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RESEARCH NOTES

A selection of notes on current research conducted by the Forestry Branch, Department of Forestry and Rural Development

BOTANY

The Use of Compressed Air to Excavate Roots of Forest Trees.—The difficulty inherent in obtaining complete data on root systems of forest trees using laborious manual excavation techniques has been outlined by Laitakari (Acta For. Fenn 33, 1929). Hawboldt (J. Forestry 45, 1947) and McMinn (Can. J. Botany 41, 1963) greatly reduced excavation time through the use of hydraulic equipment but the technique is restricted to areas having an adequate and available water supply. Studies in Australia (Agric. Gaz. N.S. Wales (Suppl.) 57, 1946) suggested that compressed air might serve as an alternative to hydraulic pressure and overcome the restriction of adequate water. The usefulness of compressed air for forest tree root excavation was consequently tested.

Equipment consisted of a trailer-mounted Jaeger compressor rated at 100 psi delivery pressure, three 50-foot lengths of ¾-inch pressure hose, and a 5-foot piece of galvanized pipe crimped at one end to serve as a nozzle. The pipe was fitted with a shut-off valve to regulate air pressure.

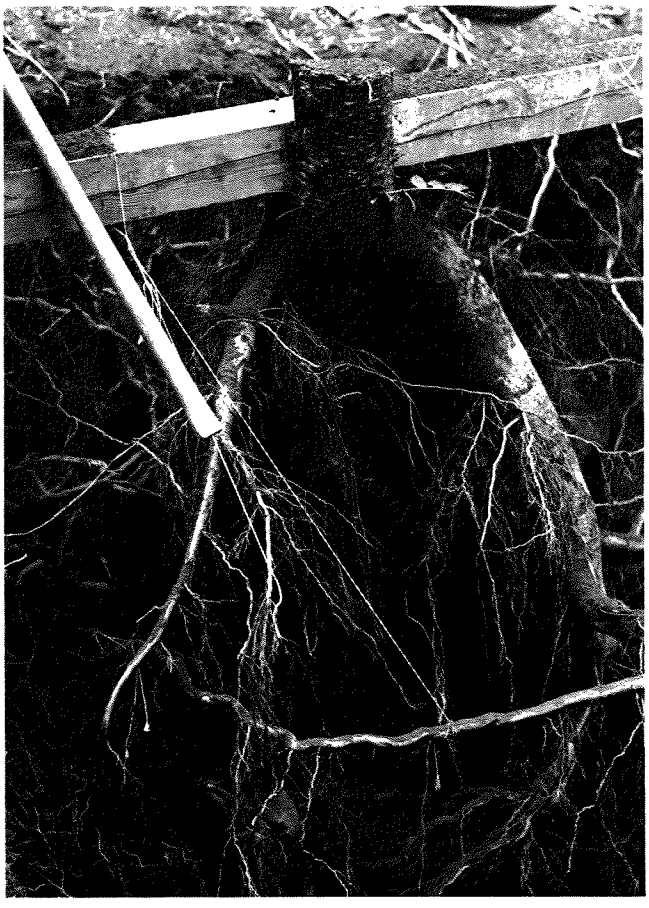

FIGURE 1. Root system exposed by compressed air showing technique of holding stump upright and the nozzle used.

The root systems of trees approximately 25 ft in height and 3 inches in diameter were excavated on two sites. The soil on each site was a relatively dry sandy loam interspersed with rocks of various sizes. The ground cover, consisting of *Mahonia* spp., bracken (*Pteridium aquilinum* (L.) Kuhn), and salal (*Gaultheria shallon* Pursh.) was sparse on the first site but on the second formed a dense subsurface mat of intermingled roots.

Under the conditions of the experiment the technique was considered to be successful. The compressed air removed litter and duff layers, cut around embedded rocks, and exposed the roots of the trees and ground vegetation (Fig. 1) with little difficulty. The time required to excavate the root systems was comparable with that using hydraulic techniques. Although abrasion caused some damage to fine rootlets it might be reduced by utilizing pressures lower than the 70 psi used in these tests. Accumulation of loosened soil in the work area caused a little inconvenience in that it had to be removed manually from where the air blast deposited it. Where excavation sites are extensive the use of small, movable conveyor belts might minimize the difficulty. Further testing is necessary to determine the applicability of the method to a variety of soils and ground cover types.—L. C. Weir, Forest Research Laboratory, Victoria, B.C.

ENTOMOLOGY

Detection and Appraisal of Damage by Balsam Woolly Aphid on *Abies balsamea* (L.) Mill. by Means of Aerial Photography.—The application of aerial photography for detection and appraisal of damage by balsam woolly aphid, *Adelges piceae* (Ratz.), on balsam fir trees in Newfoundland was investigated. The following five commercially available Kodak films were used: Plus-X, Tri-X, High Speed Infrared (with a Kodak Wratten Filter No. 89B), Ektachrome and Ektachrome Infrared. Each of these films was used for photography at scales of 1:720, 1:1,200, 1:5,000, 1:10,000 and 1:15,840. Following is a brief synopsis of the results obtained. A more detailed review of the investigation will be published elsewhere.

Damage data for 207 individual balsam fir trees and for 94 one-tenth acre sample plots were collected in the field and interpreted on the various sets of aerial photographs. The individual tree data were analysed using simple linear regression analysis, while for the plot data chi-square tests were used. The collected field data were also analysed to provide information on the existing relationship between the extent of tree damage and topography, physiography and individual tree characteristics.

The statistical analyses revealed that different damage conditions of trees can be interpreted most accurately on the 1:720 scale Ektachrome Infrared Film. The accuracy of photo interpretation was 63% when seven injury classes were used, and 90% when some of these classes were combined forming the following four: not infested, light to moderate dam-

age, severe damage, and dead. This film proved to be best at all scales for interpretation purposes. The analysis of plot data indicated that the High Speed Infrared Film at 1:720 and 1:1,200 scales provided a good estimate of ground conditions. The degree of damage was not found to be correlated with physiographic units and individual tree characteristics.

On the basis of results and on the experience of the photo interpreter, methods will be proposed for detection of early stages of injury and for the appraisal of damage by injury classes. These methods would require the use of Kodak Ektachrome Infrared Film for scales of 1:1,000 and 1:10,000. The appraisal of damage by injury classes and volume should be carried out using one-tenth acre ground and photo plots on the large scale photographs with the application of the method of "double sampling with regression."—Denes Bajzak, Newfoundland Region, St. John's, Nfld.

Freeze-drying Insect Larvae.—Conventional methods of preparing larval specimens for study and for reference collections usually include the use of one or more chemicals as preservatives, or the inflating and drying of larvae following removal of body contents. These methods often distort or conceal important morphological characters and alter coloration. Woodring and Blum (Ann. Ent. Soc. Amer. 56 (2): 138-141, 1963) described in detail a freeze-drying unit and the techniques necessary to produce durable specimens with good retention of morphological characters and colours.

In 1965, a freeze-drying unit was assembled on a two-shelved steel cart. The components used were a freeze-dryer[1], a vacuum pump[2], a McLeod vacuum gauge and several evaporator flasks. Although this unit has worked well, experience has indicated that a compact and mobile freeze-drying unit containing an electric vacuum gauge and a dial type thermometer would be desirable.

Larval specimens selected for freeze-drying are stored in shell vials stoppered with a cotton wool plug and placed in the evaporator flasks, which are held in the freezing compartment of a refrigerator at a temperature of 0° to 10°F. Frozen larvae have been retained in this condition for 1 month before drying. The evaporator flasks are wrapped in cotton wool to reduce the absorption of heat from the room during the drying process. The insulation prevents the specimen from thawing and ensures good results, but it lengthens the drying time. Larvae generally adopt a natural pose as they freeze, but a particular posture can be manipulated by chilling the specimen at 34°F, then freezing immediately. Drying time may take up to 72 hours, but many specimens can be dried in 48 or fewer hours. To ensure proper operating efficiency the freeze-dryer should be in operation for several minutes before the evaporator flasks, with the frozen larvae, are attached to the ports.

The dried specimen may be mounted by cementing it with shellac gel to a small polyporus strip carried on a No. 3 pin. In most cases dried larval specimens are almost indistinguishable from their living counterparts. They are durable, retain their colours better than inflated larvae, and keep their morphological characters intact. They have exhibited no tendency to absorb moisture. The preparation of large numbers of specimens is simple and straightforward and is thrifty of time in assembling a reference collection of larvae.

Forest pathologists of the Forest Insect and Disease Survey found the freeeze-drying unit equally effective in the drying of fungal fruiting bodies. The technique is potentially useful for other botanical and zoological specimens.—G. R. Underwood and F. A. Titus, Forest Laboratory, Fredericton, N.B.

[1] Model F.D.-Port freeze-dryer, Thermovac Industries Corporation, 41 Decker Street, Copiague, Long Island, New York, U.S.A.

[2] Model 1405 H Duo Seal vacuum pump. The Welsh Scientific Company, Skokie, Illinois, U.S.A.

Laspeyresia piperana* (Kft.) in Cones of Ponderosa Pine, *Pinus ponderosa Laws.—Insect-caused seed losses in ponderosa pine in British Columbia are due almost entirely to the cone moth *Laspeyresia piperana*.

The moth emerges in spring to lay its eggs near the base of the second-year cones. Within 1 or 2 days of hatching the larva migrates between cone scales to locate and enter a seed. Entry is always made at the micropylar end. Uusually only one larva enters a seed, but when more than one enters, only one survives. Feeding continues in this seed until the larva has passed through several instars, when it begins to migrate from one seed to another, feeding on the endosperm. By late summer all larvae have tunneled into the cone axis and remain as fifth-instar larvae until the following spring. Pupation and emergence occur in spring.

Data in Table I, obtained from cones collected in different localities in interior British Columbia, show that percentage cones infested by the cone moth is generally very high. Even in 1965 when cones were particularly abundant, 90% were infested.

Table I

Damage by *Laspeyresia piperana* in ponderosa pine cones

Year	No. cones examined	Cones infested	
		No.	%
1961	10	8	80
1962	20	19	95
1964	19	19	100
1965	29	24	90

Six cones examined in 1965 were infested with an average of 14 larvae per cone. These larvae destroyed 45.8% of the seed. However, as ponderosa pine is an excellent seed producer, 56 seeds per cone remained unharmed.—A. F. Hedlin, Forest Research Laboratory, Victoria, B.C.

First Record of Larch Casebearer on Western Larch in British Columbia.—The larch casebearer (*Coleophora laricella* (Hbn.), introduced from Europe some time during the latter part of the 19th Century, initially attacked tamarack (*Larix laricina* (Du Roi) K. Koch in eastern United States and spread to central Minnesota and southeastern Manitoba. In 1957 an infestation covering 170 square miles was discovered in western larch (*Larix occidentalis* Nutt.) in Idaho and by 1963 it had dispersed over 7,500 square miles in the Idaho panhandle, northern Washington and northwestern Montana (Denton, R. E. 1965. Larch casebearer in western larch forests. U.S.D.A. Forest Pest Leaflet 96, 6 pp.).

The insect was first collected in British Columbia near Rossland on June 2, 1966. To determine the limits of distribution along the International Boundary and in southern British Columbia, western larch stands in the valleys of the Kettle, Pend 'Oreille, Salmo, Kootenay and Yahk rivers, were examined carefully. The largest populations were in the Creston area and in the Salmo and Yahk river valleys. Small numbers were collected to the north on Kootenay Lake to Riondell and north on the Columbia River to Thrums, and from Laurier, near Grand Forks, east to Moyie Lake.

To compare the insect populations, discoloured foliage from trees on both sides of the International Boundary was collected in mid-June. Five randomly chosen 12-in-long branches from each of five trees were selected at each locality. The average number of casebearers per branch at Ione, Washington, and near Bonner's Ferry, Idaho, was 16. Similar samples averaged 1.4 larvae at Salmo, and 4 at Creston, B.C.

Insects were collected for parasite rearing. To date, only a small number of *Spilochalcis* sp. adults have been reared from the Salmo material.—R. J. Andrews, Forest Entomology Laboratory, Vernon, B.C.

Damage Caused by *Eucosma gloriola* Heinrich in Three Different Forest Sites in the Sandilands Forest Reserve, Manitoba.—Damage by *Eucosma gloriola* to regeneration jack pine in the Sandilands Forest Reserve was reported in 1963 (Wong, H. R. and J. J. Lawrence. Bi-Mon. Prog. Rept. 19(2):2). Studies on the intensity of attack and the incidence of leader and lateral damage in relation to tree height were carried out in 1962, 1964 and 1965 in two twentieth-acre strip plots selected at random each year in three different site classes. These site classes have been described by Cayford (Dept. Forestry Publ. 1016. 1963) as dry, moderately-fresh and moist, and supported approximately 800, 4,000 and 12,000 stems per acre respectively.

Observations indicate that the pine shoot moth attacks the current year's growth of the leaders and laterals, but seems to prefer the former. More laterals were attacked only when populations of *E. gloriola* increased in numbers. In the moderately-fresh and moist sites, where lateral damage was most evident, up to six larvae were present in some of the leaders instead of the usual one larva. This may have resulted from a reduction of leaders that were suitable and uninfested.

The data recorded in Table I indicate that *E. gloriola* prefers to attack trees of the intermediate height class; and

Table I

Damage by *Eucosma gloriola* in three site classes in the Sandilands Forest Reserve, Manitoba

Site	Year	No. of trees in two 1/20-acre plots	% of trees infested	Height (ft.)			
				All trees		Infested trees	
				Range	Mean	Range	Mean
Dry	1964	134	7.4	1–5	3	3–5	4
	1965	44	34.0	2–12	6	2–8	5
Moderately fresh	1962	373	10.9	2–9	6	3–8	6
	1964	412	13.0	2–11	6	3–8	6
	1965	222	19.3	2–12	5	2–6	5
Moist	1962	483	6.8	2–10	5	3–8	6
	1964	1048	16.2	4–12	7	4–11	7
	1965	356	29.4	3–16	8	5–14	8

the percentage of trees attacked does not increase with stand density. This apparent height preference by the shoot moth could benefit the taller trees, and aid in the natural thinning of heavily stocked regeneration stands.—H. R. Wong, A. E. Campbell, and J. J. Lawrence, Forest Research Laboratory, Winnipeg, Man.

An Unusual Species of Ant, *Formica fossaceps* Buren, in Quebec.—During the course of recent investigations on ants as potential control agents of insect pests in plantations, *Formica fossaceps* Buren (material identified by R. Beique, Quebec Museum) a species previously unrecorded in Quebec, was found in considerable numbers near Megantic, P.Q. in 1965. Since it is a large aggressive ant often found foraging in trees, and its nests are built on open, sunny sites (similar to those found in young plantations), it was felt that the life history and habits of the ant should be observed in some detail to determine its value for biological control purposes.

F. fossaceps belongs to the group *rufa,* generally known as red ants. It was first described in 1942 by Buren (Iowa State Coll. Jour. Sci. 16, 399-408), who reported it in the State of Iowa. It has since been found in North Dakota by Wheeler and Wheeler (Univ. North Dakota Press. 238-239, 1963), but to the author's knowledge has not been recorded elsewhere in North America. The workers of this large ant measure 4-8 mm in length, and the males and females about 8-9 mm. The nests are monogynous (with only one queen) and apparently without slaves. Males and females are produced at the same time of the year in the same nests, and they emerge in late August and early September for their nuptial flight.

The nests are constructed in and around old dry stumps and fallen tree trunks (usually cedar), in thinly forested areas, overgrown, abandoned pasture-land, or at the edge of dense stands. A few nests were found completely in the ground, under rocks or in sandy loam, to a depth of 8-9 in. There is usually considerable thatching over nests in stumps or logs, and to a lesser extent over the main entrance of earth nests. Individual nests are not large, usually containing fewer than 3000 ants. However, colonies of a dozen nests or so were found, where the distance between nests was no greater than 25 ft. Consequently, there can be a fairly high population per acre, even when compared to other ant species with larger individual nests. It was found that ants originating as far apart as 10 miles were readily accepted in each other's nests, without any sign of hostility. This very desirable habit makes it possible to build up large nests in the laboratory for propagation purposes. Tests conducted in the laboratory, to determine the aggressiveness of this ant, revealed that the species was capable of attacking with vigour, and killing, a wide variety of insects.

In the field, nests of *F. fossaceps* have been found in close proximity to nests of *F. fusca* L., *F. whymperi* Forel, *Camponotus herculeanus* L., and *C. noveboracensis* (Fitch), without evidence of hostility.

Although *F. fossaceps* has many obvious desirable qualities, its value as a biological control agent may be weakened by two factors. The first is that nests are monogynous, thus making it difficult to propagate the species into new areas. The second is that its natural range seems to be quite limited in the province of Quebec. However, should current trials on propagating the species outside its natural range prove successful, and should the ant be capable of forming large, widespread colonies over a reasonably short period of time, then it could become of importance in biological control work.—R. J. Finnegan, Forest Research Laboratory, Quebec.

Occurrence of a Fir Adelgid (*Adelges nusslini* C.B.) in British Columbia.—Surveys in 1965 and 1966 for the balsam woolly aphid, *Adelges piceae* (Ratz.), on *Abies* spp. in commercial nurseries and ornamental plantings on southern Vancouver Island and in the lower Fraser River Valley revealed another introduced adelgid attacking true firs. An examination of two nurseries in Vancouver and one in Victoria revealed approximately thirty 3 to 7 foot Nordmann fir (*Abies nordmanniana* (Steven) Spach) infested with this insect and seven similarly infested young fir were observed at a private residence in Burnaby. Seedlings in the nursery were imported from either Holland or Belgium and those in Burnaby from Holland. The only previous record of *A. nusslini* in Canada was from a residential area in Vancouver in 1941 on an unknown host.

In Europe, *A. nusslini* is an important pest of young silver fir (*Abies alba* Miller). The trees examined here showed marked injury, particularly in the upper crown where needles were yellowed and cast, and some branches were killed.

Other *Abies* spp. in nurseries and gardens were not attacked and after extensive surveys of native stands only *A. piceae* and a native adelgid (*Pineus abietinus* Underwood and Balch) were observed. It is not known if any native *Abies* are susceptible to attack by *A. nusslini.*

Eight infested trees were drenched with 0.1% lindane water emulsion spray, once in late April 1965 and again 1 month later; periodic examinations until August 1966 showed that all aphids were killed. Two infested trees were planted in a large cage and 20 *Aphidecta obliterata* (Linnaeus), a predator recently imported from Europe, were released into the cage in April 1965. Three months later, 154 adult *Aphidecta* progeny were found and most of the aphids had been destroyed. Control was not complete, as the aphid population recovered the following spring.

The discovery in local commercial nurseries of this damaging European adelgid emphasizes the danger of transporting trees into and within the Province without proper quarantine regulations. The dormant stages of many insects, commonly present when trees are moved in spring and fall, escape discovery too easily. The propagation of introduced tree species from seed would reduce the chances of introducing forest pests to the Province.—J. W. E. Harris, Forest Research Laboratory, Victoria, B.C.

Recent Outbreak of the Bruce Spanworm in Quebec.—The Bruce spanworm, *Operophtera bruceata* (Hulst), a defoliator seldom reported in Quebec prior to 1960 severely damaged sugar maple (*Acer saccharum* Marsh.) in eastern Quebec recently and was a cause of alarm to sugar producers. Sudden increases in the population of this pest were first noted in Portneuf County in 1962. During the next 2 years the outbreak continued to expand over a 15,000 square mile area extending from the Eastern Townships in the west to Chaleur Bay in the east. Populations began to decline in 1965 and in 1966 the insect was rare. The western half of the outbreak area was characterized by solid blocks of light to severe infestation whereas in the east the outbreak was restricted to relatively small areas because of the scarcity of the two preferred hosts: sugar maple and beech, (*Fagus grandifolia* Ehrb.).

In Quebec the life cycle of the Bruce spanworm is similar to that reported by Brown in Alberta (Can. Entomol. 94:1103-1107, 1964), except that oviposition may continue later in the season sometimes lasting until the end of November, and that hatching occurs earlier generally coinciding with the swelling of maple buds in the spring. The larvae usually feed on the underside of the leaves, eating out small areas without touching the veins. Defoliation is generally not conspicuous until populations reach a high level when the foliage becomes thin and crowns take a distinct reddish-brown hue. When feeding is completed, severely defoliated maple trees put on new foliage and crowns are usually green by mid-July. In all of several points under observation, the infestation period lasted only a few years, populations increasing very rapidly and just as suddenly collapsing.

The principal cause of population decline in the recent Quebec outbreak was due to the action of a virus disease. Some parasitism of eggs by *Telenomus* sp. and of larvae by *Horogenes* sp. as well as predation by birds were also recorded. The disease was first observed in laboratory material and later in nature by the senior author and was studied and described by Smirnoff (J. Insect Pathol. 6:384-386. 1964). A gradual discoloration of the abdominal segments of the larvae and cessation of feeding are signs of virus infection. In laboratory rearings of field material collected in the opening buds on May 15, 1964, disease symptoms were first observed on May 28 and most of the larvae died within the next 2 weeks. In nature, the first diseased larvae were recorded on heavily defoliated trees in early June of the same year and 2 weeks later 95% of the larvae were infected.

Despite the high mortality in the Bruce spanworm populations reported above, most of the maple trees in the areas under observation were almost completely stripped of their foliage at the peak of the infestation. However tagged trees kept under observation in severely defoliated areas, have shown no serious after-affects.—R. Martineau and C. Monnier, Forest Research Laboratory, Quebec, P.Q.

FOREST MANAGEMENT

Predicting Stem Diameter Distributions and Yield.—Mensurational data collected from 206 sample plots in red pine (*Pinus resinosa Ait.*) plantations in Ontario were analysed to determine methods for accurately describing and predicting stem diameter distributions (Bonnor, G.M., M.Sc.F. thesis. Univ. Toronto, October 1966). To describe the stem diameter distribution, seven frequency functions were tested. The Charlier Type A function, which was used by Meyer (Yale Univ., School of Forestry. Bull. No. 28. 1930) to describe stem diameter distributions of several North American tree species, proved best and was selected for further study. This function is based on the normal distribution function and its derivatives; its characteristics are the mean diameter (M), the standard deviation (S) and the coefficients of skewness (B_3) and kurtosis (B_4). This function resulted in a better fit than the other six functions, indicating that the distribution of the stem diameters in these red pine plantation plots is approximately normal.

To estimate the future development of present stem diameter distributions, the function characteristics M, S, B_3 and B_4 were calculated for each plot and the resulting values were used as dependent variables in multiple regression analyses, in which the independent variables were age (A), site index (I) and number of trees per acre (N). Site index values were obtained from site index curves derived from the basic data, using a key age of 25 years. The regression equations and their multiple correlation coefficients (R) are shown in Table 1.

TABLE 1

Regression equations predicting standard deviation, mean and coefficients of skewness and kurtosis.

Equation	R
$S = 1.699 - 9.227 \times \frac{1}{A} - 10.69 \times \frac{1}{I} - .0000003479 \times N^2 + .0005500 \times N$	.482
$M = 2.174 + .002381 \times A \times I + 806.1 \times \frac{1}{N} - .0000006999N^2 + .00001764 \times I \times N$	.910
$B_3 = .2079 - .0000003449 \times A \times N - .000001371 \times I \times N - .002803 \times A - .00001510 \times I^2$	.486
$B_4 = .04693 - .0000005766 \times I \times N - .007859 \times A - .000002745 \times N - .000000004743 \times N^2$	.333

Tests were made to determine if the relationships in the equations in Table 1 were different for thinned and unthinned stands; no significant differences were found.

The regression equations in Table 1 were then used with the equation for the Charlier Type A function to obtain estimates of stem diameter distributions from age, site index and number of trees per acre. Substitution of different age values yielded estimates of stem diameter distributions at different points in the development of the stand.

A separate regression analysis produced an equation for the estimation of tree height (H) from age (A), site index (I) and stem diameter (D):

$H = -139.6 + 1.175 \times A + 35.10 \times \ln(I) + 10.19 \times \ln(D)$

where ln is the natural or Naperian logarithm. The equation has a multiple correlation coefficient R=.975 and a standard error of estimate s.e. $= \pm 2.7$ ft.

From the above equations tables were constructed showing the estimated stem diameter distributions and tree heights corresponding to various combinations of age, site index and number of trees per acre. Tables were also developed to estimate the merchantable yield from red pine plantations showing the alternative utilization of individual trees for poles, lumber and pulpwood.

Inherent in any study predicting stand and tree growth are several limitations due to lack of knowledge of growth patterns, the causes of mortality and various interactions which take place during the life of an individual tree or stand. The results of the present study, however, are sufficiently accurate to indicate the value of this method in predicting stand potential under various management alternatives.—G. M. Bonnor, Forest Management Research and Services Institute, Ottawa, Ont.

FOREST PRODUCTS

The Effect of Boron Trifluoride Solutions on Pinene.—The volatile terpene fraction of red pine extractives plays an important role in the mechanism of resin exudation occurring in red pine lumber. As a possible means of eliminating

or reducing resin exudation, attempts were made to polymerize this mobile terpene fraction and thus reduce movement of the resin in the wood. One of the most promising catalysts for causing polymerization of terpenes is boron trifluoride, and a study was therefore undertaken of the most suitable conditions which would cause polymerization of terpenes of the type present in wood.

With alcoholic solutions of boron trifluoride, pinene is converted into other volatile products or into polymerized products, depending largely on the concentration of the boron trifluoride in the alcohol. Lombard and Kress (Bull. Soc. Chim. France, 1415-1419, 1959) found that pure boron trifluoride on pinene produced only polymers, whereas in methyl alcohol only volatile products were obtained. These products were shown to be isomers of pinene and the methyl ether of terpineol. The isomers obtained included limonene, α-terpinene, p-cymene, and terpinolene. A certain amount of the original α- and β-pinene was also present as well as a considerable amount of camphene which was thought to have been present in the original starting material.

In the present study, a sample containing 85% α-pinene and 15% β-pinene was used; this mixture corresponds with the composition of the terpene fraction from the red pine extractives. When this material was treated with a solution of 15% boron trifluoride in ethanol, only volatile products were obtained. No change occurred in the resulting products when the amount of boron trifluoride solution was varied so that the percentage of boron trifluoride based on pinene present was anywhere from 12 to 50. The chromatogram of the products is shown in Figure 1. Peaks 3, 4, 5, and 6 represent α-pinene, camphene, β-pinene, and limonene, respectively. Peak 8 is probably terpinolene, but Peaks 7 and 9 are still unknown. Their relative retention times do not correspond to the p-cymene or terpinene found by Lombard and Kress. Peak 10 was identified as the ethyl ether of terpineol and Peak 11 is terpineol.

To isolate the ethyl ether of terpineol, the lower boiling products were first removed by fractional distillation and then, after forming the dinitrobenzoate of terpineol, the ether was distilled off in pure form. This product had a boiling point of 223 to 224°C and a refractive index of 1.4612 at 20°C. The theoretical elemental percentages for the ethyl ether of terpineol ($C_{12}H_{22}O$) are C, 79.12; H, 12.09; and O, 8.79. The values obtained were C, 79.01%; H, 12.15%; and O (by difference) 8.84%. The infra-red and nuclear magnetic resonance spectra also agreed with the structure for the ethyl ether of terpineol.

Although it was possible to obtain a good yield of the methyl ether of terpineol by using methyl iodide on the potassium salt of terpineol, only a small amount of the ethyl ether could be obtained by this method with ethyl iodide. However, this small amount was shown by gas chromatography to be identical with the product from the boron trifluoride treatment of pinene. A similar boron trifluoride treatment of terpineol yielded many low boiling terpene hydrocarbons, the ethyl ether and a great deal of unchanged terpineol.

Using 26% and 41% solutions of boron trifluoride, and enough solution to give 50% boron trifluoride based on the pinene, the yield of volatiles dropped to about 40% and 8.4% respectively. If less solution was used, so that the boron trifluoride concentration based on the pinene was dropped to 12%, the amount of volatiles obtained was again greater. Thus, polymerization becomes predominant as the amount of solvent for the boron trifluoride is decreased and as the amount of boron trifluoride based on the pinene is increased. At the same time terpineol, the terpineol ether, and Peak 9 disappear completely.

The results of this work indicate that in order to produce polymers and reduce resin exudation from pine lumber it is necessary to use relatively large amounts of fairly concentrated boron trifluoride solutions. Since 15% solutions produce only volatile products, more concentrated solutions are required. In another publication (Levitin, N., Forest Prod. J. 15, 215-218, 1965) the results of tests with boron trifluoride solutions are given. A 26% solution was found to be the most suitable since it caused much less degradation than a 41% solution and still produced considerable polymerization of the terpenes. Penetration of the reagent was poor, and only areas near the surface were affected by the boron trifluoride solution. However, with thin layers of wood, a brush treatment of 26% boron trifluoride solution may effectively reduce resin exudation.—N. Levitin, Forest Products Laboratory, Ottawa.

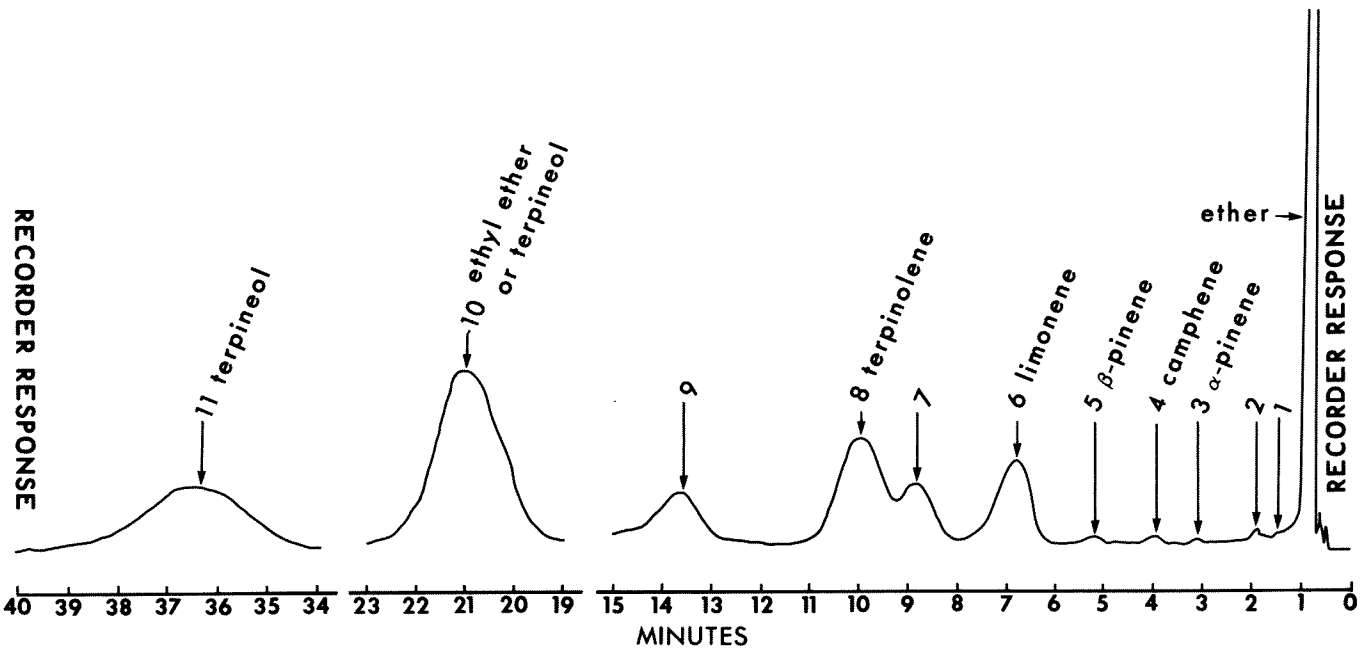

Fig. 1. Chromatogram of products from pinene, treated with a 15% boron trifluoride-alcohol solution using carbowax 4000 on chromosorb W at 135°C and 10 psi.

PATHOLOGY

Douglas-Fir Christmas Trees and Premature Needle Fall.—Occasionally Douglas-fir Christmas trees with moderate infection by *Rhabdocline pseudotsugae* Syd. are cut for marketing and when excessive needle loss occurs in transit, or shortly after being sold to the consumer, the fungus has been thought to be responsible. To determine the effects of a number of environmental conditions on needle casting, 15 infected and 12 healthy trees were selected near Invermere, B.C., in mid-November 1964, cut to a height of 5 ft, and brought to the Victoria laboratory. The crowns of infected trees were moderately thin from previous attacks by the fungus and the current year's needles were heavily infected.

Four of the infected trees and three healthy trees were placed upright without water in each of the following areas; greenhouse, heated room and refrigerated room. Three infected and three healthy trees were placed in a lath shade house. Temperatures ranged from 5 to 18° C in the greenhouse, 15 to 18° C in the heated room, −4 to 2° C in the refrigerated room and −15 to 13° C in the lath shade house. For 75% of the experimental period the relative humidity was below 80% in the greenhouse and over 95% in the lath shade house. In the heated room the humidity varied from 65% to 75%. At the beginning, and 8 weeks later at the conclusion of the experiment, the number of current year's needles missing and the number with yellow and red-brown *Rhabdocline* lesions were estimated for each treee as a whole and counted on one branch of each tree. A weekly record was made of the number of needles cast from each tree.

Under the conditions of the experiment, infected needles were not cast and there were no apparent changes in *Rhabdocline* lesions. All needles cast were 2 years old or more, the oldest being the first to fall. Trees in the greenhouse, heated room and lath shade house began casting needles in the seventh week of the experiment. No needles were cast from trees kept in the cold room. At the end of the eighth week the average number of needles cast from each tree in the cool, moist atmosphere of the lath shade house (300) was less than were cast in the warmer and drier atmosphere of either the greenhouse (575) or heated room (500).—A. K. Parker and C. H. Truscott, Forest Research Laboratory, Victoria, B.C.

SILVICULTURE

Spot Seeding to Augment Natural Reproduction of Eastern White Pine.—Five successive seed crop failures have occurred in an 1800 acre block of old-growth white pine near Temagami, Ontario, being harvested in strips over a 15-year period. This refutes the general belief that good crops can be expected every 3 to 5 years and light crops in most intervening years.

To compensate for the lack of natural seed, the Ontario Department of Lands and Forests sowed white pine directly on cutover strips in the autumns of 1960 and 1961, using two manual methods: (a) broadcasting 10,000 seeds per acre by cyclone seeder and (b) "rake and shake", i.e., sowing 20 seeds per shaker on a spot prepared by a fire rake. Some seed lots were coated with the repellents "Endrin" and "Arasan" while others were untreated.

Seeding was confined to the well-drained slopes which predominated in the area, avoiding moist, brushy pockets and dry upper sites where advance reproduction of pine was prevalent. The soil was shallow, loamy till over slatey bedrock. Considerable ground disturbance resulted from the logging which involved machine-skidding in fall, and was concentrated in alternate strips approximately 100 ft wide.

In a cooperative arrangement, the Department of Forestry superimposed seeding tests on the operations, designed to compare the effectiveness of sowing method, seed treatment and seedbed—particularly, compacted skid roads vs. ground loosely scarified by bulldozer. Seed (77% viable) was sown at the rate of 22 to 23 seeds per ¼-milliacre quadrat. In the "rake and shake" method, seed was lightly raked in; in surface broadcasting, it was sown on the most suitable spot on each quadrat. Seeding was carried out in October 1961. Employing a randomized block design, a factorial experiment was set out with 4 treatments × 2 seedbeds in 12 replications of 16 sample quadrats (¼-milliacre) per treatment. Results obtained by two criteria—'stocking' or percentage of quadrats stocked with one or more seedlings, and 'seedling catch' or percentage of seeds which produced surviving seedlings—were:

Sowing Treatment	Scarified by bulldozer				Compacted skid-road			
	% Stocking		% Seedling catch		% Stocking		% Seedling catch	
	1st yr	3rd yr	1st yr	3rd yr	1st yr	3rd yr	1st yr	3rd yr
Spot-seeded, raked in	79	75	16	13	89	89	24	20
Surface broadcast, coated seed	53	51	6	5	70	69	12	10
Surface broadcast, uncoated seed	44	45	5	4	66	60	9	9
Control, no seed sown artificially	2	6	—	—	8	9	—	—

Comparing sowing treatments, the raked spot effect proved consistently superior. Differences between it and the next best treatment were significant at the 1% level in every case, according to range tests (Snedecor, "Statistical Methods", 1956). The broadcast sowings of repellent coated vs. uncoated seed were not significantly different; nor, as the control indicates, was natural seeding of much consequence.

Contrary to expectation, the compacted skid-road seedbed produced somewhat better results than the loosely mixed seedbed effected by bulldozer action (a combination of blade and track scarification).

The "rake and shake" method of spot seeding thus seeems effective as a supplementary regeneration measure where natural regeneration has failed locally. This manual method can be economically applied by concentrating seed spots on and adjoining skidding roads and trails, preliminary scarification being unnecessary. In view of the seedling 'catch' from this test and the usual germination range of 75% for white pine, about 10 seeds per spot should give acceptable seedling density and stocking.—K. W. Horton, Forest Research Laboratory, Maple, Ont.

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Stairs, G. R. 1966. Transmission of virus in tent caterpillar populations. Can. Entomologist 98: 1100-1104.

Stanek, W. 1966. Relative quality of the major forest associations of the southern B.C. Interior for growth of lodgepole pine, Engelmann spruce, Douglas-fir, and alpine fir. Forestry Chron. 42: 306-313.

Stieda, C. K. A. 1965. Photostress analysis of timber structures. *In* Proc. Second Sym. Nondestructive Testing Wood, Spokane, Wash. pp. 349-385.

Thomas, J. B., and J. Krywienczyk. 1966. Preliminary results of a serological examination of some Scolytidae and Curculionidae. Can. Entomologist 98: 1094-1099.

Van Wagner, C. E. 1966. Three experimental fires in jack pine slash. Dept. Forestry Publ. 1146.

Whitney, R. D. 1966. Germination and inoculation tests with basidiospores of *Polyporus tomentosus*. Can. J. Botany 44: 1333-1343.

Wiksten, A. 1966. To thin or not to thin: some Nordic observations on the question. Forestry Chron. 42: 231-243.

Recent Publications

Benoit, P. 1966. Description de la larve du *Melanophila acuminata* DeGeer et de quelques caractères distinctifs du *Melanophila fulvoguttata* (Harris) (Coleoptera: Buprestidae). Can. Entomologist 98: 1208-1211.

Clements, J. R. 1966. Development of a white pine underplantation in thinned and unthinned aspen. Forestry Chron. 42: 244-250.

Condrashoff, S. F. 1966. A description of the immature stages of *Steremnius carinatus* (Boheman) (Coleoptera: Curculionidae). Can. Entomologist 98: 663-667.

Eidt, D. C. 1966. The mite *Nalepella tsugifoliae* (Acarina, Eriophyidae) on balsam fir—a new host record. J. Econ. Entomol. 59: 1279.

Elliott, D. P., and J. M. Powell. 1966. A cage for collecting insects from tree stems and branches. Can. Entomol. 98: 1112-1113.

Embree, D. G. 1966. The role of introduced parasites in the control of the winter moth in Nova Scotia. Can. Entomologist 98: 1159-1168.

Funk, A., and A. K. Parker. 1966. *Scirrhia pini* n. sp., the perfect state of *Dothistroma pini* Hulbary. Can. J. Botany 44: 1171-1176.

Gagnon, C. 1966. Fungus culture on cellophane membrane for cytochemical tests. Stain Technol. 41: 247.

Horton, K. W. 1966. Profitability of pruning white pine. Forestry Chron. 42: 294-305.

Jarvis, J. M. 1966. Seeding white spruce, black spruce and jack pine on burned seedbeds in Manitoba. Dept. Forestry Publ. 1161.

Lamb, F. M. 1966. Wood residues in Canada and their utilization. Forest Prod. J. 16: 19-23.

Laut, J. G. 1966. Cultural characteristics of three species of *Bolefinis*. Can. J. Botany. 44: 395-402.

Lees, J. C. 1966. Release of white spruce from aspen competition in Alberta's spruce-aspen forest. Dept. Forestry Publ. 1163.

Marshall, J. E. 1966. Economics of near and distant forest land management. Pulp Paper Mag. Can. 67 (7): WR 358-367.

Northcott, P. L., H. G. M. Colbeck, and A. Kozak. 1966. Can the service life of bonds be predicted? Am. Soc. for Testing and Materials. Spec. Tech. Publ. 401. pp. 3-15.

Northcott, P. L., and W. V. Hancock. 1966. Accelerated tests for deterioration of adhesive bonds in plywood. Am. Soc. Testing and Materials. Spec. Tech. Publ. 401. pp. 62-79.

Ouellette, G. B. 1966. *Coleosporium viburni* on jack pine and its relationship with *C. asterum*. Can. J. Botany 44: 1117-1120.

Ouellette, G. B., and G. Bard. 1966. A perennial canker of balsam fir on Anticosti Island. Plant Disease Reptr. 50: 722-724.

Pratt, R. H. M. 1966. Aerial spraying with 2,4-D to eliminate trembling aspen. Pulp Paper Mag. Can. 67(9): WR 460-462.

Reid, J., and A. Funk. 1966. The genus *Atropellis*, and a new genus of the Helotioles associated with branch cankers on western hemlock. Mycologia 58: 417-439.

Reid, R. W., and J. A. Watson. 1966. Sizes, distributions, and numbers of vertical resin ducts in lodgepole pine. Can. J. Botany 44: 519-525. 1966.

Roller, K. J. 1966. Resin canal position in the needles of balsam, alpine and Fraser firs. Forest Sci. 12: 348-355.

Smirnoff, W. A. 1966. *Thelohania pristiphorae* sp. n., a microsporidian parasite of the larch sawfly, *Pristiphora erichsonii* (Hymenoptera: Tenthredinidae). J. Invert. Pathol. 8: 360-364.

Smirnoff, W. A., and L. Berlinquet. 1966. A substance in some commercial preparations of *Bacillus thuringiensis* var. *thuringiensis* toxic to sawfly larvae. J. Invert. Pathol. 8: 376-381.

Sprout, P. N., D. S. Lacate, and J. W. C. Arlidge. 1966. Forest land classification survey and interpretations for management of a portion of the Niskonlith Provincial Forest, Kamloops District, B.C. Dept. Forestry Publ. 1159.

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