

IBIC

MONTHLY

**RESEARCH
NOTES**

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BI-MONTHLY

RESEARCH NOTES

A selection of notes on current research conducted by the Forestry Branch,
Department of Fisheries and Forestry of Canada

BIOLOGY

Rooting of Douglas-fir and Western Hemlock Cuttings.—Grafting has been used extensively in propagation of selected Douglas-fir plus trees for the establishment of seed orchards and clone banks. However, many trees propagated by grafting several years ago have shown signs of reduced vigor or have died. In some orchards more than half the trees are affected. The reduced vigor is caused by an unexplained incompatibility between the scion and the root stock. The partial failure in grafting has severely affected the Douglas-fir tree improvement program. Propagation by rooting of cuttings from mature Douglas-fir would eliminate this problem, but a satisfactory rooting technique has not been available. This is a report of one of many chemical and physical treatments which have been tested to promote rooting of such cuttings.

In mid-November 1967, current-year shoots of four Douglas-fir trees more than 100 years old were collected in the lower 1/4 of the crowns. The shoots were cut to about 3-inches in length and leaves were removed from the first 1 1/4 inches from the base. The cuttings were then placed in 100 ppm indolebutyric acid solution for 24 hours. The cuttings were divided into three groups of 50 from each of the four trees and set in flats containing a soil mixture of equal parts of perlite, peat moss and coarse sand. The flats were placed in three greenhouse compartments under the following temperature conditions: air and soil not heated (I); air not heated but soil heated to 20 C (II); both air and soil heated to 20 C (III). The average air temperature (°C) for treatment I were:

| | Dec. 1967 | Jan. 1968 | Feb. 1968 | Mar. 1968 | Apr. 1968 |
|------|-----------|-----------|-----------|-----------|-----------|
| High | 9.4 | 10.0 | 15.0 | 16.1 | 17.2 |
| Low | 4.4 | 4.4 | 6.0 | 8.9 | 8.9 |
| Mean | 6.7 | 7.8 | 10.0 | 12.2 | 12.8 |

The soil was heated with a leaded heating cable controlled by a thermostat. High air humidity was maintained by enclosing the cuttings in a clear polyethylene sheet. The propagation bed was shaded from direct sunlight.

By the end of August 1968, 32, 22, 20 and 18% of the cuttings from the four trees had rooted with treatment II, whereas none had rooted with the other two treatments. Rooting took place mainly in the last half of March and in April, but a few rooted as late as August.

In mid-December, 25 cuttings from each of eight Douglas-fir trees over 80 years old were set in the cold-air warm-soil condition. These trees were of a superior phenotype selected for a tree improvement program. The cuttings, collected in October and stored in polyethylene bags at 2 C, rooted with an average percentage of 20, range 8–40%. Similar cuttings in the other two treatments did not root. The success of treatment II was confined to cuttings collected in the fall and early winter. Those taken in January and up to the time of bud burst did not root well.

In support of a recently initiated tree improvement program for western hemlock in British Columbia, a study on rooting of cuttings of this species was undertaken. Preliminary trials have been made with the same treatments described above. On 4 Dec. 1967, current-year shoots were collected from the lower

part of the crowns of two hemlock trees about 80 years of age. Cuttings were prepared and treated as described for Douglas-fir. From each tree 50 cuttings were set in each of the three temperature regimes. Treatment II was beneficial to rooting of hemlock, but in contrast to Douglas-fir, the best result was obtained with treatment I. For treatments I, II and III, the rooting percentages for one tree were 94, 66 and 32, respectively, and for the other 30, 2 and 0. Many cuttings from the latter tree suffered leaf drop in the first few weeks after collection, which may be the reason for the relatively poor results. Most of the roots on hemlock cuttings appeared in May and June, or about 2 months later than for Douglas-fir.

Several possibilities for improving the rooting technique described are being tested.—H. Brix and H. Barker, Forest Research Laboratory, Victoria, B.C.

ENTOMOLOGY

Pupae of the White-pine Weevil Survive Freeze-drying.—During the preparation of immature insects for reference and display purposes by the freeze-drying technique, and interesting phenomenon was discovered with larvae and pupae of the white-pine weevil [*Pissodes strobi* Peck.]. Two prepupal larvae and nine pupae were removed from infested shoots of white pine from near Normandale, Ont., placed in small vials and stored in a freezer at -23 C for 3 hours. These specimens were then freeze-dried for 18 hours in the vacuum chamber of the freeze-drier. The vacuum ranged from 28 to 40 microns of mercury. Examination of the specimens after they had been removed and exposed to room temperatures for about 3 hours revealed that all nine pupae were still alive. Although the larvae were dead, their bodies were soft with no dehydration apparent. The pupae transformed to adult weevils within 3 days and at the end of 2 weeks the adults were still alive. A group of 12 caterpillars of *Halisdota maculata* Harr. (Arctiidae), that received the same freezing and drying treatment and at the same time, were completely dehydrated and crumbled to powder under light finger pressure.

A second test was made with three *P. strobi* larvae and five pupae from near Sault Ste. Marie, Ont., with the same freezing and drying treatment. Three of the pupae were found to be alive approximately 3 hours after removal from the freeze-drier; two pupae and three larvae were dead but still soft with little or no evidence of dehydration. In subsequent tests insect species from 15 different families representing the orders Hymenoptera, Lepidoptera, Coleoptera and Homoptera were successfully freeze-dried under virtually identical conditions as those survived by *P. strobi*.

The white-pine weevil is a pest of regeneration spruce in the northernmost parts of Ontario and of pine farther south. During the summer, larval and pupal stages exist within infested shoots where the danger of desiccation is slight and the need for cold hardiness unnecessary. Nevertheless, it would appear that the insect possesses hardiness which would, if required, safeguard its survival during late summer and early fall under the severest dry or cold weather conditions likely to occur.—Wm. J. Miller, Forest Research Laboratory, Sault Ste. Marie, Ont.

FOREST PRODUCTS

Nuclear Magnetic-Resonance Studies of the Western Hemlock Lignan α -Conidendrin and its Derivatives.—Although western hemlock [*Tsuga heterophylla* (Raf.) Sarg.] wood and, subsequently, hemlock waste sulfite liquor contains commercial quantities of α -conidendrin (1), no industrial use has been found for this important 4-aryltetra-hydronaphthalene lignan. Attempts to modify and enhance its chemical properties have been made, an example of which is the monosulfonic methyl ester derivative (3) (Barton and Manville, *J. Org. Chem.* 30:659, 1965). The usefulness of nuclear magnetic-resonance spectroscopy (n.m.r.) in elucidating the structure of this derivative was recognized at the time, even though only 60 MHz spectrometers were available. However, with the further development of high-resolution n.m.r. spectrometers and spin-spin decoupling techniques, it became evident that a serious study of the proton assignment of this derivative should be undertaken. This study has now been completed, and has resulted in a revised assignment of the methyl sulfonic ester group from the 8 to the 5' position. [It should be noted that the structure proposed for the sulfonamide derivative (4) (Barton, *Can. J. Chem.* 46:1164, 1968) will also have to be corrected to the 5' substituted analogue.] Valuable new information about the remaining protons, particularly in the aromatic and methoxyl regions, has resulted.

The revised assignment for the structure of (3) from the 8 to the 5' substituted dimethyl α -conidendrin resulted from a detailed proton magnetic-resonance (p.m.r.) study, using a Varian HA-100 n.m.r. spectrometer. This revised assignment was supported by nuclear magnetic-double-resonance (n.m.d.r.) experiments and further supported by synthesizing specifically deuterated analogues of the parent compound, α -conidendrin. A more detailed account of these findings will be reported in a forthcoming publication.

The p.m.r. spectrum of (3) showed all the aromatic protons as singlets (see Fig. 1B). The width at half height was 1.0 — 1.9 Hz, thus substitution must have occurred at either C'6' or C'5' and not as previously stated at C8; otherwise a large ortho coupling of *ca* 8 Hz would have been observed between H5' and H6'. Substitution was much more likely to have occurred at C5' rather than C6' since large steric interactions would result from substitution at C6'.

In accord with this revised assignment (5' substituted) a n.m.d.r. experiment was performed, in which the decoupling field ($\frac{\gamma H_2}{2\pi} = 13$ Hz) was located in the region of C1 methylene resonance ($\tau 6.86$). It caused *one and only one aromatic* transition to become sharp. Figure 1A shows the result of this experiment and identifies the resonance at $\tau 3.33$ as being that of H8. It is unlikely that any other aromatic proton would couple appreciably (> 0.1 Hz) with this methylene group, since all other aromatic protons are separated by five or more bonds. In a second such experiment, the C4 methine proton ($\tau 4.98$) was irradiated ($\frac{\gamma H_2}{2\pi} = 13$ Hz). Figure 1C shows the result of this experiment.

Again only one transition became sharp; it was assigned as H5. No long-range coupling was detectable between H4 and either H2' or H6'. This result indicates that this coupling is stereospecific and therefore H4 only couples effectively with that aromatic proton which is in a preferred orientation (H5). The two remaining transitions at $\tau 2.5$ and 3.45 were assigned to H6' and H2' respectively; based on the observation that (Corio and Dailey, *J. Am. Chem. Soc.*, 78: 3043, 1956) aromatic protons ortho to electronegative substituents are strongly deshielded, whereas those that are meta or para are little affected.

After identifying the low-field transitions in this manner, it was then possible to identify the methoxyl resonances using n.m.d.r. techniques. An observable coupling through five bonds

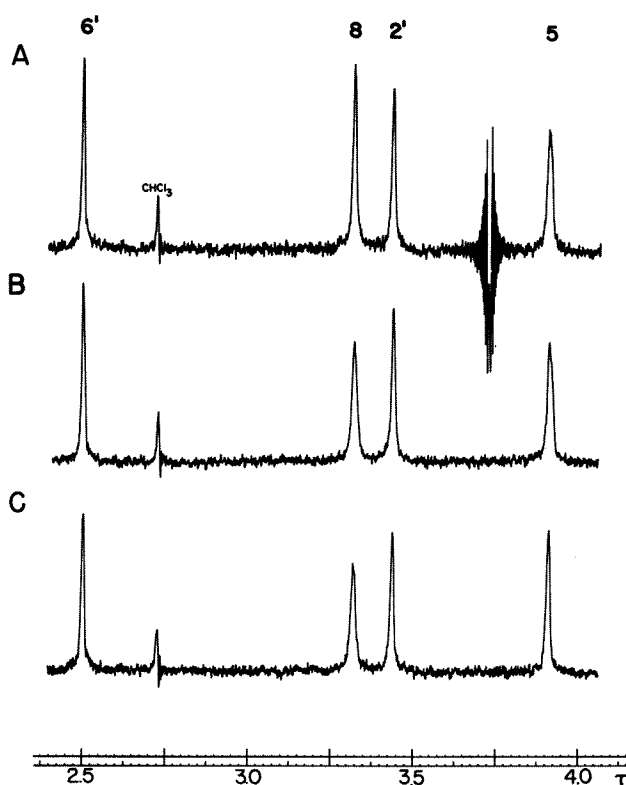
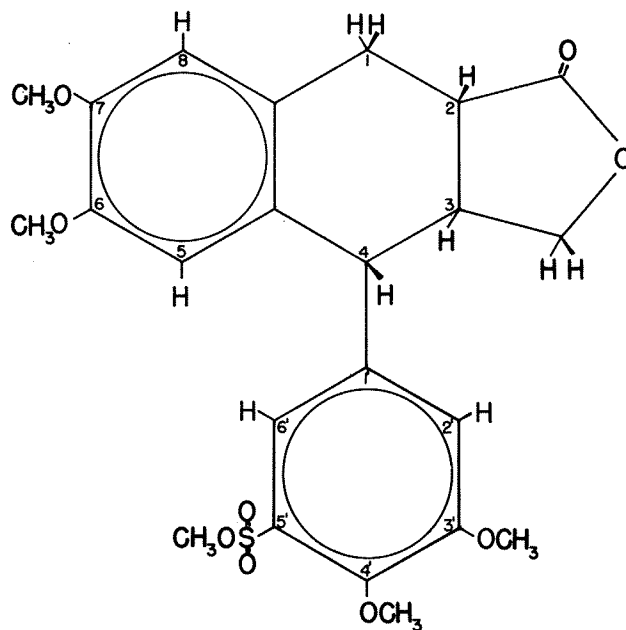


FIGURE 1. Partial 100 MHz p.m.r. spectra of dimethyl α -conidendrin-5'-methyl sulfonate (3) in CDCl_3 : (A) with an irradiating field centered at $\tau 6.86$, the zero beat pattern at $\tau 3.75$ is a spurious beat; (B) normal spectrum; (C) with an irradiating field centered at $\tau 4.98$.

Erratum

Vol. 25, p. 4, col. 1, Table 1: In first line of first column, for 0.5g read 5.0g.

TABLE 1
Proton Assignments for α -conidendrin and its derivatives

| Compound | Aromatic Protons | | | | | Methoxyls in τ units | | | | |
|---|------------------|-------------|-------------|-------------|-------------|---------------------------|---------------------------|-------------|---------------------------|-------------|
| | 5 | 8 | 2' | 5' | 6' | 6 | 7 | 3' | 4' | 5' |
| α -conidendrin (1) $R_1 = R_2 = R_3 = H$ | 3.88 (s) | (3.30-3.44) | 3.35 (d) | (3.30-3.44) | | 6.32 (s) | 6.32 (s) | | | |
| Dimethyl α -conidendrin (2) $R_1 = R_2 = CH_3; R_3 = H$ | 3.66 (s) | 3.30 (s) | 3.39 (d) | 3.13 (d) | 3.26 (q) | 6.41 (s) | 6.14 (s) | 6.20 (s) | 6.12 (s) | |
| Dimethyl α -conidendrin 5' sulfonic (3) acid methyl ester $R_1 = R_2 = CH_3; R_3 = SO_2CH_3$ | 3.93 (s) | 3.33 (s) | 3.45 (s) | | 2.50 (s) | 6.45 (s) | 6.15 (s) | 6.26 (s) | 6.15 (s) | 6.05 (s) |
| Dimethyl α -conidendrin 5' sulfonamide (4) $R_1 = R_2 = CH_3; R_3 = SO_2NH_2$ | 3.85 (s) | 3.28 (s) | 3.40 (s) | | 2.60 (s) | 6.64 (s) | 6.32 or 6.24 (s) | 6.40 (s) | 6.32 or 6.24 (s) | |

Legend: s = singlet
d = doublet
q = quartet.
Solvent-deuteriochloroform except (1)
which was deuterated dimethylsulphoxide.

of ca 0.07 Hz was found to occur between the methyl hydrogens and that aromatic proton in an ortho position. The methyl hydrogens of the sulfonic ester group also displayed an observable coupling, through six bonds, with H_{6'}. Some of the results of this investigation are recorded in Table 1.

It is evident from this study that if spin-spin decoupling techniques are applied to other lignans, valuable new information about the assignment of their aromatic and methoxyl protons will result.—J. F. Manville and G. M. Barton, Forest Products Laboratory, Vancouver, B.C.

MENSURATION

Competitive Influence-zone Overlap: a Competition Model for Individual Trees.—In the past decade, renewed attention has been focused on the study of individual tree growth as a means of gaining insight into stand development processes of interest to both the forest scientist and the forest manager. Smith (Proc. Soc. Amer. Forest., 1964) gave a detailed outline for possible applications of this approach.

The chief difficulty in these studies lies in converting individual tree data into useful stand parameters. The problem arises from the intricate, often competitive interrelationships which exist between trees growing in closed stands. With the exception of a minor "random" element, the growth, survival and death of each tree depends on its competitive status in the stand.

Many studies have been conducted to quantify competition effect from trees around an individual. Many of these use various expressions of basal area (an average stand parameter) to describe competition, and they assume a linearly additive type of competition effect between competing tree and competitors (Lemmon and Schumacher, Forest Sci. 8, 1962; Spurr, Forest Sci. 8, 1962; Steneker and Jarvis, Forest. Chron. 39, 1963). However, such models would only be effective if all trees—the subject tree and competitors alike—were of equal size.

Other investigators have recognized the well established concept of "zone of influence" or crown overlap in evaluating competition (Staebler, Unpubl. thesis, Univ. Mich. 1951; Newnham, Bi-Mon. Res. Notes 22:4-5, 1966; Opie, Forest Sci. 14, 1968). Of these, Opie's zone count model, which although ecologically derived, accounts for approximately the same amount of variation in tree basal area growth as some of the earlier approaches.

As an extension of the influence-zone concept the writer has advanced the hypothesis: Competition effect on a competing tree is proportional to the amount of influence-zone overlap of the competitors and that of the competing tree, whereas the actual contribution of a competitor is dependent on the relative sizes of the competitor and the competing tree, exponentially weighted. The essence of this hypothesis is the exponential weighting of the relative sizes of the competitors and the competing tree.

Symbolically:

$$CIO_i = \sum_{j=1}^n \left(\frac{ZO_{ij}}{ZA_i} \right) \times \left(\frac{R_j}{R_i} \right) EX \dots\dots\dots 1$$

- where CIO_i = competitive influence—zone overlap for competing tree i
- n = number of competitors whose zone intersects that of the competing tree
- ZO_{ij} = area of zone overlap between competing tree i and competitor j
- ZA_i = area of zone of influence of competing tree i
- R_j = radius of influence of competitor j
- R_i = radius of influence of competing tree i
- EX = exponent, generally greater than one and characteristic of the species tolerance.

Figure 1 shows schematically the potential zone of influence of the competing tree, those of the four competitors, and the zone overlaps.

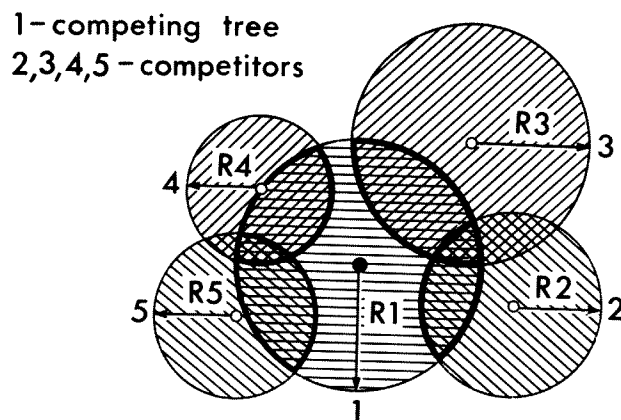


FIGURE 1. Amount of zone overlap for a competing tree with four competitors. This value is used for calculating CIO (see text).

This hypothesis was tested with permanent plot data from pure, even-aged, fully stocked, untreated stands of aspen (14 years old at plot establishment) and jack pine (11 years). Following the initial measurement, three subsequent remeasurements were conducted on each plot at 5-year intervals.

It was assumed that zone of influence of a species is related to its open grown crown size for a given stem diameter adjusted by a factor characteristic of the species, and possibly affected by

site. A factor greater than one means that competition would commence before open growing tree crowns come in contact with each other. In symbolic form:

$$\begin{aligned} CR &= (a + bD)/2 \dots\dots\dots 2 \\ R &= CR \times FC \dots\dots\dots 3 \end{aligned}$$

where CR = open grown crown radius
D = diameter at breast height
a, b = regression coefficients
R = radius of influence or competition
FC = adjusting factor.

The following CR-D regressions for open grown trees were derived:

aspen: $CR_A = (3.63 + 1.61 \times D)/2$ with $r = 0.95$; $n = 66$
jack pine: $CR_P = (2.77 + 1.73 \times D)/2$ with $r = 0.90$; $n = 148$

Values for FC and EX were obtained by computer simulation. A computer program was written with inputs of rectangular tree coordinates, and diameter for each remeasurement. CIO values were calculated in turn for each tree for the beginning of the growth period, and were outputted with relevant diameter (D inc) and basal area (BA inc) increment figures. This output was analysed using two oversimplified growth-competition regressions of the form;

$$\begin{aligned} D \text{ inc} &= a + b_1(CIO) + b_2(CIO)^2 \dots\dots\dots 4 \\ BA \text{ inc} &= a + b_1(CIO) + b_2(CIO)^2 \dots\dots\dots 5 \end{aligned}$$

Initially, various combinations of FC and EX were used for calculating CIO-s for each tree, with both parameters covering a reasonably wide range of values. Fitting growth-competition regressions to different sets of CIO estimates, the effectiveness of corresponding FC and EX values could be evaluated by comparing correlation coefficients (R or r). High coefficient values indicated optimum region for FC and EX. Then it was possible to "narrow in", with further simulations, on the best parameter values allowed by the sensitivity of this method. These were;

aspen: FC = 1.8 EX = 4.5
jack pine: FC = 1.7 EX = 2.5

The present model with these FC and EX parameters for the two species, and with the calculated CIO values combined in the above growth-competition regression equations, accounted for as much as 70% of the variation in individual tree basal area increment. Table 1 shows relevant regression statistics.

All the regressions, and both independent terms, were highly significant (1% level). The consistently high significance of the second degree term indicates a flattening-out of the regression at higher values of CIO. This suggests that a number of

TABLE 1

Growth-competition regression statistics for aspen and jack pine trees (permanent sample plot data with 3, 5-year growth periods).

| Dependent variables and growth periods | Independent variables and their significance | | | | | | |
|--|--|----------------------------|--|----------------------------|----|------------------------|------|
| | X ₁ = CIO | | X ₂ = X ₁ ² | | | Number of trees living | R |
| | Regression coeffs. and F-ratios | | F-ratios | | | | |
| a | b ₁ | F _{X₁} | b ₂ | F _{X₂} | | | |
| Aspen | | | | | | | |
| GP1 D inc | 1.15 | -0.0676 | 138 | 0.00109 | 54 | 328 | 0.64 |
| BA inc | 6.48 | -0.4415 | 153 | 0.00726 | 62 | 328 | 0.66 |
| GP2 D inc | 0.91 | -0.0515 | 159 | 0.00075 | 59 | 209 | 0.79 |
| BA inc | 7.03 | -0.4613 | 180 | 0.00720 | 77 | 209 | 0.78 |
| GP3 D inc | 0.71 | -0.0437 | 113 | 0.00053 | 43 | 152 | 0.70 |
| BA inc | 6.50 | -0.4350 | 117 | 0.00541 | 47 | 152 | 0.71 |
| Jack pine | | | | | | | |
| GP1 D inc | 0.82 | -0.0662 | 93 | 0.00134 | 46 | 244 | 0.66 |
| BA inc | 4.73 | -0.4238 | 175 | 0.00900 | 94 | 244 | 0.75 |
| GP2 D inc | 0.49 | -0.0372 | 75 | 0.00066 | 35 | 197 | 0.67 |
| BA inc | 3.35 | -0.2784 | 98 | 0.00532 | 52 | 197 | 0.69 |
| GP3 D inc | 0.98 | -0.0911 | 77 | 0.00207 | 32 | 124 | 0.77 |
| Ba inc | 8.38 | -0.8709 | 151 | 0.02148 | 75 | 124 | 0.84 |

suppressed trees, representing a wide range of high CIO values, maintain relatively low rates of growth, a tendency that has been well established by many forest growth studies.

The effectiveness of CIO was compared with that of other models by using the same data. As Opie demonstrated his zone-count method to be at least as efficient and precise as any previous models, only a version of this model was used in the comparison. For those aspen and jack pine data, the zone count model (in combination with equation 5) accounted for a maximum of 12% of the variation in basal area increment as compared to 70% accounted for by the present CIO model. It may be concluded that the results of this analysis support the above stated hypothesis.

This analysis is based on data from only one plot for each species, with a limited range of competition levels. Future work will test the effectiveness of CIO for a wide range of competition levels and species. Also, the influence of age and site will be investigated.—I.E. Bella, Forest Research Laboratory, Winnipeg, Man.

PATHOLOGY

Mycostasis in Extracts From Different Soils.—In the well known studies of Dobbs and co-workers (reviewed by Vaartaja and Agnihotri, *Phytopathol. Z.* 60:63-72, 1967), the mycostatic principle was unstable and difficult to extract from soils. Due to the negative results of many other authors and the large variation reported by Dobbs et al., the inhibition in extracts have been mostly ignored in literature. Therefore, it is urgent to test whether the fairly stable mycostasis in the extractions by Vaartaja and Agnihotri (*loc. cit.*), was limited to one soil (Midhurst Nursery, Ontario) during one season, 1965.

Samples were collected from surface soils of 0-5 cm depths. Within a few days the samples were spread 5 cm deep over a nylon mesh in glazed Buchner funnels, each with a surface area of

TABLE 1

Linear extension, as per cent of controls, of *Pythium ultimum* colony on agar amended (1:1) with sterile extracts from different Ontario soils.

| Time | SOIL | | Type | GROWTH % |
|--|------------------------------|------|---------------------------|------------|
| | Locality | | | |
| Oct. 1967 | Midhurst | | sandy nursery | 5 |
| Nov. 1967 | Maple | | sandy nursery | 10 |
| May 1968 | Maple | | garden loam | 0 |
| | Maple | | cultivated loam | 10 |
| | Maple | | sand under pines | 15 |
| | Maple | | cultivated loam | 27 |
| | Maple | | sandy pasture | 42 |
| | Maple | | hemlock humus | 62 |
| | Maple | | mixed sands | 77 |
| | Muskoka | | sphagnum | 89 |
| | Maple | | sand under litter | 92a |
| | Chalk River | | mulched sand | 92 |
| Pembroke | | peat | 131 | |
| Aug. 1968 | Chalk River | | sandy nursery | 10 |
| | Kemptville | | sandy nursery | 20 |
| Stored moist at 25 C | — | | mixture of forest sands | 19 |
| | Chalk River | | sandy nursery— | 45 |
| Randomly timed extractions from one stored soil | Midhurst | | sandy nursery | 27 ± 17 |
| | (avg ± S.D. for 10 extracts) | | | |
| Avg. ± S.D. for 10 simultaneous tests of one extract | | | | 31.0 ± 2.1 |
| May 1969 | Ottawa | | cultivated clay | 12 |
| | | | sand under maple + humus | 116 |
| | | | sand under cedars + humus | 54 |
| | | | sandy loam pasture | 30 |

¹The first two and last four extracts were not sterile but bacterial numbers were limited with centrifugation at 1000 g for 10 min. The bacteria remained inactive not affecting *Pythium* significantly; other extracts were sterilized with heat or Millipore filtration.

^aSoil noticeable cool when sampled.

100 cm². The soil samples were irrigated with distilled water to approximate saturation followed by daily applications of 125 ml of distilled water, or the equivalent of 1.25 cm of rain. The funnels were kept at about 25 C. Soil extracts percolating through were collected in sterilized flasks standing in baths of ice water, and were tested for inhibition of *Pythium*, usually within an hour. In the tests, 4% "purified" (Bacto) or Ion (Oxoid) agar was autoclaved, cooled to 60 C, mixed with an equal amount of the extract in a petri dish, and allowed to solidify. Two or three inoculum pieces, 12 mm in diameter, from a 10-day old water agar culture of *Pythium ultimum* Trow, were then transferred to each dish. After incubation for 24 hr at 25 C the average linear extension of the colonies was measured and expressed as a percentage of the controls in which distilled water was used instead of soil extract.

In some tests bacteria and other fungi were especially studied. Their growth was usually negligible due to an inhibitory effect of the extract itself or the short duration of the test and lack of nutrients. In the tests shown in Table 1, bacteria were reduced by centrifuging the extract for 10 min at 1000 g, or were eliminated by heat or Millipore filtration. Care was exercised to avoid accidental interference of *Pythium* growth by rapid increases of bacteria in condensation water. Inhibition of *Pythium* was seen most clearly on Ion agar, which was found to be the most suitable among various media tested.

The test organism, culture (No. 9248), used was selected because of its small nutrient requirements, its rapid growth on water agar, and its sensitivity to inhibitory effects.

The results (Table 1) indicate that soils of different kinds generally contained solutions which inhibited *P. ultimum in vitro*. The degree of the inhibition varied greatly between the soils and between sampling times in one soil. Such variation was due to differences in the inhibition itself and not to experimental errors in the tests, as these were relatively small.

Decreased linear growth was the most obvious and useful expression of the inhibition; the mycelium was also less dense and autolysis took place earlier in tests with strongly inhibitory soil extracts. The sensitivity of the test organism probably facilitated the observation of the differences.

Because the rapidity with which the inhibitory activities of soil flora respond to changes in physical factors and the time needed to reach equilibria are not known, these results show only that there are differences among soil.—O. Vaartaja, Sault Ste. Marie, Ont.

Chronology of Pole Blight Lesions of Western White Pine in British Columbia.— Pole blight, a disease causing premature decline and death of immature western white pine [*Pinus monticola* Dougl.], appears to be linked with climatic change. Unfortunately no records indicate precisely when pole blight first occurred. It was well established in Idaho by 1938 (Erlich and Baker, Univ. Idaho, Sch. Forest., Typed Report, 1942). Buchanan et al. (Phytopathol. 41:199-208, 1951) believed it had been present from the late 1920's. In British Columbia, pole blight must have begun some time before it was recognized in 1949 because dead trees with pole blight symptoms were already evident (Parker et al., Can. Dep. Agri., Div. Botany Plant Pathol., Forest Pathol. Note No. 3, Victoria, Mimeo. 1950).

Pole blight lesions provide a useful index for dating disease incidence because they are sufficiently durable that their date of origin can be established many years later. These elongate, fusiform patches of dead bark and wood, are the most specific symptom of the disease (Buchanan et al. (*loc. cit.*)).

The dates of origin of 189 pole blight lesions were determined from trunk sections collected from 127 white pine trees. Trees were sampled in 20 widely scattered stands in the Columbia Forest Region. The average age of trees in the stands sampled ranged from 55 to 130 years in 1967. Lesions were dated by subtracting the number of annual rings since lesion occurrence from the date of sampling, or in dead trees, from the date of death. If unknown, the date of death was estimated, in some cases, by comparing the state of the dead crown with the crowns of trees whose date of death was known from sample plot observations, and in other cases, from known dates of mountain pine beetle

infestations. Most dates of lesions originating before the last three decades were from living trees, because sufficient accuracy in dating trees which had been dead for many years could not be assured. Omitting trees that had been dead for a long time undoubtedly resulted in underestimation of the incidence of old lesions. The frequency of lesions originating many years ago was also likely to be underestimated because some were completely overgrown and externally unrecognizable.

The incidence of trees which developed lesions each year from 1900 to 1967 was expressed as a percentage of the number of sample trees which were between 28 and 114 years old in any given year (Fig. 1). In 1912, for example, incidence was 3%—two lesions originated among the 68 sample trees which were between 28 and 114 years old. In 1942, 124 of the trees sampled fell within this range. Consequently, six trees with lesions originating in that year represented an incidence of 5%. By 1966, the number of living sample trees less than 114 years old had dropped to 52. Percent incidence was based on the number of sample trees between 28 and 114 years old, in each year, because no lesions had originated in the trees sampled when they were younger or older than these ages. A tree was counted as lesioned only once in any given year regardless of the number of lesions which had developed in that year. It was counted a second time if another lesion had occurred in a different year.

An appreciable number of lesions originated in the early 1920's (Fig. 1), several years earlier than the date (1927 or 1928) suggested by Buchanan et al. (*loc. cit.*) as the time when pole blight was first evident. The development of lesions shortly after 1916 (the beginning of a succession of hot, dry summers that persisted for a number of years) provides better evidence of the congruence of pole blight with climatic change than was previously available.

Although the frequency of lesions shown for the 1920's is likely to be low due to the sampling constraints referred to, underestimates should decrease progressively in later years. Consequently if pole blight incidence were constant with time, a gradual increase in the frequency of lesion occurrences could be expected. The lack of such an increase in the 1930's (Fig. 1) suggests that a reduction in pole blight incidence may in fact have occurred during this period. On the other hand, the increase in lesion occurrences by the late 1940's is probably sufficiently great to indicate that pole blight had by then become more frequent than in previous period. A high incidence of pole blight may have occurred later in British Columbia than in Idaho, where the disease had already attracted attention in the 1930's (Erlich and Baker *loc. cit.*).

The continuance of lesions until 1967, the year that sampling was completed, shows that conditions for their development persisted despite a reduction in the frequency of hot, dry summers (McMinn and Molnar, Can. Dep. Agri., Forest Biol. Div., Bi-Mon. Progr. Rep. 15(1): 2-3, 1959). Perhaps when white pine has been exposed to moisture stress for many years, as seems to be the case in the Interior Wet Belt, pole blight eventually develops in susceptible trees even when drought conditions are only periodic. In a few recent cases, lesions occurred without pronounced crown symptoms of pole blight. The limited development of such symptoms on these trees may reflect the reduced frequency of moisture stress in recent years. The occurrence of lesions in 1912, in two trees which continued to live for more than 40 years, might also reflect a stress sufficient to cause lesions but insufficient to cause death of trees.

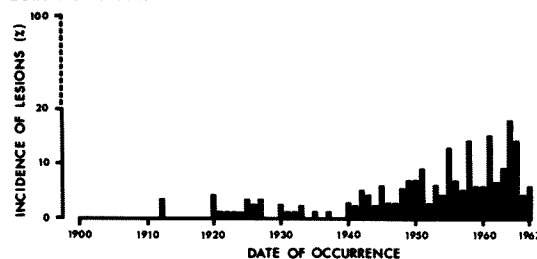


FIGURE 1. Incidence of pole blight lesions from 1900 to 1967. Percentages are based on the number of white pine sample trees which were between 28 and 114 years old in any given year.

Further analysis of the chronology of lesions and their relation to climatic events should provide more insight into the circumstances causing pole blight, and the significance of weather and decline diseases. — R. G. McMinn and M. A. Grismer, Forest Research Laboratory, Victoria, B.C.

SILVICULTURE

Conifer Reproduction in Old-Field Spruce Stands in the Maritimes.— Old-field spruce stands, so-called because they develop on abandoned agricultural lands, are a significant part of the forests of the Maritime Provinces. Drinkwater (Can., Dep. North. Aff. Natur. Resources, Tech. Note 65, 1957) estimated that such stands, usually white spruce with associated other conifers, occupied approximately 500,000 acres in Nova Scotia alone. Large areas of abandoned farmland in southeastern New Brunswick and on Prince Edward Island also support old-field spruce.

Many landowners and foresters believe that the advance growth of spruce and fir that is present in most mature old-field stands is sufficient to form new coniferous stands when the old material is clear felled. In 1957, however, Drinkwater observed the inadequacy of natural regeneration in old-field stands and suggested an objective survey. Whether cut-over old-field spruce stands reproduce to conifers or not, is of particular importance at present because thousands of acres of such stands are clear-cut annually for pulpwood.

A survey was conducted in 1962 and 1963 to obtain objective data on advance growth and regeneration in uncut and clear-cut mature stands of old-field spruce. Reproduction was assessed on 11 uncut areas in either pure white spruce [*Picea glauc* (Moench) Voss] or white spruce — balsam fir [*Abies balsamea* (L.) Mill.] stands (occasionally red spruce [*Picea rubens* Sarg.]), aged 40 to 75 years, and in eight clear-cut areas in similar stands located

The combined stocking of spruce and balsam fir indicates that only four of the uncut stands and three of the cut-overs were fully or well stocked to coniferous reproduction. In addition, two uncut stands and one cut-over had moderate stocking or reproduction. Coniferous reproduction was either low or a failure on the remaining nine.

Although both spruce and fir repeatedly seed in under the mature overstorey, the seedlings rarely live more than a few years. Therefore, when the old stand is cut, the advance growth either occurs in inadequate numbers or it lacks the necessary vigor to stock the area. Regeneration following logging is usually insuffi-

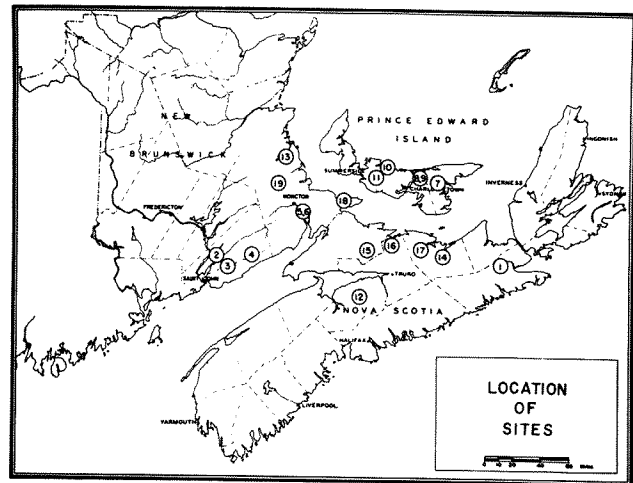


FIGURE 1. Location of sample areas.

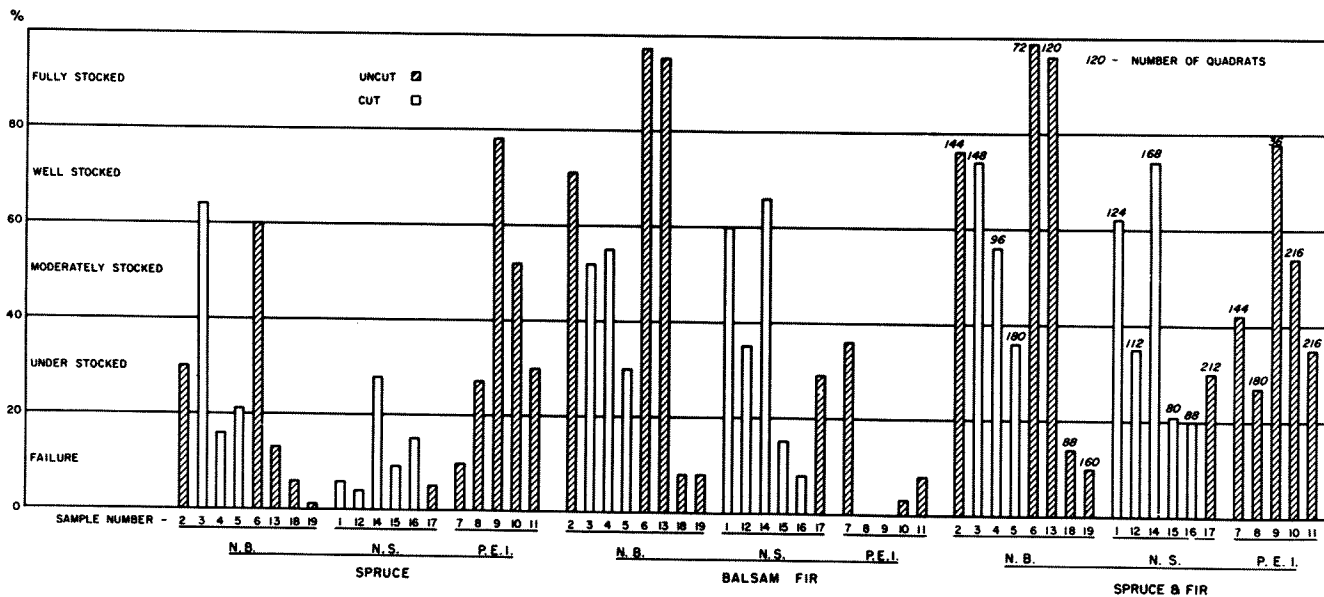


FIGURE 2. Stocking percentages for spruce, balsam fir, and spruce and balsam fir.

in southeastern New Brunswick, central Nova Scotia, and on Prince Edward Island (Fig. 1).

Individual stand descriptions and an interpretation of the results obtained in the survey have been described (Jablanczy, Can., Dep. Fish. Forest., Intern. Rep. M-44, 1969). Wide variations in stocking with spruce and balsam fir reproduction were evident for both uncut and clear-cut stands (Fig. 2). Of the 11 uncut stands, only one was well stocked and only two were moderately stocked with spruce advance growth: the remaining eight were either understocked or failures. Only one of the eight cut-overs was well stocked to spruce reproduction.

cient to compensate for the losses caused by logging damage and by subsequent drying of the forest floor. On the better sites, advance growth usually includes tolerant broad-leaved species, while intolerant broad-leaved species invade many cut-overs. Jablanczy (*loc. cit.*) reported that on four of the eight cut-overs a heavy invasion of maple, birch, and aspen occurred in the first 2 years after felling.

Conifers will form the next crop in only a portion of the clear-felled old-field spruce stands. Frequently mixed-woods, and occasionally broad-leaved species, will form the next crop. — A. Jablanczy, Forest Research Laboratory, Fredericton, N.B.

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