. Trees which had good form, were pruned in each seed source in test plantations near Ottawa and Sault Ste. Marie. The average number of buds is given for the three trees pruned in each seed source. (Table 3)

Table 3

Number of Lateral Buds on Terminal Shoot before and after Pruning Scotch Pine

Seed Source	Number of Lateral Buds on Terminal Shoot			
	Ottawa Plantation		Sault Ste.Marie Plantation	
	Before Pruning	After Pruning	Before Pruning	After Pruning
France-Haute Loire	7.0	34.0	5.1	17.6
-Auvergne	8.2	32.2	4.0	15.0
-Cevennes	8.1	33.1	6.2	20.6
West Europe	8.1	24.2	6.2	22.6
Lower Austria	7.1	29.1	4.5	22.6
Lower Austria	8.0	24.2	5.1	22.0
West Baltic	8.1	42.0	5.1	24.0
East Baltic	8.0	26.0	6.2	16.0
Sweden	7.2	34.3	6.1	15.6
Finland	5.2	18.0	6.1	9.6
S. Finland	6.0	20.2	3.1	11.3
Adirondacks	8.2	25.2	6.1	19.0

A further examination of these trees will be necessary to determine the number of shoots which have developed from the available buds. Northern sources produced in general minute buds, whereas Southern sources produced very large buds.

V. Shoot Moth Test

A comparison of Pinus nigra cebennensis from Cevennes, France, and red pine from Douglas, Ontario is being made on two areas, to determine any difference in the attack of European Pine Shoot Moth (Rhyacionia buoliana) on these species. Previous measurements have indicated that Pinus nigra cebennensis is not attacked as frequently as red pine and that attacked trees tend to develop a single stemmed form more frequently than red pine.

Specimen trees have been transplanted by the Forest Biology Division of the Department of Agriculture, to their field station at Elmira, Ontario, for detailed examination to determine if any physical factors of tree growth inhibit the development of shoot moth larvae.

An attack of Formes annosus on both species in the Site Region 6 plantation at Mansfield may disrupt the test. If not, further growth measurements will be made.

Snow depth measurements were made at Mansfield during the winter of 1958 to determine whether pockets of heavier infestations were due to snow protection. This data has to be examined as yet.

VI Rooting Leaf Bundle Cuttings

Mr. H. J. Jeckalejs of the Division of Research, Ontario Department of Lands & Forests will be extending his earlier studies on rooting leaf bundle cuttings to develop a means for the production of plants by this method.

In order to define the correct time of pruning required to induce buds in needle fascicles, a test was established in which white pine, red pine and Scotch pine were pruned at monthly intervals commencing on March 17 and at weekly intervals commencing on June 16, and extending to July 21. Trees of approximately 3 ft. and 20 ft. heights have been used for each species. One-third of the past seasons growth was removed up to June 9, after which one-third of the current seasons growth has been removed. The terminal, first and second whorls have been pruned on 3 ft. trees and the first, second and third whorls on 20 ft. trees.

1957 REPORT ON BREEDING AND NURSERY RESEARCH

W. H. Cram

Forest Nursery Station,
Indian Head, Sask.

Introduction:-

Improved facilities for breeding and nursery research were provided by the new headerhouse, and an adjoining greenhouse in 1957-58.

Weather:-

Climatic conditions were favorable for field breeding and nursery operations in 1957. The frost-free period was 120 days from April 26 to August 25, with only 9.8 inches of precipitation. An early and dry spring permitted field operations to start on May 2, when Russian poplar began to bloom. Dry weather, which was ideal for field operations presisted to the end of July. August was a relatively wet month with 3.3 inches of rain. The months of May and July were exceptionally warm as indicated by average mean daily temperature of 55.0 and 70.0°F, respectively. A dry open fall was experienced from September until snowfall on November 25.

Caragana Breeding:-

Information on the inheritance of two characters of Caragana arborescens was derived from the progenies of three compatibility determinations. Data for an 'albino' character were obtained in 1954 from the greenhouse germination of the 1953 inbred [S_1] and hybrid [F_1] seed. Data for the so-called "pendulant" character were recorded in 1957 from the 1954 plantings. Segregation data for the two characters in three F_1 progenies are presented in Table 1. It would appear that the 'albino' and the 'pendulant' characters are both inherited as simple recessive and independent factors. This information confirms the value of N-19 as a tester in the breeding program to determine the genotype of self-incompatible selections for the pendulant and albino characters.

Table 1. Segregation for Albino and Pendulant Characters in F_1 Progenies of Caragana arborescens

Progeny ♀[1]	♂	Segregation for albino: green	yellow	ratio	X^2	Genotype of ♀ Parent
		(No)	(No)			
N19	N19	77	17	3:1	2:40	Aa
A-1	N19	88	0	88:0	-	AA
V16	N19	131	0	131:0	-	AA
		Segregation for pendulant: upright	pendulant			
N19	N19	0	14	0:14	-	pp
A-1	N19	21	25	0:1	0:35	Pp
V16	N19	75	0	75:0	-	PP

[1] N19 is a pendulant, A-1 and V16 are upright in habit

Self-compatibility determinations for Caragana accession material was initiated in 1957. Only 90 of the vigorous selections were sexually mature. These selections were found in four accessions, which were field planted in 1953. The original seed came from Botanical Gardens in Europe and the United States. Results of the fertility determinations have been tabulated in Table 2.

Table 3. -Frequency distribution for Self-Compatibility Values[1] of 57 Vigorous Selections from Four Caragana Accessions

Fertility classes	C microphylla		C arborescens				Average
	A-109	Average	D-11	D-13	D-14	D-16	
(%)	(No)	(%)	(No)	(No)	(No)	(No)	(%)
0-20	2	18.2	3	2	6	12	50.0
21-40	5	45.4	4	1	2	0	15.2
41-60	3	27.3	3	3	2	1	19.6
61-80	0	0	3	0	3	0	13.0
61-100	0	0	0	0	1	0	2.2
101-120	0	0	0	0	0	0	0
121-140	0	0	0	0	0	0	0
141-160	1#	9.1	0	0	0	0	0
Selections (No.)	11		13	6	14	13	
Fertility - range (%)	4 to 145		0 to 67	12 to 52	0 to 83	o to 46	
- mean	40		37.8	34.8	37.5	7.4	

[1] Self-compatibility or fertility as % of tripped flowers

Autogamous plant exhibits self tripping

Self-fertility of the one accession of C. microphylla was somewhat similar, although greater, than any of the C. arborescens accessions. Seven selections from accessions of C. arborescens demonstrated self-incompatibility. One accession, D16, from Cheyenne, Wyoming, contained five of the seven incompatible plants. We hope to incorporate genetic diversity and increased vigor into the caragana breeding program, with these self-incompatible selections.

Maple & Ash Seed Maturity

Seed was harvested from four trees of Green Ash and of Boxelder Maple at three tri-weekly intervals in 1956. It was dried in the greenhouse for one week, then stored under room and cellar conditions until sown outdoors October 16. Moisture Content of the seed was determined at time of harvest and at time of sowing 1957 germination records and results are summarized in Tables 4 and 5.

Table 4. Moisture Content in 1956 and Germination Capacity in 1957 of Green Ash Seed

Date of harvest	Moisture content of seed[1] at harvest	Moisture content of seed[1] when sown cellar	Moisture content of seed[1] when sown room	Seedbed germination[2] cellar	Seedbed germination[2] room
	(%)	(%)	(%)	(%)	(%)
Aug. 22	51.6	14.7	6.6	0.1*	5.0*
Sept.12	48.8*	13.2*	6.7	12.2	13.0
Oct. 3	12.9**	10.3**	6.8	12.1	15.5

[1] Moisture content as % of wet weight after 24 hours of 100°C;
[2] Germination in 1957 as % of seed sown for 5 reps of 100 seed;
*, **, Significantly less than for other dates at 5%, and 1% levels.

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Table 5. Moisture Content in 1956 and Germination Capacity in 1957 of Maple Seed

Date of harvest	Moisture content of seed[1] at harvest	Moisture content of seed[1] when sown cellar	Moisture content of seed[1] when sown room	Seedbed germination[2] cellar	Seedbed germination[2] room
	(%)	(%)	(%)	(%)	(%)
Aug. 22	67.2	16.4	6.7	28.8**	30.2**
Sept.12	57.1*	15.7*	7.2**	4.1	38.8
Oct. 3	10.8**	9.3**	7.8**	40.5	40.0

[1] Moisture content as % of wet weight after 24 hours of 100°C;
[2] Germination in 1957 as % of seed sown for 5 reps of 100 seed;
*, **, Significantly less than for other dates at 5%, and 1% levels.

From these tables it is evident that neither Ash nor maple seed should be harvested in August, and that storage conditions from harvest to sowing had little influence on viability of fresh seed.

Ash seed, which was prematurely harvested in August, demonstrated over 50% moisture content and little viability. Seed, as harvested in September and October, exhibited a high degree of dormancy. Apparently some pre-sowing seed treatment is required to ensure adequate germination of ash seed especially if it must be sown in a dry fall.

Viability of Maple seed increased from 30 to 40%, when allowed to mature on the tree from August to September. Maple seed would also appear to require special treatment to increase germination especially if sown in a dry fall.

Storage of Poplar Cuttings:

Investigations on the winter storage of dormant poplar cuttings was initiated in 1956 to overcome a serious nursery problem. Cuttings were collected on October 22 from stooling beds of three clones, cut into 10 inch lengths, segregated into diameter size classes and tied into bundles of 25. Five pre-storage treatments were applied by dipping the bundles into solutions of fungicides. The five treatments involved Captan, Tersan, check (water), Semesan and Oxyquinolene Sulphate. The cuttings were stored on October 25 under five different conditions (as listed in Table 6). On May 7, 1957, the cuttings were removed from storage and planted in the field to evaluate the results. The design involved three replications of five treatments and five storages with 25 cuttings per plot. Records for field stand were compiled on September 25 with the results listed in Table 6.

Average stands for the five fungicidal treatments as listed above were: 42, 36, 36, 35 and 30%, respectively. The Captan treatment (150 grams per gallon) was evidently beneficial to rooting of poplar cuttings. It significantly increased the stand of one clone and appeared to increase that of another. Toxicity of the Oxyquinolene treatment (25 grams per gallon) caused a significant decrease in the stand of two clones.

Table 6. Stand for Poplar Cuttings of Three Clones After Five Storages.

Storages			Clones			Means for Storage
Place	Medium	Temp.[1]	N.W.	Sask.	44-52	
			(%)	(%)	(%)	(%)
Cellar	Sand	41°F	9.9	16.0	13.6	13.2
Cellar	Poly	41°F	23.5	14.0	9.1	15.5
Cellar	Poly	31°F	40.3	31.6	29.1	33.7
Cellar	Sand	31°F	52;5	42.8	25.9	40.4
Outdoors	Soil	?	89.6*	68.4*	69.6*	75.9*
Means for clones			43.2	34.6	29.5	

[1] Cellar temperatures were 31.8 ± 11°F and 41.2 ± 7°F

Outdoor or 'heeling-in' storage proved vastly superior to any of the four types of indoor storage as evident from the stands for cuttings listed in Tables 6. Regretably, temperatures of the cellar storages varied greatly (31.8 ± 11°F and 41.2 ± 7°F), due to absence of insulation and temperature control facilities. Nevertheless, it would appear that indoor storage of poplar cuttings at low temperatures of approximately 31°F is superior to storage at higher temperatures.

Stand of poplar cuttings was improved when moist sand was placed with the cuttings being stored in polyethylene bags for the following pathogenicity study. This treatment increased the stand from 38 to 77%, when the cuttings were stored at 31°F. and from 8 to 53% when stored at 41°F.

Studies to determine the pathogenicity of isolates from diseased cuttings were initiated in 1956 in cooperation with Dr. O. Vaartaja of the Forest Biology Division. Cuttings of two poplar clones were collected sized and tied in bundles of 25 in 1956 as for the storage study. These bundles of cuttings were inoculated by dipping the basal and upper ends in suspensions of the isolates. Sixteen isolates were supplied by Dr. Vaartaja, for this study. Each inoculum was applied to four bundles of cuttings, which were then sealed in polyethylene bags with sterile and moist sand. The packages were covered with moist sand and stored in the cellar

at 31 ± 11°F and 41 ± 7°F for the winter. In the spring of 1957, the cuttings were planted to evaluate pathogenicity of the isolates in terms of the rooting capacity or field stand of the cuttings so inoculated.

Only one of the 16 isolates proved highly pathogenic to poplar cuttings. This was a Pythium spp., isolate (#2058), which had been obtained from diseased willow cuttings. Cuttings of only one clone, 44-52, proved susceptible to this isolate when the cuttings were stored at 41 ± 7°F temperature.

Publication in 1957:-

Research papers:-

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

2. Cram, W. H. and H. A. Worden, 'Maturity of white spruce cones and seed'. For. Sci. 3:263-269. 1957.

REPORT TO COMMITTEE ON FOREST TREE BREEDING
July, 1958

B. W. Dance
Division of Forest Biology
Canada Department of Agriculture

General

The Laboratory of Forest Pathology, Canada Department of Agriculture, Maple, is participating in a joint programme with the Division of Research, Ontario Department of Lands and Forests for the purpose of evolving disease-resistant hybrid poplars. In this programme, the writer has been assigned responsibility for assessing the degree of susceptibility of hybrids, both presently available and to be developed, to the fungal flora of Populus in Ontario.

This project entitled "Pathological Considerations in the Development of Hybrid Poplar" (No. SFB 50.06) was reviewed in the spring of 1958 by senior officers of the Division of Forest Biology and the Division of Research. As a result of the review, the responsibilities were re-defined. This revision became feasible when it was concluded that, of all hybrid poplars evolved to date, Populus alba L.x grandidentata Michx. has the most significant economic potentialities. The assessment was made despite knowledge that this hybrid is seriously and even fatally affected by a leaf and twig blight which has been described (1,2). Justification for the conclusion was founded in observations of apparent high resistance to the disease by a few clones.

In view of the potentialities of P. alba x grandidentata it was decided that the main immediate investigative effort should be placed on the biology of the pathogen responsible for the leaf and twig blight condition.

Judged to warrant next priority in attention, was final resolution of the biology of Fusicladium tremulae Frank - a prevalent, destructive, long-misunderstood and hitherto misidentified pathogen of aspen. Specifically, it was intended to relate F. tremulae to an ascomycete, believed to be its ascigerous stage. This ascomycete, identified as Venturia tremulae Aderh., has only rarely been observed in Ontario. It seemed likely that attainment of this goal would yield a fairly complete understanding of the taxonomy of that group of fungi, including Pollaccia elegans Serv., that cause leaf and twig blight of poplar in Canada.

In addition to the foregoing lines of investigation, it was felt that a watch should be maintained for evidence of other pathogenic activity on hybrid poplar. It was concluded that the responsibilities of the Forest Pathology Laboratory in this project should be delimited as follows:

(1) Studies on the biology of currently and potentially important pathogens of hybrid poplars. At the present time close attention will be paid to pathogens that appear significant in the development of P. alba x grandidentata. The pathogen to receive foremost attention will be Gloeosporium sp. Of lesser interest are Cytospora spp. Hypoxylon pruinatum (Klotzsch) Cooke, Dothichiza populea Sacc. and Briard and Melampsora sp.

(2) The conduction of periodic surveys and assessments of disease problems in test plantings established by the Tree Breeding Section of the Division of Research.

(3) The provision of identifications and advice in respect to disease materials submitted by Dr. Heimburger, of the Division of Research, from breeding stock, test garden stock, and other related sources.

In the report to the Committee on Forest Tree Breeding submitted in 1957, the investigations underway on poplar diseases were outlined. Some phases of

these investigations have terminated; others are continuing or are being repeated. However, initiation of new investigations will be governed by the established order of priority indicated above.

Developments since the last report appeared are summarized in the following review. In general, these developments consist of an extension of knowledge relating to the biology and taxonomy of fungal pathogens of poplar.

Leaf and Twig Blight of Hybrid Aspen

Blighted leaves and twigs of P. alba x grandidentata were collected at Chalk River, in September 1957, and set outdoors in a lattice box in the vicinity of the parental trees. They were re-collected in late May 1958. Examination of leaf tissue at that time revealed the presence of an ascomycete. Perithecia of this fungus were prevalent in all leaves and were observed to contain mature-appearing asci and ascospores. The fungus was identified as Plagiostoma populi Cash and Waterman from the recently-published description (2) of that species on Populus tremuloides Michx. x grandidentata Michx. This collection from Ontario probably constitutes the first record of P. populi on P. alba x grandidentata.

Ascospore discharge onto synthetic media and onto leaves was secured but only occasionally and with difficulty. In no instance did the discharged spores germinate. In this respect, ascospores of P. populi are like conidia of the Gloeosporium sp. which is suspected of being its imperfect stage.

Until the factors that inhibit or control spore germination in these stages have been ascertained, it seems improbable that any progress can be made in determining the biologies of these organisms. Additional impeding factors, in this regard, are the small size and colourless character of the

spores of both stages.

Other Ascomycetes on P. alba x grandidentata

In addition to P. populi two, as yet unidentified, ascomycetes were detected on overwintered leaves of P. alba x grandidentata. One develops on the upper surface of leaves; the other on the lower surface.

These fungi seem likely to be saprophytic since they were collected from non-blighted as well as from blighted leaves. Both were obtained in pure culture by the usual method of shooting ascospores onto the surface of synthetic media.

Spores of both ascomycetes germinated readily and pure cultures were secured. Cultures of the fungus from the upper surface of leaves produce conidia in large numbers. These are being used to inoculate leaves of P. alba x grandidentata for the purpose of establishing the parasitic capability of the fungus.

Cladosporium subsessile El. and Ev.

A collection of C. subsessile was made on an unidentified host believed to be P. tremuloides. Severe leaf spotting had occurred which was accompanied by heavy sporulation. Leaves of P. alba x grandidentata are being inoculated with spores of this pathogen.

Fusicladium tremulae Frank

Related to ascigerous stage. This prevalent leaf and twig blight pathogen of aspen has been connected with Venturia tremulae Aderh. The connection had been suspected but due to difficulty in finding V. tremulae

and to the reluctance of ascospores to germinate it has, until recently, been impossible to prove the connection.

It is now evident that the former complex of fungi causing leaf and twig blight of poplar consists of two pathogens: V. tremulae; imperfect stage F. tremulae, and Venturia populina (Vuill.) Fabric.; imperfect stage Pollaccia elegans Serv.

Spore Release Mechanism and Dissemination. Spore release and dissemination in F. tremulae was studied. Conidia were trapped on glass slides exposed, daily, in a stand of aspen regeneration heavily infested with this pathogen.

It was found that spore release was triggered by rainfall in any degree. At such times, up to several hundred spores per square cm. were deposited on the horizontal glass surfaces. Practically no spores were trapped during dry periods.

From the pattern of distribution of spores on the slides, it was evident that they are disseminated by the impact of fragmenting and splattering raindrops. In view of the high concentration of spores on the traps and from the observed radius of splattering (a minimum of five feet from sporulating leaves) it appears that all leaves in a diseased area are thoroughly inoculated with conidia.

Germination tests. A series of spore germination tests were conducted ranging, at regular intervals, from 50° to 80°F. The results obtained confirmed previous findings that optimum spore germination in F. tremulae lies in the range 72° - 74°F. This knowledge should increase the effectiveness of future inoculations with this organism.

Inoculations

Several poplar species and varieties were inoculated with three pathogens of poplar noted for their destructiveness. The inoculum employed was mycelium grown on artificial media. In all instances the inoculum was introduced between the inner bark and the cambium. Inoculations and controls were wrapped with wet cotton and tin foil. The hosts inoculated were:

Populus tremuloides Michx.
P. tremula L.
P. alba L. x grandidentata Michx.
P. maximowiczii Henry x berolinensis Dipp.
P. angulata Ait. x vernirubens ?

The fungi used as inoculum were:

Hypoxylon pruinatum (Klotzsch) Cooke
Dothichiza populea Sacc. and Briard
Cytospora chryososperma (Pers.) Fries.

Of all these inoculations, only one yielded what appear to be positive results. This consisted of H. pruinatum on P. tremula. A very extensive canker developed at and below the site of inoculation. The control callused over completely and has remained healthy.

The negative results are attributed to resistance, in the host, induced by the time of year at which the inoculations were made (summer) and by the fact that all trees, with the exception of P. tremula, seem to be growing vigorously.

H. pruinatum on P. alba x grandidentata

During a recent visit of Dr. M. Boyer of the Laboratory of Forest Pathology, Quebec, to the Laboratory of Forest Pathology, Chalk River, a sporulating imperfect stage collection of H. pruinatum was obtained from P. alba x grandidentata. A large canker had formed around a branch stub on

a five inch stem. Should this hybrid be very susceptible to H. pruinatum as well as to Plagiostoma populi, then its usefulness may be reduced to a very low level.

References

(1) Cash, E. K. and M. Waterman. A new species of Plagiostoma associated with a leaf disease of hybrid aspen. Mycologia; XLIX, No. 5, 756-760. Sept. - Oct. 1957.

(2) Dance, B. W. A fungus associated with blight and dieback of hybrid aspen. Canada Dept. of Agr. Bi-monthly Progress Report; 13(6): 1-2. 1957

SUMMARY FOR TREE BREEDING COMMITTEE MEETING

August 1958

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

D.A. Fraser
Petawawa Forest Experiment Station

This study is divided into two parts:

(a) Investigation of environmental factors influencing flowering in mature trees and the biochemical and anatomical changes associated with reproductive and vegetative growth. These data have been used to design experiments for growth chamber investigation of young trees.

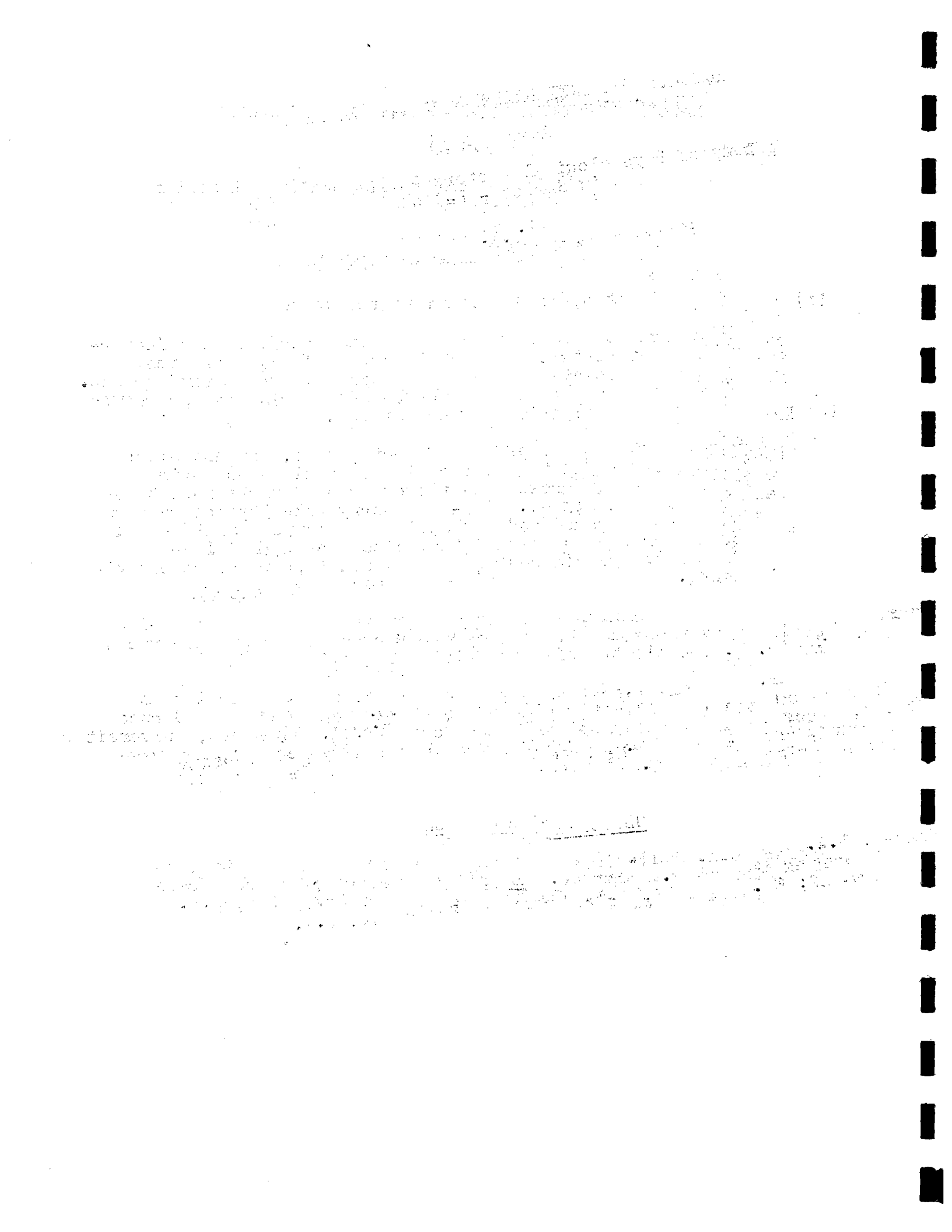
(b) Experiments on the effect of photoperiod, day and night temperatures and the application of auxins and auxin antagonists on growth and flowering of young spruce trees are being continued. A 3-acre Corry Lake Physiology area has been prepared and a planting programme for white and black spruce has been initiated so that material in different age classes will be available for future experiments.

The auxin assay research awaits the completion of the auxin assay room and the replacement for the position made vacant by Dr. L. Ebell's transfer to British Columbia.

Mr. W. Vanden Born has initiated Ph.D. studies on "Histochemical Investigation of Vegetative and Flowering Spruce Trees", under the auspices of Professor D. S. Van Fleet, University of Toronto, and D. A. Fraser, Tree Physiology Section, Petawawa Forest Experiment Station.

PUBLICATIONS

Fraser, D.A. 1958. The Relation of Environmental Factors to Flowering in Spruce. In The Physiology of Forest Trees 629-642; Ed. K.V. Thimann, The Ronald Press Co., N.Y.



SUMMARY OF REPORT ON FOREST TREE BREEDING IN 1957

C. Heimburger

Breeding work with white pine, aspen poplars and two-needled pines was continued, and some new work with white cedar was expanded.

White Pine

The seeds for an international 5-station provenance test were assembled and sown. Seeds of 12 provenances were sown at St. Williams to raise plants for two provenance test plantations, and at this Station, for a blister rust screening test. In a special study of seed germination in relation to length of stratification, it was found that seeds of the northern origins, as a rule, require less stratification than seeds of southern origins. The collection of scions from selected trees in the plantation at Connaught Ranges near Ottawa was completed. The plantation was then thinned, liberating all selected trees. Scions were also collected from Dr. Haddow's selections at Orono and of the 5 weevil resistant trees in the Lake of Two Rivers plantation in Algonquin Park. A test for weevil resistance was started at Thessalon, utilizing the plantation of Scotch pine established there in 1947 for top grafting of white pine test materials. These comprised 5 clones selected for good growth form and freedom from weeviling at Midhurst, 5 clones of weeviled white pine, and 5 weeviled and 5 seemingly weevil resistant clones of Pinus peuce near Havelock.

[illegible]

[illegible], aspen poplars and two-
[illegible] white cedar
[illegible].

[illegible]

It was possible to induce bud formation in needle bundles of young white pine after summer pruning and to propagate these buds by means of plate budding in the greenhouse. A method of summer grafting was worked out, similar to the method developed previously for red pine. A new method of bark grafting was tried but proved inferior to the current method of veneer field grafting. A method of hastening the germination of freshly harvested seeds has been found. It consists of carefully removing the seed coat after soaking the seeds in water. The naked seeds then germinate promptly when placed in moist sand. Fifty-six inter-specific crosses out of 89 made in 1956 yielded viable seeds. One hundred and twelve new such crosses were made in 1957. Inoculation with blister rust was very successful, due to favourable weather conditions. The population of Pinus strobus x peuce showing outstanding low frequency of infection in 1956 continued to do so in 1957. A collection of named varieties of black currants was assembled, to find materials retaining their leaves until fall, for white pine inoculation with blister rust. Thus far, some of our own black currant seedlings appear more suitable in this respect.

Poplars

The production of aspen-like hybrids for easy propagation and growing in Southern Ontario, continued to be the chief aim of this project. By means of exchange with other poplar breeders, 18 new clones and 2 populations were obtained. A new method for determining rooting ability of cuttings was introduced, consisting of planting the cuttings in protected beds and mulching with leaves over winter. In breeding for good rooting ability, 20 new hybrid populations were produced. In breeding for early flowering,

several hybrid populations produced in 1954, contained plants with flower buds in the fall of 1957. A progeny of two precocious aspens contained the largest proportion of precocious seedlings. It was possible to combine the precocious flowering habit with normal growth rate, at least up to the age of 4 years. Ninety-four seedlings with outstanding growth rate and good form were selected from 1,552, for further propagation and testing.

Two-needled Pines

Resistance to attack by the European pine shoot moth and adaptation to the growing conditions of Southern Ontario continued to be the chief aims of this project, and included the breeding of improved types of red pine. Twenty-six new clones and 4 populations were obtained, mostly of selected red pine and pitch pine, and Asiatic pine species. Five inter-specific crosses out of 38 made in 1956, yielded seemingly viable seeds. Twenty new such crosses were made in 1957. The method of summer grafting developed in 1956, was utilized for the propagation of 11 selected clones. Over a thousand seedlings and grafts of exotic hard pine species were set out in a plantation at Turkey Point, in a warmer climate than at this Station.

White Cedar

The production of improved types of this species and of western red cedar hardy in Southern Ontario, is the aim of this project. Seeds of one origin in Ontario and of 41 origins of western red cedar in British Columbia were obtained and sown. In addition, cuttings of 2 clones of Japanese red cedar and of 15 clones of western red cedar from British Columbia were collected and planted in rooting media.

Chestnut

The aim of this project is the production of hardy dwarf types, suitable as dwarfing stocks for timber-type chestnuts. Two seed lots, one of native chestnut and one of Chinese chestnut, were obtained and placed in boxes with sand in the fall of 1957. A seedling lot of native chestnut was received in the fall and heeled-in for the winter.

ANNUAL REPORT 1957 - '58

Forest Tree Breeding and Genetics

at the

Petawawa Forest Experiment Station

General

This report is issued for the information of co-operating persons and agencies in the field of tree breeding. It is not a research report, but merely gives an outline of the physical work accomplished in tree breeding at Petawawa during the year ending March 31, 1958.

Progress was disappointing for several reasons. Flowering was poor in 1957 owing to the combination of a heavy 1956 cone crop and cool, wet spring and summer weather in 1956 which discouraged formation of flower primordia. No control pollination work could be done.

White Spruce

A large white spruce provenance experiment with about 70 provenances has been in preparation for planting in the Great Lakes--St. Lawrence Forest Region for several years. Most of the seed has been assembled, but poor cone crops in 1957 prevented collection of the missing lots and we only managed to get a few small seedlots from the Lake States. However, we hope to collect the missing provenances in 1958 and to start the first series of experiments that fall.

A nursery provenance experiment in white spruce (Exp. No. 93-A) was measured and scored for several characters in an attempt to obtain data for studies of population genetics. The data have not yet been compiled and analysed.

Observation plots (Exp. No. 78) including eight races of white spruce and two races of Colorada blue spruce were planted in the Fuel Wood Area (P.A. 114).

One provenance experiment in white spruce (Exp. No. 93-D) including 25 races was field planted during the fall of 1957 at Kapuskasing, Ontario, by the Spruce Falls Power and Paper Company. This experiment will be described in more detail when the complete series is planted during the Spring of 1958.

Norway Spruce

A number of Norway spruce experiments were established at the Station. Hybrids and selfings resulting from controlled pollination

between weevil susceptible and weevil resistant individuals from Hudson's place were planted in the Fuelwood Area (Exp. No. 6-A, P.A. 114). Single tree progenies of elite slender Norway spruces were planted for later selection of frosthardy and weevil resistant trees (Exp. No. 75, P.A. 114). Slender genotypes may be associated with weevil resistance. Observation plots including 11 provenances of Norway spruce from selected stands in Poland, Germany, and Austria were field planted after being heavily graded in the transplant beds. (Exp. No. 80-A, P.A. 114). These observation plots will be heavily thinned at an early date to rogue out individuals susceptible to frost damage and white pine weevil.

Three experiments established to allow comparison of the progeny of the best Norway spruce stands in Europe and "second generation" Norway spruce in Canada were planted on the Valcartier Forest Experiment Station (Exp. Nos. 57-E, 57-G) and on the Causapscal Forest Research Station (Exp. No. 57-H). Another experiment in the same series had been planted with transplants that were too small, which resulted in a low survival. This experiment was replanted and enlarged (Exp. No. 57-C).

So far we have only worked with Norway spruce types from western Europe. Although these are easy to grow in the nursery, they may well be too tender for the continental climate of eastern Canada. For some years we have tried to obtain hardier types from Russia and Siberia. We finally managed to exchange seed with the Main Botanical Garden in Moscow and now have some very good seedbeds of Russian and Siberian Picea abies and Picea obovata. This material, was collected along the southern border of the species range to get hardy continental types which are also fairly fast growing. These may be used in future breeding and selection of spruces suitable for acid sites.

Eight clones including 506 grafts of selected weevil-resistant Norway spruces were planted in the A.E.C.L. graft plantation (P.A. 117). Grafted population samples of Norway spruce from Romania, Serbia, Slovenia, Denmark and some slender types of German Norway spruce selected in Sweden were planted in the arboretum on the Meridian Road (P.A. 101).

Red Spruce and Black Spruce

Observation plots including eight provenances of black spruce (Exp. No. 79) were planted in an area with a high water table in Young's Creek Road Area (P.A. 106). We lost a rather extensive black spruce provenance experiment due to pregermination in the autumn so we will have to wait with further black spruce provenance experiments until our white spruce experiments are completed.

About 42,000 2-0 red spruce seedlings of various provenances (Exp. No. 95) were transplanted in the nursery. The plants were obtained from Acadia Forest Experiment Station, and were not too thrifty.

Grafted population samples of red spruce from the Appalachian Mountains were planted in our Spruce Graft Arboretum and also at the Southern Research Station, Maple, Ontario.

Other Spruces

Grafted samples of various exotics, such as Picea schrenkiana, P. pungens, P. orientalis, P. omorica and P. asperata were planted in the arboretum on the Meridian Road (P.A. 101).

Fifty-seven seed lots of various spruce hybrids were sown in the nursery and some of these were transplanted to the greenhouse in the fall and given a 20-hour photoperiod. This technique produced seedlings in one year which are the size of normal 3-year-old seedlings. Only the P. glauca × pungens hybrids show variation in growth response; some plants have developed slowly in comparison with the remainder.

Red Pine

An experiment including two Ontario and three Quebec provenances (Exp. No. 81) was planted in the Young's Creek Road area, (P.A. 106). This experiment is intermediate between our established series of provenance experiments with Ontario red pine and the provenance experiment with samples from the entire range of red pine. The latter experiment is to be established across Canada in 1958.

A single tree progeny test (Exp. No. 38), a provenance experiment (Exp. No. 39), and a nursery provenance experiment (Exp. No. 74-A) were remeasured.

We also initiated a study of all known red pine provenance experiments in Canada and the United States to investigate the relationship between the climate in the place of origin and the growth in plantations of each provenance recorded. These data will be compared with our local phenological observations on red pine provenances. The compilation of data is nearly complete and we hope to publish the results soon.

We obtained seed for another red pine provenance study and a single tree progeny test to be conducted in co-operation with R. G. Hitt of the University of Wisconsin. (Exp. No. 215 and Exp. No. 216). The experiments are to be planted at Petawawa and in Wisconsin.

Jack Pine

An experiment with nine provenances of Ontario and Quebec jack pine (Exp. No. 82) was planted in the Young Creek Road Area (P.A. 106). In the same location a number of jack × lodgepole pine hybrids were planted with the true species for comparison; these will be investigated at a later date and the undoubted hybrids will be selected.

Another provenance experiment including twelve lots of Ontario jack pine (Exp. No. 40) was remeasured. When plotted on graph paper, the heights of the various provenances appeared to be related to the mean summer temperature and the length of growing season of the respective places of origin.

Collection of cones was continued for a jack pine provenance experiment covering the range of the species. Twenty-five collections were made by a number of co-operators.

Scots Pine

Seed of Russian and Siberian Scots pine provenances were sown in the nursery. Scots pine has a very poor reputation in Canada mainly because the seed originally imported came from stands of notoriously malformed trees near Darmstadt in southwestern Germany. However, well adapted Scots pine of good form may have some merit on jack pine sites, and may produce more timber of a better quality than jack pine.

Scots pine provenances noted for a high production of resin in certain areas of Russia also may be of value for breeding of shoot moth resistant types.

An attempt was made to rate Scots pine Christmas tree selections grafted at an earlier date. This proved difficult. Future rating should be done five years after the grafts have been planted in the field.

Progenies of Scots pine selected for early flowering (Exp. No. 85) were planted. In due course these will be rated for their value as Christmas trees.

Other Tree Species

Observation plots for the comparison of Austrian and Polish larch and Ontario tamarack were planted in the Fuel Wood Area (Exp. No. 90-A, P.A. 114). In the same area a number of *Larix eurolepis* × *laricina* hybrids were also planted. (Exp. No. 100, P.A. 114).

Various *Betula verrucosa* lots which originated from plus trees in Sweden were planted in the Arboretum, (P.A. 101), and in the Young Creek Road Area, (Exp. No. 101-A and Exp. No. 101-B, P.A. 106).

Four provenances of high altitude Douglas fir from Montana, Utah and Wyoming were established in the Arboretum, (Exp. No. 84, P.A. 101).

Vegetative Propogation

Eight hundred grafts were made for an interspecific grafting

experiment in which white, Norway, red and black spruce were grafted in all combinations (Exp. No. 212). There were no apparent differences in the per cent take and all scions look normal. In time we shall see whether black spruce rootstocks have a flower inducing effect.

Nursery Work

A study of damping-off in relation to soil types and various soil treatments (Exp. No. 191) indicated that a combination of forest litter and steam sterilization gave the best protection against damping-off.

About 68,000 seedlings were transplanted.

Plantation Work

Sixteen experiments including 39,500 plants and covering an area of 21 acres were established on the Petawawa Forest Experiment Station. Three Norway spruce experiments including 26,400 plants and covering an area of 17.9 acres were planted in the Province of Quebec.

REPORTS

Establishment Report for Experiment No. 57-E, Project P-136. Provenance experiment planted fall 1956 including six races of Norway spruce planted in Compartment B of the Valcartier Forest Experiment Station.

M. J. Holst.

Establishment report for Experiment No. 57-G, Project P-136. Provenance experiment planted spring and fall 1957 including eight races of Norway spruce planted in the Hart Hill Block of the Valcartier Forest Experiment Station.

M. J. Holst.

Establishment Report for Experiment No. 57-H, Project P-136. Provenance experiment planted fall 1957 including seven races of Norway spruce planted on the Causapscal Forest Research Station of the New Brunswick International Paper Company.

M. J. Holst.

How are our white spruce provenance experiments progressing? Paper presented at the Annual Meeting of the Woodlands Section of the C.P.P.A. in Montreal, March 27, 1958.

M. J. Holst.

Planting plans for Spring, 1958.

C. W. Yeatman.

TABLE 1

SPRING PLANTING 1957, PETAWAWA FOREST EXPERIMENT STATION

Experiment Number	Description		No. of Plants	Area (acres)	Plantation Area
—	Weevil resistant Norway Spruce	Grafts	500	1.64	P.A. 117
—	Botanical spruce grafts	Grafts	700	2.30	
6-A	Controlled hybrids between weevil resistant and weevil susceptible Norway spruces on Hudson's Place		490	1.80	P.A. 114
75	Single tree progeny test with 15 Norwegian elite Norway spruces		3,000	1.14	P.A. 114
78	Observation plots including eight races of white spruce and two races of Colorado blue spruce		5,000	1.18	P.A. 114
79	Observation plots including nine provenances of black spruce		3,000	1.10	P.A. 106
80-A	Observation plots of eleven provenances of Norway spruce		11,000	3.25	P.A. 114
81	Provenance experiment in red pine including two Ontario races and three Quebec races	Experiment Div. & Surround	2,500 852 3,352	1.22	P.A. 106

TABLE 1 (Cont'd)

Experiment Number	Description		No. of Plants	Area (acres)	Plantation Area
82	Provenance experiment with nine races of jack pine	Experiment Div. & Surround	2,700 964 2,664	1.35	P.A. 106
83	Mixed jack pine lodgepole pine hybrids		3,000	1.10	P.A. 106
84	Provenance experiment with four races of Douglas fir		200	0.07	P.A. 101
85	Selection of early flowering Scots pine for root stock purposes		240	0.09	P.A. 106
87	Lodgepole pine test		1,000	0.37	P.A. 106
90-A	Observation of Austrian, Polish, Finnish and Ontario larch		3,000	3.94	P.A. 114
100	Interspecific hybridization in Larix		400	0.25	P.A. 114
101 A+B	Trial of Scandinavian elite birch		1,000	0.37	P.A. 101 & P.A. 106
			39,546	21.17 ac.	

TABLE 2

PLANTATIONS ESTABLISHED IN 1957 OUTSIDE PETAWAWA FOREST EXPERIMENT STATION

Experiment Number	Title	No. of Plants	Area (Acres)	Agent
57-E	Provenance experiment planted fall 1956 including six races of Norway spruce	18,940	13.0	Compartment B Valcartier F.E.S. Loretteville, P.Q.
57-G	Provenance experiment planted spring and fall of 1957 including eight races of Norway spruce	4,160	2.4	Hart Hill Block Valcartier F.E.S., Loretteville, P.Q.
57-H	Provenance experiment planted fall 1957 including seven races of Norway spruce	3,300	2.5	Causapscal Forest Research Station, New Brunswick International Paper Co.
	TOTALS	26,400	17.9	

TABLE 3

SUMMARY OF GRAFTING DURING SPRING AND FALL 1957

Lake States red pine plus trees	150
Early flowering red pine	52
Fastigiate red pine	60
Pinus sinensis	86
Pinus nigra	77
Pinus sylvestris	105
Interspecific grafting in spruce	800
One plus tree	20
Total	1350

TABLE 4

TRANSPLANTING SPRING 1957

Experiment Number	Material	No. of Plants
140	Slender Norway spruce types to be selected for weevil resistance	12,335
139	Danish white × sitka spruce hybrids and comparison material	5,485
95	Red spruce provenances (obtained from Acadia F.E.S.)	42,000
98	High resin yield Austrian pine for shoot moth resistance work	1,260
-	Russian Scots pine	850
-	Pine and spruce rootstocks	6,000
	Total	67,930

PROJECT INVENTORY OF FOREST GENETICS RESEARCH
UNIVERSITY OF BRITISH COLUMBIA

Under a Grant from the National Research Council

by
A.H. Hutchinson, Ph.D., Professor Emeritus

Abstracts of Research in Progress, 1958

1. An Analysis of Growth Variation in Douglas Fir with a View toward Seed Selection — A. H. Hutchinson.

Thirty localized seed collections from areas west of the Rocky and Sierra Nevada Mountains have been utilized in coastal British Columbia nurseries, under comparable conditions, during the period 1953-58. The total number of readings exceeds 90,000. Particular attention has been given to stem and branch length and diameter; leaf size and colour; bud activity cycles and frost sensitivity. Evidences of disease and insect resistance are noted.

During the five year period, climatic extremes have been recorded. For instance, the November frost of 1955 resulted in complete annihilation of seedlings from California seed, 70 to 90 percent killing of lower level coastal British Columbia seedlings and distortion of 40 to 60 percent of the survivors; conversely, seed from higher levels, including coastal and interior areas show increased tolerance, to the extent of completeness.

There is evidence that variation is greatest under optimal conditions and that adaptive standardization results from selection under rigorous conditions and that these characters are hereditarily retained in the new environment.

It is concluded that multiple factors are operative in the inheritance of these physiological characters. The mode of operation of polygenes is formulated in the second project reported here and a basis of controlled selection is presented.

2. The Cyto-operative System Basic to the Binary Frequency Distribution of Multiple Factors - Polygenic Alleles.
A.H. Hutchinson.

The inheritance of many quantitative characters, as colour and size of wheat was attributed by Nilsson-Ehle (1911) to the action of multiple factors or polymeric genes. Mather (1943-53) uses 'polygenes' to designate the components of any group contributing to a common phenotypic product. Nilsson-Ehle, Lang (1911) and Sirks stipulated Mendelian segregation as a requisite and Lang stipulated equality of the factors. A paper presented to the Tenth International Congress of Genetics by A. H. Hutchinson emphasized the quantisized concept; that the phenotypes may include overlapping phenotypic ranges of the

classes without loss of identity.

Characteristics of the population may be expressed in terms which are in accord with Pascal's binomial triangle and the binary notation: specifically let the number of polygenic alleles = 'N', the heterozygocity of genotypes = 'h' and the combined heterozygocity of biparental genotypes = 'H', then the number of polygenes = 2N; the number of phenotypes (2N+1); the number primary genotypes is 3^N; the base of phenotypic and genotypic frequency is 4^N; the number of effective genotypes is factorial (N+1); the number of filiotypes = factorial (2N+1); the frequency of the phenotypes in a filiotypic series = $(1+1)^H \times 2^{2N-H}$. The class frequencies of filiotypes are characterized by polygon curves.

The limitations of gamete or spore dispersal results in localized establishment of filiotypes. Further the operation of adaptive natural selection increases the completion of adapted ecotypes, races or subspecies.

3. Cytological Studies of Sensitivity to Nutritional Deficiencies in Conifers. A. H. Hutchinson.

Leaves of Douglas fir, sitka spruce, western hemlock and western red cedar have been sectioned and stained by special methods. There is a notable variation of sensitivity to nutritional deficiencies, which is not only inter-generic and inter-special, but also applies to individuals within species and is evident in particular tissues and cellular structures. The cytological changes finally become externally evident as characteristic markings or deformities.

The leaves were obtained from experiments conducted by Prof. V. Krajina of the University of British Columbia.

4. Cytological studies of Chromosomes and Plastids in Douglas fir. A. H. Hutchinson and H. Sweet.

Studies of leaf buds of Douglas fir show definite individuality of chromosomes and under varying cultural conditions aberrations occur in a number of chromosomal structures suggesting translocations and polysomaty.

Special methods of preparation and staining have been utilized.

5. Aberrations in the Chromosome Complement of Douglas fir. A. H. Hutchinson.

There is much evidence of the nuclear origin of plastids and other "cytoplasmic" bodies in the leaf cells of Douglas fir. In some cases the nuclear orifices, from which the protoplastids emerge, have specific loci. Further investigation is necessary.

Publication:

Hutchinson, A. H. The Principles Involved in Polygenic Selection from a Polyzygous Population of Douglas Fir. Proc. X Int. Gen. Congress., McGill University, Montreal, Aug., 1958.

Abstract

A genotypic evaluation of wind pollinated Douglas fir populations is premised on polygenic segregation involving various growth rates, frost sensitivity and cyclic bud activity. In each case three or four allelic factors are required to satisfy the polyzygous states, which are evident from more than 80,000 readings. Simple equations in terms of 'N', the number of polygenic alleles and 'n', the degree of parental heterozygocity, relate the phenotypes and genotypes of the progenitors to the class frequency distribution coefficients of the progenies, $(1+I)^n \times 2^{2N-n}$. All population curves are reduced to the common base, 2^{2N}.

Each controlled biparental class frequency polygon of a specific polyzygous population is balanced and includes (n + 1) phenotypic classes from a possible (2N + 1) classes each of which belongs to one of (factorial (N + 1)) effective genotypic classes. These genotypes may combine to produce factorial 2N + 1 class frequency series, as progenies. Wind pollinated, multiparental stocks are characterized by class frequency polygons which show predictable skewness, multiple peaks and extended plateaus.

Selection may be controlled genotypically on these bases. Examples of natural selection are presented.

REPORT ON TREE IMPROVEMENT WORK AT THE ACADIA FOREST EXPERIMENT STATION, 1957-58

H. G. MacGillivray

This report deals with the tree improvement work that was done at the Acadia Forest Experiment Station from the summer, 1957 to the spring, 1958. This work was chiefly concerned with red pine, Pinus resinosa, red spruce, Picea rubens and balsam fir, Abies balsamea.

Red Pine Provenance Experiment

A red pine provenance experiment was established at the Chignecto Game Sanctuary, in Nova Scotia in May, 1958. This is part of a larger provenance study being conducted by Mark Holst. The planting stock for the Chignecto experiment was supplied from the Petawawa Forest Experiment Station.

The pre-planting treatment of the planting site was completed in August, 1957. This consisted of clear cutting a light hardwood overstory and spraying the root collars of the stumps with 2,4,5-T in diesel oil with a concentration of 2.5 ounces of 2,4,5-T acid equivalent per gallon of spray.

The planting material consisted of 16 provenances from the United States and Canada. A lattice square design, with five replications of each provenance, was used. Each plot or replication consisted of 49 trees--seven rows of seven trees each. The spacing was 4 feet x 4 feet. One division row was planted between the plots and two surround rows were planted around the outer edge of the plantation. Planting was done with Saguenay tools.

Red Spruce

Selection

The selection of red spruce, as described in the report to this Committee last year, was continued during the fall of 1957. Selections were made of the two best and one of the poorest trees in each of five stands. Scions from these trees were grafted during the late fall, 1957. A side line experiment to check the effects of red spruce, black spruce, P. mariana and white spruce, P. glauca, rootstocks on the growth of the red spruce scions was initiated using this material. Thirty-three scions from each tree were grafted to each species of rootstock. Unfortunately a needle-cast disease attacked the rootstocks in February. It did not appear to harm the scions.

Conditions in the greenhouse, temperatures of 50°- 55°F and relative humidity 80 - 95 per cent, may have favoured the development of the disease. The temperature was raised to 60°F and the relative humidity was lowered but mortality of the rootstocks was heavy.

Provenance Experiments

Sites for three red spruce provenance experiments were selected and are being prepared in New Brunswick near the Bay of Fundy, at Acadia Forest Experiment Station and in the northwestern part of the Province.

Balsam Fir

Breeding

Attempts to produce a hybrid fir, suitable for Maritime conditions, were made in May, using balsam fir as the female and pollen from A. nobilis, A. cephalonica, A. grandis, and A. nordmanniana. This pollen had been in cold storage since it was collected in 1957.

Ten special tents were made with the cooperation of Mr. B. Douglass, Superintendent, Acadia Forest Experiment Station, for isolating the cone producing sections of the crowns of balsam fir trees. The use of these tents greatly reduced (1) the amount of work, and (2) the danger involved in bagging and pollinating.

Each tent is cone shaped and about 4 feet high and 4 feet in diameter at the bottom. The top of the tent is a cone-shaped cap of galvanized iron, about 1 foot in diameter. The cloth (pillow ticking) part of the tent is lashed to the cap. A hoop of light iron, 4 feet in diameter, is fastened inside the lower part of the tent to keep it flared and away from the branches. A flap or skirt, 3- to 4-feet long, extends below the iron hoop.

In placing the tent in position a 20-foot pole was first tied to the top part of the stem of the tree to support the tent. The top of this tent pole extended just beyond the leader of the tree. The tent was raised on an aluminum rod and set down over the tent pole. The tent pole supported the metal cap which in turn supported the tent. The lower flap was puckered and bound around the stem and tent pole. Cotton wool was wrapped around the tent pole and stem, under the tent flap to ensure a pollen tight joint. Four guy ropes from the iron hoop to the tree stem secured the tent in position.

To make pollination less dangerous an 8-foot piece of copper tubing was attached to the tent pole. The top of the tube came within a foot of the upper end of the pole. A car tire hand pump was used to force the pollen up through the tube into the flowering part of the crown. This made it unnecessary to climb into the weak section of the crown during the pollination.

The tent poles will be left in position until the fall. The tents will be replaced at the end of August to catch the seeds should cone collecting be delayed. Nicotine or DDT will be applied to the cone bearing section of the crowns when the tents are replaced to discourage squirrel damage.

Miscellaneous

Material is growing in the nursery which will be suitable for provenance experiments in balsam fir and Norway spruce, P. abies and observation plots of exotic fir.

The following were published during the past year.

MacGILLIVRAY, H. G. 1957. Rooting balsam fir cuttings under intermittent mist. For. Chron. 33: 353-354.

MALCOLM, D.J., C.F. EVERETT, and H.G. MacGILLIVRAY. 1957. Preplanting treatments for control of weeds in conifer seedling beds. In. Res. Rep. Nat. Weed Comm., East Sect. 1957, pp. 60. Canada Dept. Agriculture.

_____ 1957. Pre-emergence treatments for weed control in conifer seedling beds. A. Early pre-emergence (residual). B. Late pre-emergence (contact). In. Res. Rep. Nat. Weed Comm., East Sect. 1957, pp. 60-61. Canada Dept. Agriculture.

_____ 1957. Post-emergence treatments for weed control in conifer seedling beds. In. Res. Rep. Nat. Weed Comm., East Sect. 1957, pp. 61-62. Canada Dept. Agriculture.

_____ 1957. Post-emergence treatments for control of weeds in conifer liners. In. Res. Rep. Nat. Weed Comm., East Sect. 1957, pp. 62-63. Canada Dept. Agriculture.

The work on weed control is mentioned here because of the importance of nursery management in tree breeding. This was started when it became apparent that weeds were going to be a serious nursery problem in 1957. It was done in cooperation with members of the Field Husbandry Branch, New Brunswick Department of Agriculture, and the Experimental Farm, Canada Department of Agriculture. This work is being continued in 1958. In 1957 only chemicals recommended for use in forest nurseries were tried. None of these proved to be entirely satisfactory when both weed control and damage to seedlings and liners were considered.

CYTOGENETIC STUDIES IN CARAGANA
1958

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Caragana arborescens Tetraploid

The selfed seed obtained in 1957 from a colchicine-treated branch of a bush of C. arborescens germinated and produced seedlings with the tetraploid (2n=32) chromosome number. The seedlings were grown from time of emergence (Nov. 22, 1957) under daylight supplemented by artificial incandescent light to produce a 16 hour day. Seedlings from self and open-pollinated diploid seed of the same bush were grown for comparison. All tetraploid seed germinated and grew at about the same rate as the diploids, all seedlings having 4-6 leaves one month after emergence. At this time the more variable open-pollinated seedlings ranged in height from 2.5 to 9 cm. whereas the selfed seedlings (diploid and tetraploid) were more uniformly 5-6 cm. About 2 months after germination the tetraploids ceased growth at a height of 7 cm. (10 leaves) and remained thus for 3 months, eventually losing their leaves. The diploid seedlings continued growth for 4 months from germination and easily surpassed the tetraploid in height (to 30 cm.). The tetraploids were planted outdoors in early May but not until early July did the terminal bud begin to open to resume growth. One tetraploid seedling was placed at emergence (late April) under continuous light (daylight plus 1000 fc artificial). Growth was apparently normal for 2 weeks but then ceased (ht. 2 cm.). The seedling began to deteriorate and although it was returned to natural daylight, soon died. Under these conditions of continuous illumination Dr. Senn has found that diploid C. arborescens makes continuous growth and some plants will flower in 9 months.

Caragana arborescens Lam. f. lorbergii Koehne

Observation of this narrow-leaved, narrow-flowered, usually seed-sterile form and of the progeny of crosses with typical arborescens and with lorbergii have led to the hypothesis that the form is a periclinal chimera. It is believed that mutation of the wild gene (l) to an incompletely dominant condition (L) has produced lorbergii from the species. The peripheral tissue (tunica) of the form lorbergii is of the genotype Ll, the core (corpus) being ll-- as in normal

arborescens. Occasionally bushes of lorbergii are seen where a branch arising from ground level is typical arborescens. Presumably such a branch is composed of corpus tissue only.

It is believed that gametes are formed from the heterozygous tissue. When crossed with arborescens, 2 types of progeny result: typical arborescens (Ll) and plants with foliage intermediate between lorbergii and arborescens and variable on the one bush (Ll). The occasional fertile flowers of lorbergii are self-sterile but when open-pollinated, presumably by other adjacent lorbergii bushes, produce the above 2 classes of progeny and, in addition, a third class -- super-lorbergii--foliage lorbergii-type, bush dwarf and non-flowering (Ll). Seedlings wholly of tissue Ll are unlike the parental chimera composed of Ll tissue on the ll core.

(Assistance of Dr. W.H. Cram, Indian Head, Sask., in providing seedlings of crosses made by him, is acknowledged).

ANNUAL REPORT ON FOREST GENETICS 1957

by

A. L. Orr Ewing, Research Division, B.C. Forest Service.

1. General

No changes in personnel have taken place and the shortage of trained assistance with a rapidly expanding program remains a constant problem.

General interest in forest genetics has increased considerably and talks to both professional and public groups were given during the year. The annual field meeting of the Western Forest Genetics Association was held at the Duncan Nursery and the Forest Experiment Station of the B. C. Forest Service. This Association draws members from the western states of the U.S.A. in addition to those from B. C.

There were again a large number of requests for seed and a seed consignment form has been introduced for the purpose of recording the source of all seed sent out of the province. During the year seed was sent to India, South Korea, Iceland, Denmark, Argentina, U.S.A. and other provinces of Canada. A seed receipt form has also been introduced in order to record all seed brought in to the province, special seed lots were received from California, Formosa, Japan and the Soviet Union.

2. Seed Classification and Registration

The new system of seed classification and registration was used for the first time in 1957 and all seed lots collected by or for the B. C. Forest Service were duly registered. The research nurseryman now supervises the reception of all cone collections at the seed extraction plant at Duncan nursery. He is also responsible for keeping all records concerned with registration and for the seed while it is in storage. Some amendments and improvements to the system have been made, it will now include all those seed lots stored and sown in the Forest Service nurseries which are the property of the Forest Industry and other agencies. In future lots of either cones nor seed will not be received for extraction or storage at Duncan unless they are accompanied by the necessary information.

3. Plus tree selection for Douglas fir seed orchards

Selected high elevation stands of Douglas fir were intensively cruised in 1957 and ten plus trees were finally selected, the criteria of selection being based on quality rather than on volume. The stands were from forty to ninety years of age as it was considered that selection in these age classes would be preferable to selection in mature stands of Douglas fir where the ages commonly range from 250 to 600 years. In these latter stands, the effects of the environment are even more difficult to dissociate from those that may be genetic. Scions were shot down from all

ten trees and successfully tip grafted on to root stock in the spring of 1958. These will serve to initiate a clone bank as the plus trees are not readily accessible. Some cones were also collected from three of the trees and progeny tests will be instigated as early as possible. The root stock for a small seed orchard has been planted at Duncan nursery and grafting of the plus tree scions will begin in 1959. Other suitable high elevation stands are being cruised at the present time and a further ten plus trees remain to be selected. The seed orchard will be represented by sixteen clones from each of the twenty plus trees with a final spacing of twenty-one by twenty-one feet. A four by five rectangular lattice design replicated five times has been used in establishing the orchard.

It was felt that an early start should also be made on evaluating the inherent factors related to wood quality and a co-operative study with the Vancouver Forest Products Laboratory of the Dominion government is accordingly being initiated. It is planned that the important wood characters of all selected plus trees will be analysed and that later parent progeny relationships will be made.

4. Inbreeding experiments with Douglas fir

Eight inbred lines have been planted out on experimental area for later outcrossing and it is hoped that this work can be extended to the selected plus trees.

5. A study of phenotypes in Douglas fir

This study was initiated to compare the development of the progeny from poor and good phenotypes growing at high elevations in order to determine the significance of unfavourable aspects of environment. Stock from both seed sources was fall planted in 1957 in three replicated blocks at an elevation of 3,000 feet.

6. Phenotypic selection in open grown Douglas fir

This study was initiated to demonstrate the need for careful selection of parent trees for cone collections. Both scions and wind pollinated cones were collected from both good and poor phenotypes in an open grown stand, the parent tree being selected on the basis of form, growth and branching characteristics. The scions were veneer grafted on to root stock and planted out in replicated blocks in 1957. The seedlings resulting from the wind pollination of each of the parent trees were planted out in the same blocks in 1958. Both the seedlings and grafts from one of the poorer phenotypes already provide an excellent demonstration of the risks attached to uncontrolled cone collections. There was encouraging evidence of early cone production from the grafted scions. One of these which was grafted in March 1956 and planted in 1957 produced one fully developed female cone and several male cones that same year, the female cone, moreover, produced seven viable seeds. A detailed analysis of this study will be made at an early date.

7. A co-operative seed provenance study of Douglas fir

Seed from sixteen sources in British Columbia, Washington and Oregon has been collected and sown at the Oregon State nursery. The seedlings from all sixteen seed sources will be outplanted in replicated blocks at each of the sources and will be available for planting in either the fall of 1958 or in the spring of 1959. Each outplanting area is over eleven acres in size and considerable clearing has been necessary on the one selected by the B.C. Forest Service, who are also responsible for co-ordinating the project for the other four co-operating agencies in B. C.

8. Experimental plantings of exotic conifers for future hybridization studies with related coastal species

It was felt that a start should be made towards the establishment of a small arboretum which could be used for later hybridization studies. Seed from the following species of Douglas fir were obtained in 1957 and sown in the spring of 1958, Pseudotsuga macrocarpa, Mayr, from California, U.S.A., Pseudotsuga japonica, Beissner from Japan, Pseudotsuga Wilsoniana (Hay) from Formosa, Pseudotsuga forestii, Craib and Pseudotsuga sinensis, Dode from China, and Pseudotsuga menzeseii var glauca from Arizona, U.S.A. One species of Hemlock, Tsuga siebaldii, Carr was obtained from Japan.

9. Seed Production Areas

In order to improve both the quality and quantity of Douglas fir seed, the Reforestation division have recently established two high elevation seed production areas of from 4.4 and 7.4 acres respectively. The better phenotypes in the stand have been retained at an arbitrary spacing of twenty feet, the remaining trees have been removed and the underbrush sprayed in order to eliminate competition. The two stands are from 28 to 30 and from 31 to 38 years old and average 34 feet in height. Seed coming from such areas in the future will be in the B2 category. Several replicated fertilizer treatments were applied in May and June of this year in attempts to stimulate cone production.

PUBLICATIONS IN 1957

Orr Ewing, A. L. Possible Occurrence of Viable Unfertilized Seeds in Douglas Fir. Technical Publication T. 47, 6 pp. Reprinted from Forest Science, Vol. 3, No. 3, September 1957.

A Cytological Study of the Effects of Self-Pollination on Pseudotsuga Menziesii (Mirb.) Franco. Technical Publication T. 48, 7 pp. Reprinted from Silvae Genetica. Vol. 6, No. 6. December, 1957.

Further Inbreeding Studies with Douglas Fir. Technical Publication T. 50. 15 pp. Reprinted from Forestry Chronicle. Vol: 33. No. 4. 1957.

Better Timber for B. C. Depends on a Good Seed Programme. B. C. Lumberman. 4 pp. Vol. 41. No. 5. 1957.

Report to Committee on Forest Tree Breeding

August 1958

Rene Pomerleau

Forest Biology Laboratory

Canada Department of Agriculture

Quebec City, Que.

Dutch Elm Disease

The breeding program for elm strains resistant to this desease was initiated in 1949 in co-operation with the L'Assomption Experiment Station. The main purpose of this project was the finding of resistant or tolerant strains of the American elm to the attack of Ceratocystis ulmi. From a number of trees, which have escaped infection in the central zone of the outbreak in Quebec, seeds and cuttings are collected every year and propagated in the greenhouse and the field of the experiment station. To test their resistance, one-year-old seedlings and cuttings are inoculated with the fungus the following year and trees showing symptoms of the infection are discarded the same year. Those that have not shown wilting of leaves are left another year and re-inoculated. An increasing number of seedlings have been inoculated since 1952 and now more than 30,000 new seedlings are grown for this purpose every year at L'Assomption.

After a consultation with Dr. Swingle in Columbus, Ohio the writer and Dr. Hunter of the Horticultural Division in Ottawa in 1953, it had been agreed to treat a number of seeds with x-rays in view of obtaining mutations which may prove resistant to the infection. In 1956, a seed lot was also treated with Thermal neutrons for the same reason. The result of these tests for resistance up to 1957 is summarized in the following table:

Inoculation Tests of Elm Seedlings in L'Assomption since 1952

Year of inoculation	Year of sowing	Treatment	No. of inocu-lations	Number of seedlings	
				Inoculated	Infected
1952	1949-51	None	0	288	33
1953	1949-51	"	1	33	15
	1949-52	"	0	1,341	144
1954	1949	"	2	15	1
	1949-51	"	1	47	0
	1952	"	1	97	6
	1952-53	"	0	4,576	701

Year of inoculation	Year of sowing	Treatment	No. of inoculations	Number of seedlings	
				Inoculated	Infected
1955	1949	None	3	1	0
	1952	"	2	6	3
	1952-53	"	1	701	21
	1954	"	0	14,092	2,584
	1954	X-rayed	0	2,698	416
1956	1952	None	3	3	1
	1952-53	"	2	21	1
	1954	"	1	2,584	19
	1955	"	0	1,000	53
	1954	X-rayed	1	416	6
	1955	"	0	19,000	1,265
1957	1952	None	4	1	1
	1952-53	"	3	1	0
	1954	"	2	19	2
	1955	"	1	53	0
	1954	X-rayed	2	6	0
	1955	"	1	1,265	185
	1956	None	0	3,050	846
	1956	X-rayed	0	19,490	4,574
	1956	T.N. *	0	12,481	3,441

* T.N. = Thermal-neutrons

Total number of inoculated plants in 1957 = 36,366

During the six years more than 70,000 seedlings have been inoculated once and sometimes twice, thrice and even four times. Results of this work indicated that a large number of seedlings have succumbed from one inoculation, and those which were not symptomatic the first year and have apparently resisted to the attack were infected after two and three inoculations. One tree from the 1950 seed crop was not killed by the fungus after five inoculations, but was thoroughly infected and finally died in 1957. Another one planted in 1952 is still living after six inoculations. However, both trees are stunted individuals which hardly grow every year. This cannot be considered as a resistant material since the fungus development is limited in the small wood vessels.

In view of surveying for possible existence of resistant elm strains, collections of seeds have been made in 1957 and 1958 in the Quebec city area and further north at the border of the American elm range. The result of the first test carried out this year is not yet compiled.

Since the American elm had not yet shown definite signs of tolerance to the disease, a number of hybrids of European elm species with low susceptibility to the fungus attack were obtained in Holland. In order to initiate a series of tests on the potentiality of such trees in Eastern Canada, scions from height clones, produced at the Willie Commelin Scholten laboratory in Baarn, Holland, were imported last winter and grafted in the Quebec laboratory greenhouse. As many as five and sometimes ten grafts were successful and are now growing in the laboratory nursery. This material will be used for propagation and for testing their hardiness and susceptibility to native diseases.

Poplar Hybrid Disease Resistance

This project, initiated in 1956, was undertaken in co-operation with the Harrington Forest Farm and the Maple Experiment Station in view of determining the hardiness of poplar hybrids and their resistance to diseases under the conditions of Quebec. A number of clones provided by the Harrington Farm and Dr. Heimburger were planted on the laboratory nursery for future observations.

The first significant observation on the condition of health of these hybrids in Quebec was made in the Harrington Farm, during August 1957, where many poplars of a few years of age are severely sunscalded and show heavy top dying. As reported by Mr. Jaap Salm, the clones which could not withstand winter and spring conditions of 1957 at Harrington were the following ones:

P. angulata x Simonii no. L611
P. berolinensis x Simonii no. L885
P. candicans x berolinensis no. L978
P. nigra x laurifolia Strathgloss no. L1060

Since May 1958 this project has been assigned to Dr. M. G. Boyer, who is now surveying diseases occurring on poplars in Quebec. The main aspects of this problem to be investigated in this laboratory will be determined at the earliest possible date when enough information on poplar diseases will be gathered.

Report to Committee on Forest Tree Breeding
July, 1958

W. A. Porter - Forest Biology Laboratory - Victoria, B.C.

General.

One wing of the permanent Departmental greenhouse and headerhouse was completed this spring in Victoria. A research greenhouseman has been added to the staff. These new facilities will be of great assistance in the grafting and preliminary artificial inoculation work on the blister rust project.

In co-operation with the British Columbia Forest Service, a two-acre outplanting area for long-term observation of some selected white pine crosses and grafting scions is being cleared. In the disease garden, which is located on a forest service nursery, routine maintenance and inoculations were continued.

Active membership is maintained in the Western Genetics Association.

White pine seed is being collected in the coast and interior regions of British Columbia for a provenance study of the Northeastern Forest Experiment Station.

Testing white pines for resistance to blister rust.

In British Columbia this Department is responsible for testing for blister rust resistance in western white pine from coast and interior white pine regions.

Five hundred grafts for this year's outplanting were made from 10 coastal selections which show varying degrees of resistance in the disease garden. These grafts include 4 selections previously reported as canker free, and still free, from the 1952-7 inoculations; and the best 6 of

the 11 selections previously reported having 1 to 2 cankers. Replicated selections from the interior white pine region remain canker free in the disease garden. In one field outplanting area most selections received from Ontario, Wisconsin, and Idaho remain canker free under conditions of heavy natural inoculation. Scions from additional clones previously selected from the field and awaiting resistance testing in the disease garden, will be grafted this winter. Planting space is now available for resistance testing of pines from other pine areas. Approximately 40 man days were spent on this project during the past year. An interim report is being prepared on the detailed progress to date.

Frost damage to coastal Douglas fir saplings.

Following the November, 1955, sudden freezing period, damage to needles, buds, twigs, and trunk was noted on some sapling Douglas firs in both planted and natural regeneration on the coast. The damage varied greatly between adjacent trees on the apparently same micro-climatic and soil regimes. Secondary fungi quickly entered the damaged trees through frost cracks or killed portions of trunk or leader, and these fungi are still active in many trees causing a continued dieback and canker. Two years of observations on the damaged trees show clearly that such trees flush out earlier in the spring and have a higher bark moisture content later in the fall than do the undamaged trees. Thus the difference in susceptibility to this extreme natural environmental condition differs greatly between individual trees. It is definitely related to differing durations of the growing period of individual trees. All of the damaged trees showed varying amounts of a characteristic frost ring in the 1955-56 annual ring juncture. Many of the damaged trees from Sooke on Vancouver Island showed additional frost rings in the 1948-49 and 1949-50 annual

rings, indicating that in some individuals there is a definite frost history. No such frost rings were observed in the sectioned healthy trees. Weather records show that sudden freezing conditions terminated moist-mild extended growth periods during these years.

Many of the frost-damaged, susceptible trees are showing distress cone crops and could be attractive to cone collectors. Such seed, however, might produce a higher number of frost-susceptible seedlings than those from non-damaged trees. Thus, seed collected from local frost-free areas or over periods when there was no frost to give a natural selection, would likely contain a high number of frost-susceptible individuals.

The original objectives of this study have been completed and are being prepared for publication.

Reference:

Porter, W. A. Dieback of Douglas fir. In Can. Dept. Agr. For. Biol. Div. Bi-Monthly Prog. Rept. 13(5): 3. 1957.

BREEDING OF FIRS AND ASSOCIATED STUDIES

AT

ST. FRANCIS XAVIER UNIVERSITY

A programme of breeding involving different species of fir (Abies)has been initiated in the spring of 1958. Abies balsamea has been used as the female parent, and the following species have been used as putative male parents: A. koreana, A. homolepis, A. homolepis var. umbellata, and A. cephalonica.

It is hoped to make comparative studies of the cytology of these species and of their hybrids if obtained.

The purpose of these crosses is to obtain a fir type that would be fast-growing possibly through heterosis, and resistant to some of the common entomological pests of A. balsamea.

It is intended to use colchicine and gibberellic acid on native fir, and on hybrids to determine their effects on growth.

Some study is presently being done on the details of fertilization and seed development.

A constant watch is being maintained for native trees of superior quality that would involve particularly resistance to parasites, good seed production, seed production at an early age, and rapid growth with symmetry.

L.P. Chiasson

2. PROGRAMME REVIEWS BY VISITORS

FOREST GENETICS AND TREE IMPROVEMENT RESEARCH AT THE SOUTHEASTERN FOREST EXPERIMENT STATION

by

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I. Objective

To determine the principles of tree-to-tree and racial variations and inheritance of characters in important southern forest trees, evaluate their importance in silvicultural practices, and apply them in the selective breeding of improved strains.

II. Racial Variation

A. Cooperation in Southwide Pine Seed Source study with the four major species of southern pine. Test plantings are distributed over a 5-State area.

B. Local (State-wide) studies of loblolly pine in Georgia and slash pine in Florida.

C. Cooperation in interregional study of variation in yellow-poplar and white pine (Southern Appalachian Mountains).

D. Cooperation in a study with red oak and hemlock (Southern Appalachian Mountains).

E. Variation in resistance to littleleaf in shortleaf in South Carolina and Georgia (Forest Disease Research Division).

III. Tree-to-Tree Variation

A. For slash pine variation in resin yield, specific gravity and tracheid length of the wood, vigor, form, and resistance to southern fusiform rust.

B. For loblolly pine, variation in wood quality and tree form in Georgia and Virginia.

C. For shortleaf pine, variation in resistance to littleleaf disease (Forest Disease Research Division).

IV. Inheritance of Traits (with clonal, one-parent, and two-parent tests)

A. Resin yield, form, wood quality, resistance to pests in slash pine.

B. In loblolly pine, form, wood quality, and resistance to pests.

C. In shortleaf pine, resistance to littleleaf (Forest Disease Research Division).

V. Introduced Species

A. Pines and a few other species that may be useful in tree breeding in the naval stores region in Georgia and Florida.

B. Pines and other softwoods in Southern Appalachian Mountain area.

C. Hardwoods that may be useful in the Piedmont for production of forest products and soil rehabilitation.

VI. Cooperative Projects

A. Technical guidance to the tree improvement project of the Ida Cason Callaway Foundation.

B. Technical guidance to the Georgia Forestry Commission's seed orchard project.

C. Assistance in the development of seed certification programs in Georgia and South Carolina.

D. Supplying of study material to colleges and universities, Southern Institute of Forest Genetics, and the Forest Products Laboratory.

E. Participation in the work of the Committee on Southern Forest Tree Improvement and the Regional Technical Committee for Project S-23, Forest Tree Genetics.

CURRENT RESEARCH IN FOREST TREE IMPROVEMENT AT THE OHIO AGRICULTURAL EXPERIMENT STATION

by

H. B. Kriebel

- - -

1. Tree Breeding.

At the present time, tree breeding is being concentrated in Section Cembra of the soft pine. Two objectives are the improvement of Pinus strobus with particular attention to growth rate and the production of as many hybrids as possible within the section for tests of adaptability, form and vigor. Species crosses attempted to date have included strobus, flexilis, griffithii and parviflora as female, and pollen species have included strobus, flexilis, griffithii, parviflora, monticola, albicaulis, and lambertiana. Selfs, unpollinated and wind-pollinated strobili are included in the breeding which began in 1957. Studies of time and duration of strobilus receptivity in relation to seed yield are being made in Pinus strobus. In 1958 about 2800 flowers were pollinated, the large majority on strobus.

2. Progeny testing.

Several hundred seedlings resulting from earlier intraspecific crosses in Acer saccharum are lined out in the nursery and will be planted out next year. These trees will be used to test inheritance of sugar content of the sap, and include putative crosses of high x high, high x intermediate, low x intermediate, and low x low. There are quite a few seedlings resulting from selfing.

3. Vegetative propagation and establishment of seed orchards.

About 25 clones of sugar maple have been propagated by grafting and budding. Greenhouse grafting included a multi-factor study of factors affecting survival and growth of grafts. An electrically-heated hotbed and a lath house are used in conjuction with the greenhouse. Budding has been fairly successful, but less so than grafting. Outdoor grafting in the nursery has been quite successful, when high-quality scion material was available. Unfortunately, this is frequently not the case with sugar maple.

A seed orchard of sugar maple was planted in 1958, consisting of twenty selected clones, some of ortets averaging 4% to 7% sugar content. Ramets from trees in Vermont, New Hampshire, Massachusetts, New York, and Ohio are included. The orchard is planted on a 30' x 30' spacing, using the triangular layout described by Langner (Zeitschr. für Forstgen. 4: 81-88).

Grafting of soft pines on Pinus strobus has included the following species and cultivars: koraiensis, parviflora, parviflora pentaphylla, flexilis, griffithii, peuce, strobus, strobus fastigiata, cembra, monticola, armandi, and ayacahuite. Several clones of each species are being propagated. A breeding arboretum will be started in 1959.

In addition, other subspecies and cultivars of hard maple were grafted on Acer saccharum in 1958.

4. Race studies

A comprehensive race study of Acer saccharum includes about 45 seed sources. Two permanent experimental plots have been established, one in northern Ohio in 1957 and one in southern Ohio in 1958. A "seedling-source" plot was also planted in 1954 at Wooster, including trees from 18 sources. A small plot was established in Florida in January, 1958 to compare response under a radically-different daylength-temperature regime.

A series of oak genotype plots has been established at Wooster in cooperation with the Morris Arboretum in Philadelphia, which furnished the material. Twenty-two American species and from one to sixteen seed sources per species are included, a total of 101 collections, with three trees per collection.

Provenance tests of shortleaf pine from six northern sources from New Jersey to Missouri have been initiated. The first phase is in cooperation with stripmine reclamation research and is a greenhouse test of first-year seedlings on two types of spoil material, one with a pH of 3.6 and the other with a pH of 6.8. Highly significant differences in growth rate have been identified; the differences are related to seed origin and not type of spoil material in which the trees are growing. Phosphorus and nitrogen deficiencies are common to all sources. A similar test is being conducted of Pinus strobus from two geographic origins, with no differences as yet evident. The origins are eastern Tennessee and central Ohio.

Racial tests of Pinus strobus are planned, as a part of the large-scale inter-regional study, in cooperation with the Central States Station and the Northeastern Station of the Forest Service.

5. Clonal tests and selection tests.

A series of field tests is being initiated of ten clones of black locust, in cooperation with the Soil Conservation Service. Five selections of Castanea mollissima are also under test in a plot now in its fifth year in southern Ohio.

6. Techniques for dwarfing and flower induction.

An experiment was established in 1958 on six-year-old trees of Pinus strobus, using various modifications of the phloem inversion technique to evaluate the effects on vegetative and reproductive behaviour. Six treatments are included in the experiment.

7. Special studies of morphological and physiological variation.

A study of geographic variation in root systems of Acer saccharum was completed in 1958, and is being prepared for publication. Results show relationships between root and stem morphology of four-year-old trees and drought resistance of first-year seedlings. Ecotype differences are very pronounced.

Two factorially-designed studies of chilling requirement in relation to provenance were made in 1957-58. A study of Acer saccharum included trees from four sources at 500-mile north-south intervals, and eight lengths of chilling period. Phenological observations, made at weekly intervals, showed systematic differentiation between genotypes. A similar analysis of Pinus strobus of two origins was evaluated in terms of stem elongation. In both species the minimum chilling requirement for normal bud-breaking was only a few weeks, even for the northern trees, although northern maples with the shortest chilling period, ending October 16, were just breaking bud on August 1. Analysis of these studies is not yet completed.

Q-7.

ANNUAL REPORT 1957 - '58

FOREST TREE BREEDING AND GENETICS

AT

YALE UNIVERSITY

by

François Mergen

Assistant Professor of Forest Genetics

Graduate Students Working on their Ph. D. Dissertation.

Mr. J.R. McWilliam completed his research work on the various phases of incompatibility in Pinus and has presented his dissertation to the Graduate School. The title of the dissertation is, "pollination, pollen germination, and interspecific incompatibility in Pinus." He found significant results, as set forth in the Digest of his dissertation:-

"The objective of this study was to investigate the problem of interspecific incompatibility in Pinus. For this purpose certain aspects of pollination and pollen germination were studied to provide the necessary background for a proper understanding of this problem.

"An investigation of the pollination mechanism revealed that the reception of pollen on the micropyle is a chance phenomenon, and no evidence was found to suggest that bioelectrical forces are involved in this process. Once on the micropyle, the pollen is conveyed to the nucellus by the micropylar fluid, which is produced during the period of pollination. The production of this fluid is a constant feature of the genus, and resembles the phenomenon of guttation. No stage during pollination imposed any restriction on the success of interspecific pollination, and in all the crosses studied, pollen grains reahced the nucellus.

"The influence of certain environmental factors on pollen germination in vitro has been studied to obtain a better understanding of the physiology of pollen growth in vivo. The important feature of the growth of pine pollen is the long interval between pollination and fertilization. This provides favourable conditions for selection to operate, and makes the nucellus effective as an incompatibility sieve against the pollen of another species. Pollen germination in vitro responded to changes in the environment, and was most sensitive to changes in the chemical nature of the germination medium. The effect of temperature was more limiting at high than at low values, except when the pollen was subjected to low temperature during imbibition. During hot weather, temperatures inside pollination bags used for control-pollination can reach a level that is lethal to germinating pollen. This problem can be overcome by protecting the strobili from direct insolation.

"Incompatibility between certain pine species appears to be incomplete, indicating that reproductive isolating mechanisms are still evolving in this genus. This process has been accelerated by geographic separation. Interspecific incompatibility is genetically determined, and acts to prevent the formation or survival of hybrid zygotes. In one cross (Austrian pine x red pine) which was studied in detail, chemical differences between the ovules of the two species may be one of the primary causes of

incompatibility. This appears to affect the ability of the pollen of one species to either germinate or function effectively in the nucellus of the other. This functional failure of the pollen tubes caused the breakdown of the gametophyte, and the ultimate collapse of the ovule. Differences in the pattern and timing of the incompatibility may reflect the extent of the genetic diversity between the species."

Mr. Henry Gerhold is still working in absentia on his dissertation entitled, "Genetic variation in needle coloration of Scotch pine." Mr. Gerhold has completed all his field and laboratory analyses and is presently working on the statistical analysis of his results.

Research Work Completed:

1. Distribution of reaction wood in eastern hemlock as a function of its terminal growth. A relationship was sought between the shape of the terminal shoot of eastern hemlock trees and the type of wood produced. As a result of its peculiar height growth, irregular zones of compression wood were formed. It was postulated that these zones might be involved in the initiation of ring shakes.

The growth pattern of the terminal shoot was traced during one growing season and there was a strong correlation between the curvature and orientation of the leader and the reaction wood which was produced. By preventing the leaders from drooping during the growing season, no compression wood was formed. By subjecting green sections of hemlock stems to freezing and thawing cycles, and bending these sections gently during the frozen state, ruptures between normal wood and reaction wood cells were produced. These minute failures which are brought about by differential internal stresses might be comparable to shearing failures which eventually enlarge to the size of the common ring shakes in the boles of living hemlock trees.

The results of this study appeared in the June 1958 issue of Forest Science.

2. Male flowers on one-year-old Mugo pine seedlings. Staminate flowers were observed on Mugo pine seedlings that were growing in our nursery and were less than one year old. The catkins were of normal size and the pollen was fully developed at the time of shedding. Both percentage germination and tube growth were normal when the pollen was cultured in double distilled water.

The results of these observations appeared as a short article in Forest Science, with Steve Cutting as co-author.

3. Natural polyploidy in slash pine. Abnormal slash pine seedlings were collected in a Florida State Nursery for a cytological study. The frequency of these abnormal seedlings in the nursery beds was about 0.0002 per cent, and their subsequent survival and growth was greatly hindered because both their roots and shoots were depressed. Some of the seedlings were verified to be polyploids (mixoploids), having chromosome complements of 2n, 3n, and 4n.

The results of this study, along with photomicrographs of the chromosomes, have been accepted for publication in Forest Science.

4. Chromosome number of Pseudolarix amabilis. A chromosome count of 22 in haploid tissue of Pseudolarix amabilis has been reported, but the actual number in somatic tissue has never been verified. By forcing several golden larch trees it was possible to obtain tissue suitable for a chromosome count. A total of 44 chromosomes was observed in all of the cells undergoing mitotic division.

A note on this, along with idiograms of the chromosomes, will be prepared for Tropical Woods.

5. The cytology of fertilization in Pinus. With the cooperation of Mr. McWilliam, an attempt was made to follow the movement of individual chromosomes during the actual fertilization process in Austrian pine. A report on this work will appear in the Botanical Gazette. Along with the description of syngamy in Austrian pine, a photographic record is presented of the sequence from the time when the two sperm nuclei enter the egg until the first two free nuclei of the zygote are formed.

6. Colchicine-induced polyploidy in pines. Polyploidy was induced in pines by treating seed, seedlings, and male strobili with colchicine. The results have been summarized in a report, and will be published either in the Journal of Forestry or in Silvae Genetica. The manuscript was divided into three main parts:-

a. Treatment of seed and seedlings of slash pine, Pinus elliottii Engelm. with colchicine.

b. Culture of slash pine embryos on colchicine-enriched agar.

c. Treatment of male strobili of three species of pine with colchicine during meiotic and post-meiotic divisions (Loblolly pine, Pinus taeda L., Austrian pine, Pinus nigra Arnold, and Mugo pine, Pinus mugo Turra).

7. Photosynthetic efficiency of polyploid slash pine. In cooperation with Mr. Bourdeau the respiration and photosynthetic rates of diploid and polyploid slash pines were determined. It was found that polyploid shoots had a lower rate of photosynthesis than diploid ones, while their respiration rates were about equal. This might account for part of the reduced rate of growth of polyploid slash pine trees.

The manuscript on this phase of the polyploidy study will be submitted for publication along with the article mentioned under (6).

Research Work in Progress:

1. Effect of photoperiod and temperature on height growth of Norway spruce and Scotch pine seedlings from different geographical sources.

2. Analysis of needles from pine hybrids.

3. Effect of fertility level of soil on seed and seedling characteristics of slash pine.

4. Factors determining needle coloration of Scotch pine from different geographic sources.

5. Cytological study of abnormal Pinus radiata seedlings. It is anticipated that one of the abnormal P. radiata seedlings located in our nursery might be polyploid, caused by a spontaneous mutation.

6. Rooting of needle fascicles of slash pine. Using modified tissue culture techniques, attempts are made to initiate adventitious roots on excised needles fascicles. Preliminary attempts have been successful.

7. Air-layering of several species of pines. In cooperation with Mr. Cutting, red pine and Scotch pine trees are induced to form roots by manipulating the environment and varying the chemical treatments.

9. Studies on flower induction. There are several studies in progress on the induction of flowers in Mugo pine, red pine, sand pine, loblolly pine, etc.

10. Breeding plantations. All of the breeding plantations had to be lifted and the main and important plants (pines and hardwoods) have been moved to the Great Mountain Forest.

The spruce hybrids and other species from our nursery have been moved to the Yale nursery in New Haven. These trees will be moved to the Great Mountain Forest during the spring of 1959.

TREE BREEDING IN THE CAMPINE, BELGIUM

by

A. de Jamblinne

General

The Centre de biologie forestiere de Bokrijk is located in the Campine of north-eastern Belgium. The Campine is an area of sandy soils and heathlands.

The Centre was established in 1949 by private and public wood owners in two Provinces, mainly Limburg. The work is supported by the IRSIA (Institute pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture), an organization comparable to the Canadian Research Council. The research is supervised by and in close co-operation with the University of Louvain, while the Province of Limburg provides the establishment and maintenance of the Centre.

The aim of the Centre is to promote silviculture in its broadest aspect. The increase and improvement of wood production on the poor soils in the Campine is especially important. The Centre has the following sections: Forest Pedology, Microbiology and Soilchemistry, Zoology, (entomology and soil fauna), and Forest Genetics.

Each section has its own program but all co-operate on problems such as erosion, and new techniques in silviculture. For instance, the Genetics section co-operates with the Pedology section to produce growth curves as related to soil quality for different tree species.

Genetic Section

The genus Pinus is important in the Campine Woodlands, because of the poor soils there. Two lines of study are pursued: provenance and population genetics of various pine species, and inter- and intra-specific hybridization.

Provenance and Population Genetics

The main purpose is to study the phenotypic and genotypic variability within the species and within the population. The procedure of clearcutting and replanting with plants of unknown origin which is common in the Campine makes the genetic value of the stands a mystery. For instance, I do not know whether poor form and growth is due to heavy podsols or poor genotype of the trees.

We attempt to solve this problem by planting provenance trials on different soil types, and also by studying the growth potentials of different soil types and drainage classes.

The provenance experiments include both exotic and local provenances. The exotic provenances are chosen according to a latitude gradient, while both good and poor types of the local provenances are tested. Each of the local provenances is represented by 30 trees selected at random. The progenies of these single trees are kept separate for further study. This technique is used for both Pinus nigra and Pinus sylvestris.

The variability of local provenances (which may be second or third generation in the Campine) are compared with original exotic provenances. The Campine provenances of Scots pine are very variable which indicate their mixed origin. Controlled pollination of a number of selected mother trees will yield further information about the variability of the Campine provenances.

Hybridization Program

This program includes inter- and intra-specific hybridization. Interspecific crosses have been performed with Pinus sylvestris and Pinus nigra. Provenance hybridization in Pinus sylvestris was done with ten provenances (Brandenburg, Scotland, Pin d'Augrerne, Sweden, Bulgary, Campine, East Prussia, Bavaria, Riga (Latvia)).

Different varieties of Pinus nigra (caramanica, calabrica, and Austriaca), and a number of local phenotypical types of Pinus nigra found in the Campine have been crossed. These crosses have been made as test crosses, using one mother and many fathers. The crosses Pinus sylvestris x pinaster and Pinus nigra x pinaster have been successful. These hybrids may eventually display high resin yield and shoot moth resistance. The hybrid between jack pine and lodgepole pine display no heterosis in the Campine.

Two single trees of Pinus nigra calabrica were crossed with one tree of P. sylvestris and three different trees of Pinus nigra. The Pinus nigra pollen parents produced differences in seed weight and seed set which were superior to open pollinated seed. The P.sylvestris parent showed no such relation. It was found that there is an optimum number of seed per cones where the seed reaches the best development.

FOREST TREE IMPROVEMENT

AT THE NORTHERN INSTITUTE OF FOREST GENETICS

Hans Nienstaedt
Lake States Forest Experiment Station 1/
Northern Institute of Forest Genetics
Rhinelander, Wisconsin

INTRODUCTION

The Northern Institute of Forest Genetics is one of three such institutes maintained in the United States by the Forest Service. The two others are at Gulfport, Miss., and Placerville, Calif. The facilities at Rhinelander were opened about a year ago and what is there now is only the beginning. We are at present in the planning stages of another building and additional greenhouse space for which funds are available. After completion, the new building should accommodate seven professional men plus subprofessional aides. At present we are staffed and equipped for work in genetics and physiology, but eventually we shall also conduct studies in cytology, pathology, and entomology.

Being new, we have very few results as yet. In the following, I shall describe some results very briefly and outline our more important current work:

TREE IMPROVEMENT

Spruce, specifically white spruce, is the species on which we are concentrating our work at present. This choice is based on the growing interest in spruce management, on planting stock demand, and on the fact that most non-Federal efforts in tree breeding in the Lake States emphasize the pines and broadleaf species.

The work so far has centered around the development of research techniques and the studies of variation in white spruce. It has included studies of (1) racial and ecotype variation, (2) individual tree variation, (3) grafting techniques, (4) pollination techniques, and (5) selection of plus trees.

Racial Variation

In one study 28 seed sources of white spruce, covering the entire range of the species from Alaska to Maine, were seeded in our nursery this spring. We owe our thanks to many of you here in Canada for help with the seed collections for this study.

Another study involves 19 sources of white spruce from the Upper Peninsula of Michigan. In it, we are trying to determine whether or not distinct ecotypes have evolved as a result of the very drastic climatic differences we have in this otherwise fairly uniform area. Based on the development during the first growth period in the greenhouse, all we can say at this time is that distinct differences between sources

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1/ A field unit of the Forest Service, U. S. Department of Agriculture.

are evident. To a large extent they appear to be independent of seed weight; however, we have not yet compiled all the climatic data necessary for the complete analysis.

Individual Tree Variation

Preliminary studies of individual tree variation in white spruce got under way this summer. Our objectives are to determine the range of variation of the more important characteristics, such as: (1) Growth and vigor, (2) wood quality, and (3) branch characteristics--for example, diameter and length. For the present, we are trying to develop sampling techniques, and have limited ourselves to wood quality in terms of specific gravity. The relationship between ring width, age, percent summerwood, and specific gravity is being studied on samples from 120 plantation-grown white spruce 37 years of age.

Ultimately, we hope to develop indices for the selection of superior trees and for evaluating progeny.

Grafting

Like Mark Holst, we have concentrated our efforts on fall grafting. In one study we have tried to determine the effect of rootstock activity at the time of grafting in September on the percent "take." The growth of the rootstock was controlled by a combination of temperature and daylength treatments. However, they had little effect on graft survival.

Treatment after grafting, on the other hand, had marked effects on survival and growth. Treatments which drastically changed the physiology of the stock plant at the time of grafting lowered percent "take." The best treatment combination is long-days (20 hours) for 4 weeks, followed by short-days (13 hours) for 2 weeks, and then 8 weeks of chilling at 36° to 40° F. before the plants are returned to the greenhouse. By repeating this schedule beginning in the middle of March the following year, the plants will be ready for the second flush of growth in late May or early June.

Pollinations

Work in pollination so far has been limited to the testing of bagging techniques, studying the period of receptivity, and testing the crossability within the genus Picea. As expected from Mark Holst's experience, a combination of a viscose casing bag and a kraft bag was the best. Female strobili are receptive over a period of 3 to 5 days beginning at the time of the first pollen flight, and this receptivity is well synchronized throughout an individual tree. These results substantiate earlier reports by Jonathan W. Wright.

The Selection of Plus Trees

The number of plus trees reported has so far been below expectations and we have, therefore, held several training sessions with field personnel this summer. The results remain to be seen.

TREE PHYSIOLOGY

Dr. Philip R. Larson is carrying out our research in tree physiology. At present his work emphasizes the auxins in (1) the formation of springwood and summerwood, (2) flower induction, and (3) rooting of cuttings. In addition, he has worked on the effect of gibberellic acid on bud dormancy of a number of hardwood species and conifers.

The Formation of Springwood and Summerwood

The formation of springwood and summerwood is studied in seedling and physiologically mature red pine. Dr. Larson is working on the assumption that the change from springwood to summer wood is associated with the termination of elongation and that the control is hormonal in nature.

Treatments of seedlings have attempted to (1) induce summerwood formation on the one hand, and to maintain springwood formation through hormone applications in spite of this induction on the other hand, (2) induce the formation of false rings, and (3) determine the effect of debudding on annual ring formation in seedlings grown under various photoperiods. The course of growth and wood formation has been recorded at intervals after treatment. The treatment effects on wood formation have not been determined as yet.

In the mature trees, the auxin concentration in terminal shoots has been determined at intervals during the growing season, using a combination of paper chromatography and Avena coleoptile bio-assays. At the same time, samples have been collected for the determination of the developmental stage in xylem formation. A change in the auxin concentration apparently takes place during the season, but whether it corresponds to any change in the wood being laid down has yet to be determined.

One of the early problems in this study was the interference from resinous compounds in the quantitative assay. Dr. Larson has been able to overcome this partly, so he now can use the bio-assay method. He still has not been able to prevent streaking on the chromatograms so completely that he can use the densitometer for his auxin determinations.

Flower Induction and the Rooting of Cuttings

For the studies of flower induction and of the rooting of cuttings we propose to use the tissue culture techniques, or more particularly organ culture. When looking for two particular types of tissue, roots and flowers, we believe it would be simpler to start with an already differentiated organ rather than with a mass of undifferentiated cells. At present Dr. Larson and Karl E. Wolter--one of our summer students--are working on methods of sterilizing detached buds and stem pieces with buds attached. It is a difficult problem, but some progress has been made and we are confident that a method can be developed. Thereafter the problem of flower induction and root formation can be attacked in any number of ways: from the standpoint of chemical or physical environment or a combination of both.

Smaller Studies

A number of smaller studies in physiology have been made. Gibberellic acid may perhaps be useful in shortening the forcing period of male flowers collected as early as January 10. Best results were obtained with Acer and Prunus. Pollen yields with Betula and Populus were low, but can probably be increased by improving the forcing environment. The effects of the gibberellic acid on pollen viability have yet to be determined.

The chilling requirements of white spruce 2-year-old seedlings have been determined to be 4 to 6 weeks for fully developed buds; partially developed buds apparently require more chilling, 6 to 8 weeks, and their growth does not compare with that of the fully developed buds. Long photoperiods partially compensate for lack of chilling. Incidental observation on older seedlings and grafts from physiologically mature trees indicate that the chilling requirements may change as the trees grow older. The studies are being repeated, using several seed sources of white spruce and a number of exotic spruce species.

PLANS FOR THE FUTURE

These, then are our results and endeavors up to the present. With our expanding staff and facilities, our plans for the future are far from definite. The emphasis will continue to be on spruce, but we will undoubtedly take up other genera fairly soon, starting with Betula and adding other species including those used in Plains shelterbelt planting as we go along.

A SUMMARY

FOREST-TREE IMPROVEMENT AT THE UNIVERSITY OF MINNESOTA (1958)

Scott S. Pauley

Tree improvement research at the University of Minnesota was initiated in the period 1939-43. During this time Dr. T. Schantz-Hansen established a seed source study of jack pine designed to assess the degree of genetic diversity that exists within the species throughout its natural range.

Later, in 1947, Dr. D. P. Duncan initiated selection and testing studies of poplar, elm and blue spruce. The primary objective of this work has been to isolate hardy, disease-resistant, and vigorous materials adapted for windbreak and ornamental planting.

In 1955 the University's research in the tree genetics field was expanded and a graduate training program was established. In addition to increased University support, vital contributions to the program have been made by the Charles K. Blandin Foundation of Grand Rapids, Minnesota and Resources for the Future, Inc., Washington, D. C.

Most of the briefly summarized projects below are being carried on through the assistance of graduate students.

Mode of Inheritance in Populus. Several F_2 and backcross progenies involving European and American aspen have been produced and outplanted for study. A cross of two F_1 hybrids of the eastern black cottonwood was made during the current season. The F_2 population derived should yield data on the mode of inheritance of the photoperiodic response in this species.

Hermaphroditism in Trembling Aspen. Studies of bisexuality in apsen are being continued by S. C. Hong, a Korean student. Two selfed and two cross pollinated progenies from each of two hermaphroditic trees were produced from controlled pollinations by Mr. Hong during the current season. Particular interest is centered on growth rate and other developmental characters of the selfed and crossed progenies.

Field Budding of Aspen. In cooperation with the Diamond Match Co. of Cloquet, Minnesota, field budding tests of genetically elite aspen clones on native 2-year suckers were initiated this summer.

Birch Studies. Seed collections from phenotypically elite paper birch stands in northeastern Minnesota were made in 1957 and are currently being propagated for tests in cooperation with the Diamond Match Co. Portions of the seed were also used during the past spring in a series of direct seeding experiments designed to determine the influence of different soil preparations on seedling establishment and survival.

Studies of the natural hybrid Betula X Sandbergii Britt. (B. papyrifera Marsh. x B. pumila L. var. glandulifera Regel) are being carried on by Knud E. Clausen. The hybrid is relatively common throughout those parts of Minnesota where the two parents occur.

Jack Pine Variation. The phenomenon of "lammas" or late season shoot growth in jack pine is being investigated by Thomas O. Rudolph. Observations of seed source plantings suggest that diversity in this character varies geographically. The influence of long day on lammas shoot formation is currently being investigated.

A study of geographical variation in jack pine has been undertaken by Roland E. Schoenike. Extensive field studies throughout the range of the species are currently underway.

Toxin Tests for Dutch Elm Disease. Tests of a toxin screening method for the isolation of American elm seedlings resistant to the Dutch elm disease were undertaken by Frank S. Santamour. Results of these tests did not support the feasibility of such a screening method nor support the hypothesis that a toxin, produced by the causal fungus, is the prime disease-causing factor in infected trees. (A report on this study was published as Minnesota Forestry Notes No. 65, April 15, 1958.)

Pollen Storage. A study of the vacuum storage of white spruce, Norway spruce and jack pine pollen was conducted recently by John C. Barber. The trials indicated that vacuum storage is feasible and opens up the possibility of long term storage of pollen samples by this method. (See Minnesota Forestry Notes No. 62, October 15, 1957.)

Grafting and Hybridization of Elm. Grafting and hybridization studies in elm initiated by Paul E. Collins while in residence as a graduate student are being continued at South Dakota State College.

Progeny Test Analysis. A 6-year evaluation of several slash pine progeny tests growing in the state of Georgia is being carried on by John C. Barber.

Basswood Propagation. Studies of basswood propagation from seed and from stem and root cuttings are being conducted by William J. Peters.

Growing Northern Planting Stock in the South. This problem, under investigation by Richard F. Watt, is designed to assess the feasibility of growing certain native northern conifers in nurseries of the deep South. Through the use of artificially lengthened photoperiods, transplantable nursery stock may be grown in the long frost-free seasons of the South in a shorter time.

Plot Size for Progeny Tests. Determination of the minimum plot size requirement for short and long-term progeny tests of red and jack pine is being conducted by George M. Blake.

Early Selection for Heterosis. Studies concerned with the problems of early selection for heterosis in poplars, particularly as they relate to the anatomy of hybrids, are being conducted by Frank S. Santamour.

Tulip Poplar Hardiness. Winter hardiness tests of several tulip poplar seed sources in the St. Paul area of Minnesota have thus far been uniformly lacking in promise.

Air-layering Studies. The use of air-layers as a practical means of vegetatively propagating selected jack pine trees is under investigation by Thomas O. Rudolph and William E. Cromell. Results thus far have not been promising.

Stimulation of Early Flowering in Spruce. Although work in this area is just getting under way, Mr. Cromell has had excellent survival of white spruce seedlings grafted into the terminal shoots of cone-producing black spruce.

White Spruce Seed Source Plantation. Through cooperation of Mr. Mark Holst a white spruce seed source plantation was established in the Grand Rapids area this year. Nineteen Quebec and Ontario sources and six from the Lake States are represented.

Tree Improvement Arboretum. Initial plantings in a tree improvement arboretum near Grand Rapids, Minnesota were made in 1956. Betula and Populus are now chiefly represented. We plan to include selected specimens of all potentially useful natives and exotics.

NATURAL POLYPLOIDY IN SLASH PINE*

by

François Mergen**

Introduction

In some orders, or families of plants, the chromosome number is quite variable among the different species; in others the number is quite constant. The coniferales belong in the latter group, in which polyploidy and other major chromosomal changes are rare. In the Pinaceae, particularly, all of the species studied so far occur normally as diploid plants, with the exception of Pseudolarix amabalis (Nehls.) Rehd. which occurs as a tetraploid. There have been several reports on the occurrence within the Pinaceae of freak plants whose chromosome number varied from that of their normal diploid ancestors. These abnormal plants were identified through their external appearance; namely, by their stunted growth, by thick fleshy needles, or by the unusual color of their foliage. There has been only one report so far of a study which verified the chromosome number of an abnormal seedling in the genus Pinus. The presence of polyploids, however, has been postulated by many foresters. A search was made in a forest tree nursery to locate abnormal slash pine, Pinus elliottii Engelm., seedlings. The following comments refer to these plants.

Materials and Methods

The abnormal seedlings were collected in the Florida State Nursery at Olustee, Florida, where some 40 million slash pine seedlings are grown annually. The nursery beds were surveyed for abnormal seedlings at various times during seven growing seasons; the first collection being made during September of 1951 and the last during February, 1957. The greatest number of abnormal seedlings was located when they were about 3 months old. At this stage their needles had a bluish hue, and the neighboring normal seedlings had not yet had time to crowd out the slower growing abnormal types. At this age, the frequency of abnormal seedlings as about 0.0002 per cent, and they occurred singly and at random throughout the beds. As the season progressed, the apparent percentage of abnormal seedlings decreased, presumably because they were unable to survive, or were crowded out by the larger, more vigorous seedlings. Over 50 abnormal seedlings were dug up and potted in fertile soil and moved to a greenhouse. All of the abnormal seedlings had under-developed root-systems, and many lacked lateral roots. In those instances when lateral roots were present they were short and club-shaped.

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*Note: Figures referred to in the text are photographs which it is not possible to include in this publication.

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To obtain vigorous growth for the chromosome counts, soluble fertilizer was added to the soil and the plants were kept under a 17-hour photoperiod for several weeks before material was collected for analysis. Normal seedlings (controls) were treated in the same manner.

To obtain chromosome configuration in the metaphase stage the treating schedule of Mergen and Novotny (1957) was followed. Actively growing buds, and root tips, 3-8 mm. long, were used. The vegetative needle buds supplied sufficient meristematic tissue with mitotic divisions to make chromosome counts possible. On the other hand, chromosome counts could be made from only a few squashes of root tips. The chromosomes were counted by drawing idiograms at an approximate enlargement of 2000X with the aid of a camera lucida, or a projection mirror.

Tangential and transverse sections were prepared from several of the terminal buds to determine the location of the polyploid or abnormal cells.

Cross-sections were made from segments of fully-grown secondary needles, with the exception of those from one seedling which had not developed secondary needles. In this instance primary needles were examined.

The arrangement and size of the stomates was determined on the outer face of the needles. The needle segments were macerated at room temperature for 1-1/2 to 2 hours in a 1:1 mixture of 20% hydrochloric acid and 35% nitric acid. After this treatment the epidermis, along with some cells of the hypodermis, could be separated from the subjacent cell layers.

Results

Normal diploid seedlings. The characteristic features of an average diploid slash pine seedling are illustrated in Figure 1. When the seedling was photographed it was 2 years old, and bore only secondary needles. The anatomy of the needles was similar to that described for slash pine by Sutherland (1954); the stomates appeared in straight rows and were uniform in appearance. The chromosome number of mitotic figures in somatic tissue was verified to be 24, as had been reported previously by Sax and Sax (1933), and by Mehra and Khoshoo (1956).

Abnormal seedling #1. Seedling number 1 grew very slowly, being 20 cm. tall after three years (Figure 2). The branches, to the extent that they were present, had not elongated more than about 1 cm. Most of the needles were primary, but there were a few short and exceptionally thick secondary needles.

About 65% of the secondary needle buds dried and fell off before they were 5 mm. long. The needles, as well as the growing shoot, were dark green with a bluish hue. Their surfaces were rough with many ridges and expanded teeth. The thickness of the hypodermis was not uniform but was greater under the ridges, and the roughness of the outer surfaces was also reflected in the irregularity of the endodermis. There was a well-developed mesophyll but the number of

resin ducts was lower than in the normal seedlings. The stomates appeared in uneven rows; both the spacing within the rows and between the rows was irregular.

Chromosome counts indicated that the majority of cells were tetraploid ($4n=48$). Normal diploid cells were also present and these occurred in the needle bases in a approximate ratio of 1:4 tetraploid cells, whereas in the root tips the ratio of diploid to polyploid cells was about 1:2.

Abnormal seedling #2. Seedling number 2 was slow-growing and after three years it had a height of 15.5 cm. (Figure 3). The secondary needles appeared singly, and in some instances there was a partial split through the middle, indicating that two needles from one fascicle had fused together. In addition to being very short, the needles started to curve and had the appearance of claws. The root system was poorly developed, and consisted of an enlarged growing knob with several short laterals above it. The cross-sections through the needles showed a very distorted arrangement of the anatomy; the resin ducts were present in only one-half of the needle, and the cells of the plicate mesophyll were arranged and oriented differently in the two halves. Teeth were present on the various ridges, and their arrangement did not appear to follow a definite pattern. The stomates occurred in irregular partial rows, and were slightly smaller than those in the normal seedlings.

The chromosome count showed that the seedling was a mixoploid and was made up of diploid, triploid and tetraploid cells, with the majority of cells having 48 chromosomes. The ratio of diploid cells to tetraploid cells was 1:4.5; the frequency of triploid cells was about 1:10.

Abnormal seedling #4. While in the seedbed, seedling number 4 had dark bluish needles that were quite thick and long. The height growth was somewhat slower than that of the surrounding seedlings and the hypocotyl and the growing points were thick and succulent. After the early seedling stage, its morphology did not differ appreciably from that of normal seedlings, with exception of the secondary needles which were much thicker. The anatomy of the needle appeared normal, with the exception of the stomates which were arranged in uneven rows and were much larger, their diameter on the outer surface being the largest (51.8μ) in any of the seedlings examined.

Chromosome counts showed seedling number 4 to be a mixoploid. It differed from the other plants by its relatively high frequency of polyploid cells in the bases of the needles--13 polyploid cells to one diploid cell. Of the polyploid cells, about three quarters were tetraploid and the remainder were triploid. The number of triploid cells was higher in the other trees studied, and the ratio of diploid to polyploid cells in the root tips was 1:2. Several stages of mitosis could be observed in the dividing cells. There appeared to be no tendency for the chromosomes to move toward the equatorial plate during metaphase, and during anaphase the daughter chomatids remained in an apparently random location within the cell. This partial mitosis doubled the number of chromosomes within the cell because no cell wall formed to separate the daughter chromosomes.