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NATIONAL RESEARCH COUNCIL OF CANADA

PROCEEDINGS

OF THE

THIRD MEETING

OF THE

SUBCOMMITTEE ON FOREST TREE BREEDING



OTTAWA

25 APRIL, 1940

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SUBCOMMITTEE ON FOREST TREE BREEDING

Held at the National Research Laboratories, Ottawa. 25 April, 1940

Present:

Members:	Dr.	R.	Newton (chairman)
	Mr.	С.	E. Atwood
•	Mr.	D.	Roy Cameron
	Dr.	N.	H. Grace
	Dr.	C,	Heimburger
	Dr.	Σ.	P. V. Johnson
	Mr.	C.	G. Riley
	Mr .	W.	M. Robertson
	Dr.	H.	A. Senn
	Dr.	F.	H. Peto (secretary)

Visitors:

Mr. J. L. Farrar Dr. J. G. Malloch Mr. A. W. McCallum Mr. A. Skolko

39. The minutes of the second meeting of the Sub-Minutes committee on Forest Tree Breeding were read and approved with the following changes suggested by Mr. Riley. Minute 22, (b) "rust free" to replace "resistant"; Minute 29, paragraph 3, "Septoria" to replace "septorial"; Minute 29, paragraph 3, "diseased" to replace "susceptible".



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40. Project Organization

Dr. Heimburger discussed the advisability of modifying the project outline to bring it in line with that in use in the United States. Dr. Heimburger's suggestions are incorporated in Appendix A.

Dr. Johnson considered that the matter of project outline should be given further consideration. He explained that Section E (Reforestation and Afforestation) was included for the sake of completeness.

The chairman suggested that further deliberations on this matter should be left to the special subcommittee originally appointed for this purpose.

41.

Report

In outlining the progress of forest-tree breeding during the winter, Dr. Johnson dealt briefly of progress . . with the following studies: and

The relation of growth rate to specific plans 1. gravity, fibre characteristics, and pulping qualities in of the wood in hybrid poplars. (See Appendix 4) forest-

tree breeding

Damping-off control in pine and spruce grown 2. in the greenhouse under controlled conditions of temperature, humidity and soil moisture. Of several chemical treatments, a 1 - 400 suspension of Semesan in water was found to give the best control.

Germination of dormant basswood seeds. At-3. tention is being given to the improving of existing methods (which have sorious disadvantages) and one very promising lead. is being studied.

Artificial germination of pine and poplar 4. pollen. A medium of 5.0% sucrose in 0.75% agar was found best for poplar pollen. This concentration was the best of the sugar media for pine pollen also, but was not significantly superior to a distilled water medium.

The effect of nutrient solutions on the 5. development of detached flower branches of Populus grandidentata. None of the concentrations of Hoaglana's solution, sucrose solution nor combinations of the two was superior to the distilled water check.

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6. Colchicino treatments of forest-tree seeds was applied to some twenty-five species involving ten genera. The characteristic preliminary effects of chromosome doubling appeared in all species.

7. The effect of humidity on longevity of poplar seed. The best result was in the case of <u>P. grandidentata</u> stored at 20% humidity, which still gave 3% germination after 555 days.

8. Greenhouse hybridization of Populus species was continued. The most promising new cross is <u>P. berolinensis</u> x Northwest poplar, the latter species being resistant to Septoria canker.

With respect to the breeding work during the coming season, Dr. Johnson proposed the following additions to the existing program:

1. The extension of hybridization work to include maple, oak and ash, providing such work does not interfere with essential work on more important genera. It was pointed out that in the planted woodlot it was quite possible that species not commercially important in the exploitation of virgin stands might prove to be the most profitable to the grower.

2. Studies on genetical and environmental characters in seed trees. The work of the Ontario Forestry Branch at Timagami, in which seed trees are being left in the cutting of extensive virgin white pine stands, was cited as a prospective field for these studies. A related study would involve the effect of inbreeding in isolated seed trees of monoecious species, e. g., white pine.

3. General plans for the development of an experimental area at the Annex were outlined; but, in view of uncertainties arising from the war, the matter could not be considered as being in immediate prospect.

Attention was drawn to the following publications relating to forest-tree breeding:

> Johnson, L. P. V. The breeding of forest trees. Forestry Chron. 139-151. 1939.

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Johnson, L. P. V.

A descriptive list of natural and artificial interspecific hybrids in North American forest-tree genera. Can. J. Research, C, 17:411-444. 1939.

Mr. Riley pointed out that Northwest poplar is not immune to <u>Septoria</u> canker but may be more resistant than most other species. Dr. Heimburger stated that Northwest poplar is believed to be a single clone of <u>P. jackii</u>.

The importance of spruce breeding and poplar breeding for the prairie provinces was emphasized by Dr. Heimburger.

Mr. Robertson drew attention to the need for the selection of superior types of balsam for the Christmas tree trade but Dr. Heimburger suggested that this problem was only of secondary importance.

Dr. Johnson admitted the great importance of spruce breeding but suggested that certain other species may prove to be of more value than spruce under woodlot and plantation conditions.

The secretary pointed out the danger of evaluating breeding possibilities in any species for woodlot productions on its value for exploitation in natural stands. The economic advantages of rapid growth might outweigh advantage in quality of slower-growing species.

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Work in progress.

42. Vegetative propagation

Work during the past winter has been confined to white spruce, Norway spruce, white pine, canescens poplar, trembling aspen, and basswood. Season of collection and treatment with hormonized dusts continue to be the main features being investigated. A new idea is the storing of winter collection of cuttings outdoors for spring planting. Further work on media and watering with nutrients is being done with Norway spruce cuttings. Stoutemyer's precallusing technique with hardwoods is being tried with the poplars and basswood. Exploratory experiments with various dusts have been carried out on these species.

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The animal rooms on the fourth floor of the National Research Laboratories are unsuited to growing conifer cuttings for the following reasons:

The ventilation is poor, the air is dry, and chemical fumes are often present. Zinc in the tap water also caused considerable trouble but this has been remedied by the use of distilled water.

Plans for summer work at the Petawawa Forest Experiment Station.

Experiments now in progress will require much of the time available during the coming spring and summer. This will include planting the cuttings now heeled in at the National Research Laboratories, taking notes of new growth and mortality on these and on the experiments put in during the summer and fall of 1939. This spring final notes on root development will be taken on the experiments put in by Dr. Grace in the spring of 1939, and in the fall the same will be done for the later experiments of 1939.

New work in the spring will consist of two or three collections of Norway spruce to complete the series begun in 1939, lining out rooted cuttings for observation on their growth, and potting of seedling transplants for experiments on grafting. In midsummer some collections of hardwoods will be tried. The most of the new work will be done in the fall, the time of year that past experience has indicated to be the most favourable.

Publications

There follows a list of papers published to date dealing with the vegetative propagation of forest trees. In addition a paper is now in the course of preparation based on Investigation IV-A-38-G1, and another on a group of six experiments.

Grace, N. H. Vegetative propagation of conifers,

I Rooting of cuttings taken from the upper and lower regions of a Norway spruce tree. Can. J. Research, C, 17:178-180. 1939.

II. Effects of nutrient solution and phytohormone dusts on the rooting of Norway spruce cuttings. Can. J. Research, C, 17:312-316. 1939.

III. Effect of month of collection on the rooting of dormant Norway spruce cuttings. Can. J. Research, C, 17:376-379. 1939.

IV. Effects of cane sugar, ethyl mercuric phosphate, and indolylacetic acid in talc dust on the rooting of Norway spruce. Can. J. Research, C, 18:13-17. 1940.

V. The effect of indolylacetic acid and nutrient solutions on the rooting of Norway spruce cuttings. Can. J. Research, C, 18: 122-128. 1940.

Deuber, C. G. and Farrar, J. L.

Rooting Norway spruce cuttings without chemical treatment. Science 90:109-110. 1939.

Rooting Norway spruce cuttings. American Nurseryman 70 (4):3-5. 1939.

Farrar, J. L.

Rooting of Norway spruce cuttings. Forestry Chron. 15:152-163. 1939.

Dr. Heimburger reported on certain experiments on propagation. A summary of this work is to be found in Appendix B. During further discussion of the propagation studies, he particularly emphasized the importance of further research on the influence of various horticultural practices on rooting of stem and root cuttings.

43. Forest Pathology Mr. Riley presented a summary of work proposed for 1940 which is found in Appendix C.

The secretary stated that the white pine blister rust disease garden will be started at the Annex in the spring of 1940. Both the Ribes plants and certain white pine seedlings will be planted there this spring by Dr. Johnson.

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44. Nursery development at the Annex

The secretary described the rather extensive plans for the development of the nursery at the Annex this year. However, the uncertainty of ob-taining the appropriations asked for in the main and supplementary estimates of this committee will probably result in a marked curtailment of this development.

Dr. Senn stated that if the cuts in appropriations made it impossible to grow all of the valuable breeding material, he felt sure that the Division of Botany might be able to grow some of it for us.

45. Test area at the Annex

Dr. Johnson discussed the plans for development of a regional test area at the Annex. He explained that this development was to quite an extent dependent on whether a unit of the N. F. P. would be able to assist with the large amount of manual labour necessary. Since these units may not be operating this year he felt that immediate development of this area was probably not possible.

46. Wood quality tests

studies

Dr. Johnson reported on the tests conducted by himself and also at the Pulp and Paper Research Laboratory in Montreal. The reports are given in Appendix D.

The secretary reported that he had continued 47. his heat and cold treatments of poplar catkins with Cytogenetic the object of producing triploid and tetraploid poplar hybrids.

> A large proportion of giant pollen grains were obtained in certain treatments. This pollen was used in crosses and the resulting plants will be examined cytologically to detect polyploid plants.

Dr. Heimburger suggested that decapitation and callusing with indolylacetic acid should be tried since it has been particularly successful in producing polyploid tobacco plants.

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48. Dr. Heimburger summarized a statement he had Statement of prepared on arboretum requirements. This statement Arboretum re- is included as Appendix E. quirements

49. An interesting description of this institute Visit to was given by Dr. Heimburger who visited there during Institute of the winter. Forest Genetics, Placerville, California

50. It was agreed to hold a summer meeting at Summer Petawawa, the date to be arranged by the secretary meeting on consultation with the members.

The meeting adjourned at 12:30 p.m.

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APPENDIX "A"

(Dr. C. Heimburger)

Project Outline

This outline is dynamic, not static, although the main framework is relatively permanent. It consists of two parts - original framework - i. e., project classes and statement of individual projects under way, planned for more or less immediate future, and projects terminated. Our present outline is a combination of these two parts, which is a drawback. Therefore a revision is needed. Another reason for revision: The project outline under discussion was drawn up by the Lake States Forest Experiment Station in co-operation with the Division of Biology and Agriculture of National Research Council of United States and recently adapted by the Dominion Forest Service of Canada. Similarity of main framework would be of great advantage for present and future co-operation and exchange of information.

The United States outline is as follows:

FOREST BOTANY Taxonomy Anatomy and Morphology Physiology Phenology Genetics Source of seed Tree Breeding

This Subcommittee is concerned chiefly with Genetics in its broad sense and it is therefore suggested that the projects be grouped according to the following main framework:

Genetics

Source of material Breeding, with the other phases having an equal rank

In respect to organization the project outline of 6 April, 1939, is far superior to the outline of 28 November 1939, which is deplorable. We should advance in this respect, not retrograde into complicated impractical rigidity.

General Outline

Forest Botany Genetics Source of material Breeding Cytogenetics Wood technology Vegetative propagation Pathology Zoology General

Source of Material

Selection of native types, in natural stands, in artificial stands.

Selection of exotic types, in natural stands, in artificial stands.

Testing of: biotypes in: laboratory select types seed bed clones one-parent progenies greenhouse transplant row

test (plantation) stand

Breeding

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Controlled pollination Phenology Pollination technique Fruit protection Fruit harvesting Seed extraction Seed quality tests Tests of hybrid material obtained in:

laboratory seed bed, propagation frame, greenhouse, transplant row, test-stand

Compatibility Dichogamy Study of character inheritance Correlation of juvenile with mature characters Comparison of hybrids with equivalent parent material

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Cytogenetics

Histology Mitosis Meiosis Fertilization studies Production of polyploid forms by: temperature, radiation, chemical agents Unreduced sexual cells Polyploid somatic cells Artificial mutant production by: temperature, radiation, chemical agents Wood Technology Anatomy Mechanics Chemistry (including tanbark) Correlation of juvenile to mature wood characters Comparison of offspring with parents Vegetative propagation Stands as it is 28 November, 1939. Grafting may be amplified using stem or root cuttings as example. Pathology Non-parasitic diseases Parasitic diseases Observation of diseases in: seed beds, transplant rows, stands Artificial inoculation in: seed beds, transplant rows, stands Zoology

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Game Observation of influence in: (as pathology) Vermin Domestic animals Artificial infection (subjection to influences by-) in: (as in pathology) Man

Insects Mites

General

Administration Co-operation Equipment and Facilities Reports Publications Exchange of information Distribution of produced material Application of produced material - advisory activities co-ordination.

APPENDIX "B"

(Dr. C. Heimburger)

Experiments with aspen poplar roots during the winter 1939-40

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Propagation by means of root cuttings so far appears the only practical method for aspen poplars and their hybrids, and will have to be used until a fully satisfactory method of propagating this material by means of stem cuttings Therefore basic research on the behaviour of aspen is found. roots, leading towards the development of improved methods of propagation by means of root cuttings is justified. Some observations of this kind were made by me in the laboratory during the winter of 1939-40. Roots of young seedlings of trembling aspen (Populus tremuloides) were dug out in a gravel pit near Pensive Depot of the Gatineau Division of the Canadian International Paper Company in September, one single root about 18 inches long being taken from each seedling. The roots were bundled and kept in moist sawdust in a refrigerator until their use in the laboratory during the winter. In the winter, each root was cut into sections about 2 inches long and forced on moist filter paper in Petri dishes. During November and December the roots were largely dormant and did not react to forcing except a few of the distal sections of some of the roots. In January and February the dormancy gradually disappeared and it became possible to force an increasing proportion of the sections, the more distal sections, however, responding more rapidly to forcing than the proximal sections. During the latter part of the winter it was possible to force all sections of the roots, even the most proximal sections responding quite readily to forcing. Some roots were, however, quite inactive in this respect even very late in the winter, and great individual variation in respect to reaction to forcing could be observed. As a rule the root sections first started to produce shoots near their proximal ends and shoot production started much earlier in the winter than root production from the distal ends of the sections. All root sections showed a very distinct polarity in their root and shoot production. In respect to root production the sections of each individual root behaved in a very similar way, i.e., certain roots produced abundant roots from the distal ends of their sections, others produced only a few weak roots from all their sections, and some did not produce any roots at all, even if shoot production was quite pronounced at the proximal ends of the sections. Thus, it seems as if there is great individual variation in shoot as well as in

root production by root sections taken from different seedlings. This cannot but greatly influence the propagability of the seedlings in question when grown under nursery conditions.

The sections showing good shoot and root production were placed in perforated corks in Erlenmeyer flasks with their roots immersed in Knop's solution with soil extract. The resulting plants grew quite well, if the solution was changed weekly. The shoots of some section groups soon produced healthy dark leaves and grew quite rapidly. The roots developed side-roots and grew to a considerable length in some Also in this respect there was considerable individual cases. variation in the extent of the root system produced by sections taken from different roots. Some groups of sections taken from individual roots produced only fair to poor root systems in the nutrient solution, and did not improve even after 1-1/2months of growth. A few section groups only produced a single weakly developed root which branched out in a dense brush of thin side-roots and remained in this stage for the rest of the winter.

A series of experiments in cutting off the newly formed roots of the sections growing in nutrient solution was then made. Some section groups showed a marked capacity of root regeneration, irrespective of the size (thickness) of the sections, while other section groups showed moderate to poor regeneration capacity. The growth and especially the root regeneration capacity of the sections was improved by the addition of yeast extract to the nutrient solution in which they were growing. The reaction is possibly due to the content of vitamin Bl in the yeast extract. In this respect the section groups showing the greatest root regeneration capacity responded more markedly to the addition of yeast extract than the section groups showing poor or no root regeneration capacity. Root regeneration capacity thus in essence corresponds to rooting capacity of stem cuttings and is a good index of propagability of this material. Aspen poplar belongs to the group of plants reacting favourably to the application of yeast extract, either because of its content of vitamin Bl or of another substance beneficial to their growth. Towards the end of the winter some of the newly formed roots reached the thickness of the original sections and an attempt was made to cut these into sections, to place them on moist filter paper in Petri dishes and to produce new plants from them. All these attempts failed, however, It seems that a root section has to be dormant before it is forced or that the sections produced in nutrient solution are not equivalent to the sections obtained from roots growing in nature at the end of a summer. The following conclusions can be drawn from these observations:

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The pronounced polarity of the root sections allows the planting of horizontal root cuttings in the nursery, the proximal ends of the cuttings producing shoots and the distal ends producing roots. This is far more simple than the usual method of oblique or vertical planting of root cuttings usually practised in nurseries. The pronounced dormancy of the roots during the early part of the winter makes it possible to ship root cuttings without the danger of sprouting during transportation. The response of the material to yeast extract opens the possibility of treating weak aspen seedlings or growing young plants, as well as flowering branches used in crossing, with yeast extract to improve their growth so as to overcome the critical seedling stage during which the seedlings are subject to excessive damping off, and on the other hand, to improve the seed setting of cut branches used in crossing according to the method of Wettstein. The ability of root formation, the kind of root systems formed, and the ability of root regeneration, are three characters influencing propagability of the material from root cuttings. In respect to all three factors there appears to be individual variation which is most probably inherent. This opens the possibility of testing the material for rooting capacity from root cuttings in the laboratory which is far simpler and quicker than routine nursery tests. The statement made by several nurserymen that root cuttings should be dormant when made and planted is confirmed by these experiments.

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APPENDIX "C"

(C. G. Riley)

Summary of work proposed for 1940

Heartwood decay in poplar

In order to determine the degree of susceptibility of poplar and other kinds of trees to heart rot, it is desirable to develop a shorter method than to wait till the trees reach the age of normal heartwood development, before making the tests. Experiments are under way to determine if younger trees can be used for this purpose. Some success has been attained in infecting 3-year-old poplar. A number of inoculations made in 1939 on 10-year-old poplar will be examined this year, and additional experiments along similar lines will be undertaken.

Rust of poplars

(a) Studies to determine if more than one kind of rust involved, and identification. It is important to know if we are dealing with the eastern or western species, or both. The study involves: (1) A search for the aecial stage on possible alternate hosts. (2) Inoculation experiments on possible alternate hosts, using overwintered teliospores.
(3) Inoculation experiments on poplars using aeciospores, if these can be found or produced artificially. (4) A search for possible overwintering on poplar.

(b) Determination of degree of susceptibility or resistance of poplars in nurseries: (1) By observations on natural infections. (2) By means of artificially controlled inoculations.

Napicladium die-back of poplar

Indications are that this disease can become serious, though instances of this are not common at Petawawa. Studies planned for this year, involve: (1) Search for, and studies of the overwintering stage and primary infections, in the nursery and in the woods. (2) Inoculation experiments for purpose of studying early symptoms and for testing trees for degree of susceptibility.

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Septoria, Hypoxylon, and Cytospora cankers of poplar

Preliminary inoculation tests will be made on such trees as may be ready, for determination of degree of susceptibility or resistance to these diseases.

Poplar test plot

The experiment station authorities have agreed to set aside a portion of the Russian poplar plantation on Meridian Road, to be used as a test plot. Septoria canker is very prevalent on these trees. It is planned to plant out samples of experimental breeding stock on this plot so that they will be subjected to severe conditions favouring natural infection, as part of the test to determine degree of resistance to this disease. Similar test plots may be established for other diseases, or these may be combined.

Blister rust of white pine

Inoculations will be made in order to develop technique, and become familiar with the early symptoms, in preparation for testing experimental breeding stock when such becomes available.

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APPENDIX "D"

(Dr. L. P. V. Johnson)

Studies on the relation of growth rate to wood quality

1. Report of pulping tests on Populus grandidentata and P. alba x P. grandidentata

An entire trunk (AG-106) representative of the more vigorous <u>P. alba</u> x <u>P. grandidentata</u> hybrids, and a similar trunk (G-2) representing the average <u>P. grandidentata</u> type, were sent last fall to the Pulp and Paper Division, Forest Products Laboratory, Montreal, for tests of pulp quality (Prog. Rept. 18/39). Reports on these tests received from Montreal are summarized and discussed in the following sections.

(a) Description of material

The tree from which sample G-2 was collected was an ordinary <u>P. grandidentata</u> and may be considered as parental, or check, material. It grew relatively slowly, being about 18 years of age, 40 feet in height and 3.9 inches in diameter at 18 inches from the ground.

The tree from which sample AG-106 was collected was a representative hybrid of <u>P. alba</u> x <u>P. grandidentata</u> which grew near G-2 but under conditions of less competition. It grew rapidly, being six years old, 34 feet in height and 5.0 inches in diameter at 18 inches from the ground.

It is considered that since these two samples differed so greatly in growth rate, the tests should indicate whether any marked peculiarities in pulping quality might be expected in wood derived from abnormally rapid-growing hybrids.

(b) Chemical analysis

Wood analysis shows nothing of interest except that specimen AG-106 is slightly higher in lignin and somewhat lower in cellulose than is G-2.

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(c) Screen classification of fibre

Fibre length of G-2 is similar to that of aspen soda pulp now on the market. In AG-106 the proportion of 48mesh unbeaten fibre is smaller (i.e., fibres are longer and less pass through the screen). Average diameter of unbeaten fibre is 0.020 mm. for G-2 and 0.022 mm. for AG-106.

(d) Pulp (soda) and paper tests

"The pulps are only slightly inferior to commercial soda pulp as regards printing opacity at the start of beating, but lose their opacity rapidly when beaten.

"Both pulps are inferior to the dried commercial pulp in bulk, AG-106 in particular giving dense sheets. Drying increases the bulk considerably, but AG-106 is definitely less bulky in the dried condition than G-2.

"The bursting, tearing and tensile strengths of the laboratory pulps are somewhat higher than normal for this type of pulp.

"Pulping of the two woods was repeated on a small scale with slightly different cooking conditions as a check. Tests of the pulp confirm tree AG-106 gives stronger but less bulky pulp than G-2."

(e) General Discussion

For soda pulp, AG-106 appears to have one main peculiarity which might cause discrimination against it - that is, the associated condition of being stronger and less bulky. The shorter, weaker fibres and bulky pulp give the desired formation and printing quality to some of the more important soda pulp papers. It is possible that soda pulp from trees such as AG-106 might not meet the standards demanded for these papers.

We must not forget, however, that the larger part of hybrid poplar wood grown in most sections of Eastern Canada will be utilized for sulphite rather than soda pulp and that in the sulphite process a longer, stronger fibre than that of ordinary poplar is desired. We can state, upon the authority of officials of the E. B. Eddy Co., that the proportion of poplar that may be used in sulphite pulp is determined by degree of weakening occasioned by the weaker poplar fibres; and that, if a hybrid poplar had a longer, stronger fibre, a correspondingly larger proportion of poplar wood could be used.

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It may be, therefore, that in spite of its effect on soda pulp quality, a longer, stronger fibre may be desirable in hybrid poplars generally. Further, there is some satisfaction in knowing that there is a place in the pulp industry for both long- and short-fibre types of poplar.

2. Progress in the study of the relation of growth rate to specific gravity and fibre characteristics of the wood of Populus hybrids

Preliminary work on the relation of vigour of growth to wood quality in Populus hybrids was described in Prog. Rept. 18/39. To date the specific gravity of core and branch samples and the vigour indexes have been determined, with some exceptions, for each individual tree under study. Trees being studied are as follows:

Ρ.	alba x P. grandidentata	24	trees
P.	alba x P. tremuloides	8	**
P.	alba	2	11
Ρ.	grandidentata	6	11
P.	tremuloides	3	**
		13	17

The method of calculating volume (use of the cone formula) previously described has been replaced by a graphical method in which a curve was plotted from a standard volume table for aspens of given diameter and height. This curve permitted interpolation for the more accurate diameter measurements (nearest tenth of an inch) used in the present study.

The age of each tree was determined by observation of annual rings in the core removed by a standard increment borer from the trunk at 18 inches from the ground. All holes were plugged with creosote-treated cedar dowels.

Vigour index was calculated by the formula:

Vigour index = volume in cubic feet age in years

Cores for specific gravity studies were removed by a specially-designed, 1/2" borer at a height of slightly more than 18 inches from the ground, and on the side of the trunk most exposed to light. All holes were plugged as described above. Sections about the size of these cores were collected from a typical branch on each tree for correlative studies on branch and core wood.

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Specific gravity determinations were made by: (1) determining the volume of trimmed, thoroughly-soaked cores (or branch sections) by the water displacement method using a small specific gravity balance and weighing to the nearest 0.01 gms; (2) determining dry weight of the cores after drying overnight at 110° C.; and (3) calculating specific gravity by dividing volume in cc. into dry weight in grams.

In calculating the correlation between specific gravity and vigor index it is necessary to treat the different age-groups separately, since the vigor index of older trees may be greater because of a larger area of cambium rather than of greater actual vigor.

The following table summarizes the results of correlative studies made to date.

Variables	Age group	No• of samples	Value of r of bles Obtained Necessary fo 5% level of significance	
vig. ind sp. gr. core "	6- 7 yr. 14-19 yr. 6- 7 yr. 14-19 yr. both	26 8 26 10 35	-0.2305 0.2351 -0.0647 0.5584 0.2431	0.388 0.707 0.388 0.632 0.325

It will be noted that none of the values of r reach the 5% level of significance, and that the values are negative in the case of the young age group and positive in case of the older age group. No significance is attached to this difference in sign at the present stage of the work.

It is believed that, with larger populations and better conditions of sampling, the correlation between the specific gravity of core and branch wood on the same tree would attain significance. However, it appears doubtful that such correlations would be sufficiently strong to permit the use of branch wood rather than core wood in correlative studies with vigor of tree growth.

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This study on the relationship between

rapidity of growth and specific gravity of the resulting wood is very gratifying in the sense of practical breeding, since the lack of significant correlation indicates that the production of wood by abnormally rapid-growing hybrids does not necessarily imply a lighter, inferior product.

The work herein reported has been greatly facilitated by the assistance given by Mr. R. Packman, who will incorporate the results in a thesis to be presented to the faculty of the Ontario Agricultural College in fulfilment of a requirement for the B.S.A. degree.

APPENDIX "E"

(Dr. C. Heimburger)

Arboretum requirements for forest-tree breeding.

- <u>Purpose</u> To serve as a living collection of biotypes and horticultural varieties and hybrides of native and exotic trees and shrubs of value for forest-tree breeding. Also to be used for purposes of demonstration, phenological observations, and, to a limited extent, for studies of the influence of climatic factors on the material at hand.
- Locality Situation within a climatic region where economic conditions allow the practice of intensive forest management, especially reproductive forestry, or where forest-tree planting is of economic importance for other purposes.
- <u>Site</u> Easy accessibility and a site allowing the normal and and healthy growth of the material desired, are essential. This would include natural protection against late spring and early fall frosts, freedom from drifting soil and sand, dusts, and noxious fumes. The site should be free from the danger of floods, erosion, avalanches.
- <u>Protection</u> Fully adequate protection against trespassing, damage by domestic animals, game, vermin, fire, windfalls from adjacent areas, and possibility of additional intensive protection against insects and fungi-eradication of alternate hosts. Facilities for protection against snow and sleet damage of young material, if desired. Adequate facilities for irrigation and artificial watering in subhumid regions.
- Spacing The material is spaced rather widely; about 20' x 20' at the time of planting seems to be sufficient for most of the species under investigation. The different types are set out in rectangular blocks of 8, 16, 32, etc., and later thinned out, so that at no time there is crowding between the individuals. The size of the blocks is, in part, governed by the maximum size of the species or types in question, at maturity. The specimens should be allowed to develop side-branches right down to the ground and express their inhorent characters in this respect

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to the fullest extent. This induces early flowering, makes climbing and other manipulation easy and facilitates studies of inherent branching habits.

- Arrangement Care should be taken to allow for differences in rate of growth and ultimate size, and shade tolerance, when setting out the material, and in later replacements. Similar attention to differences in site requirements should be given. Ample space for roads in connection with expansion should be allowed.
- <u>Material</u> The material set out is usually carried for another transplanting period in the nursery, i.e., the pines are set out as 1-2-2 and the spruces as 2-2-2 stock. The more rapidly growing poplars can probably be set out as 0-1-1, while some other material of slower growth will have to remain for longer periods in the nursery. Grafting to overcome troubles from sucker growth and differences in lime and other nutrient requirements of some of the material may be used, although it is generally considered an advantage to have the material growing on its own roots.
- <u>Planting</u> In the planting the usual procedure of establishing an orchard is followed. A hole is dug at the exact location of each specimen, and as/rule it is laid out after careful surveying and mapping. The speciments are tied on to a stake until they are fully established. Correct and permanent labels are very important - detailed plans and maps showing the location of each specimen with all pertinent data are of utmost importance.
- <u>Care</u> Full protection against all factors mentioned under "protection". Adequate weeding out of advance growth, volunteer reproduction and sucker growth. Periodic pruning of dead branches; tree repair work.
- <u>Maintenance</u> Sufficient funds to keep the arboretum in good running order are essential. It's better to have a small but good and useful arboretum than a large and neglected one, because of insufficient funds. A co-operative arrangement for the maintenance of a fully adequate and useful arboretum could possibly be arrived at if any one of the co-operating organizations is unable to maintain an arboretum adequately.



Plantations made for the purpose of observing and utilizing segragations for selection work and physiological studies are not included in an arboretum. They can be called <u>physiological test plantations</u> or <u>breeding test plantations</u>, and would include disease gardens.

Silvicultural test plantations (or stands established by other methods then planting) are established for testing of selected material under conditions of current silvicultural practice, allowing for the establishing of sample plots or for other means of observing the performance of the material to be tested. Experimental shelterbelts are included in this class.

Distribution List

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