bi-monthly research notes

Vol. 28—No. 2, MARCH-APRIL, 1972.

Vol. 28—No. 3, MAY-JUNE, 1972.

Environment Canada | Environnement Canada
Forestry Service | Service des forêts

bi-monthly
research notes

"A selection of notes on current research conducted by the Canadian Forestry Service and published under the authority of the Minister of the Department of the Environment. A French edition is published under the title of Revue Bimestrielle de Recherches".

ENTOMOLOGY

A Willow Shoot-boring Sawfly *Euura atra* (Jurine).—Willows [*Salix* spp.] are widely planted as ornamentals and occur naturally over vast areas, often along river banks where they help prevent soil erosion and add aesthetically to the landscape. Any agent, therefore, that detracts from their appearance and vigor merits attention. Such an agent is the sawfly *Euura atra* (Jurine), whose larvae feed within new shoots causing partial or complete shoot mortality.

Euura atra is holarctic and was recorded from Quebec in 1807 (Jurine, Nouv. Method, Cl. Hymenopteres Dipteres, Vol. I; J. J. Paschoud, Geneva, 1807). It was recorded in England in 1936 by Callan (Bull. Entomol. Res. 31: 35-44, 1940), and in Alberta in 1952, and in Ontario in 1956 (Benson, Bull. Brit. Mus. (Nat. Hist.), Entamol. 12: 403, 1962). It was first found in the Maritimes in 1964.

This sawfly attacks several species of willow. In Ontario, it has been found on weeping willow [*Salix babylonica* L.] and in the Maritimes on crack willow [*S. fragilis* L.] and European yellow willow [*S. alba* var. *vitellina* L.]. According to Benson *(op. cit.)*, it has also been found on *Salix repens* L., *S. viminalis* L., and *S. purpurea* L.

E. atra is univoltine. In New Brunswick, the adults emerge in late May and early June and, after mating, the female inserts its eggs in the new shoots, often near the base. The newly-hatched larvae feed in the pith of the shoot, forming a gallery of 8 to 20 mm length (average of about 12 mm). Frequently two, and occasionally three, galleries may be formed in one shoot, usually near a point of leaf attachment. No more than one larva was found in a gallery, although galleries may closely adjoin and be separated only by a wall of frass. In the course of feeding, the larvae may bore toward the tip or the base of the shoot. When through feeding, the larva cuts a hole through the bark and plugs it with debris and webbing. It spins a cocoon and overwinters as a prepupal larva. Pupation occurs in early spring. Attacks become noticeable near the end of the growing season when the affected host tissue dies and turns brown. Dead shoots may remain on the tree for 2 or 3 years.

Dissections of galleries showed up to four shed head capsules, indicating at least five larval instars. The largest specimens measured had a head capsule width of 1.0 mm and a body length of 8.0 mm.

In the Maritimes, the following chalcids were reared from infested shoots: *Tetrasticus* sp.; *Trichogrammatidae* (possibly a species not previously recorded from America); *Eurytoma* sp. (A- salicis group); and another *Eurytoma* sp. (B- not salicis group).

In Ontario, similar rearings yielded *Tetrasticus* sp. and *Eurytoma studiosa* complex. Sawfly and chalcid adults were identified by officers of the Entomological Research Institute, Canada Department of Agriculture, Ottawa.—C. D. MacCall and F. A. Titus, Maritimes Forest Research Centre, Fredericton, N.B., and A. H. Rose, Great Lakes Forest Research Centre, Sault Ste. Marie, Ont.

A Simple Method for Immobilizing Spruce Budworm Pupae During Topical Application of Liquids.—When disturbed, spruce budworm pupae will often react vigorously, rolling themselves over and over by rotating and flexing the abdomen; therefore, they must be immobilized if experimental liquids, such as insecticides, are to be applied topically. Pupae can be anaesthetized with carbon dioxide, but must be kept under anaesthesia until the applied liquid has dried and can no longer be lost by the movements of the pupa. If the liquid is oily or of low volatility, the period of anaesthesia may be quite long, which can be detrimental to the survival of the pupae and influence interpretation of response to the treatment. A simple method has been devised for immobilizing spruce budworm pupae without the use of anaesthetics; this method might also be useful for other species.

Strips of soft plastic sponge, about 35 x 1.5 x 1.5 cm, are glued to a rigid base of stiff card and shallow transverse grooves, 1.0 to 1.5 cm apart, are cut in the upper surface of each strip. The pupae are picked up by the abdomen with an aspirator and placed ventral side down in the grooves so that the abdomen projects freely over the edge of the strip; they are then secured in place with transparent adhesive tape over the dorsal thoracic region (Fig. 1).

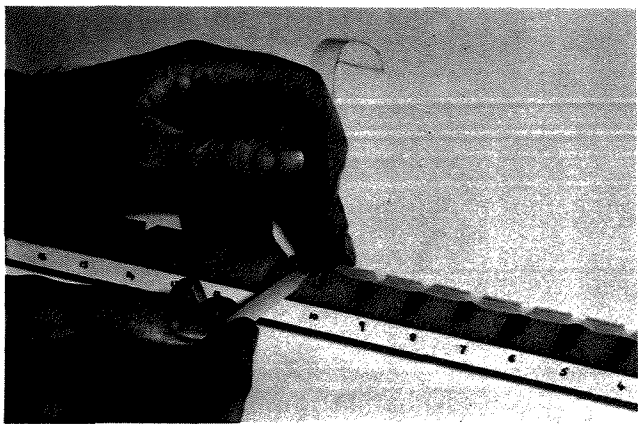

Figure 1. Loading plastic sponge strip with pupae.

The experimental liquids are usually applied to the first two abdominal sternites of each pupa; if necessary the pupa is prodded gently until it flexes its abdomen and exposes the thinner intersegmental cuticle. In this laboratory, an automatic micro-applicator with a foot-operated switch is used, which leaves both hands free to handle the strip, and with practice it takes but a few minutes to load and treat a strip containing 20 pupae. When the applied liquids have dried, the adhesive tape is peeled from the sponge strip bringing the pupae with it. The pupae are then eased off the tape with the aspirator.—I. Outram, Forest Research Laboratory, Fredericton, N.B.

Past and Present Hemlock Looper Outbreaks in Quebec.—A severe and widespread infestation of hemlock looper [*Lambdina fiscellaria fiscellaria* (Guen.)] was discovered in 1971 on Anticosti Island, Quebec. Some 3 million cords of mature and overmature wood are already dead or dying. Should this outbreak continue, a must greater amount of wood is endangered. To save these stands, aerial application of insecticide is planned for 1972.

Records with the Quebec Department of Lands and Forests show that six outbreaks of the hemlock looper have occurred in Quebec since the 1920's. The earliest of these was in 1927 and continued until 1929. The pest killed or damaged a large area of balsam fir between Bersimis and Pentecôte on the North Shore.

To a lesser degree, trees in the Wesseneau watershed (St. Maurice region), at Lake Mitchinamichus (upper Lièvre watershed) and north of the transcontinental railroad near Chibougamau, were also affected.

The second infestation was observed in 1936 on the north coast of Gaspé Peninsula (Marsoui region) and at the head of Washicoutai River on the North Shore. In 1947, a third outbreak was reported on 580 square miles of inland forest in the Gaspé Peninsula. Approximately 180 square miles of forest was destroyed before the epidemic collapsed in 1950.

A fourth outbreak occurred suddenly in 1956 over 90 square miles in Grenier Township and Iles de Mai on the North Shore, slightly more than 1 square mile was severely damaged; this infestation collapsed in 1957. A few years later a vast area of dead balsam fir forest, probably killed by the looper in the mid-fifties, was observed from the air in Vachon and Riverin watersheds, North of Iles de Mai. The extent of this damage was not determined.

In 1970 the insect was generally present in small numbers, from the Ontario-Quebec border in the west, to Natashquan River in the east, and from the American border as far north as Chibougamau, Quebec. A small, but severe outbreak, occurred in Withworth Township, Rivière-du-Loup County, in 1970. Approximately 2 acres of balsam fir were dead or seriously defoliated. Twenty miles west of Withworth, at Lac des Huards and Lac des Roches, Kamouraska County, moderate to severe defoliation of balsam fir was reported.

Surveys on Anticosti Island in 1970 showed a marked increase in the looper population indicating an outbreak was eminent. In fact, a severe and widespread hemlock looper outbreak, the most important of all these, did occur on Anticosti Island in 1971. The insect was also found in outbreak proportions in localities on the North Shore opposite Anticosti Island. Aerial and ground surveys estimated the affected areas at 560,000 acres on the island, and 40,000 acres on the mainland (Fig. 1). On Anticosti Island defoliation was light on 110,000 acres,

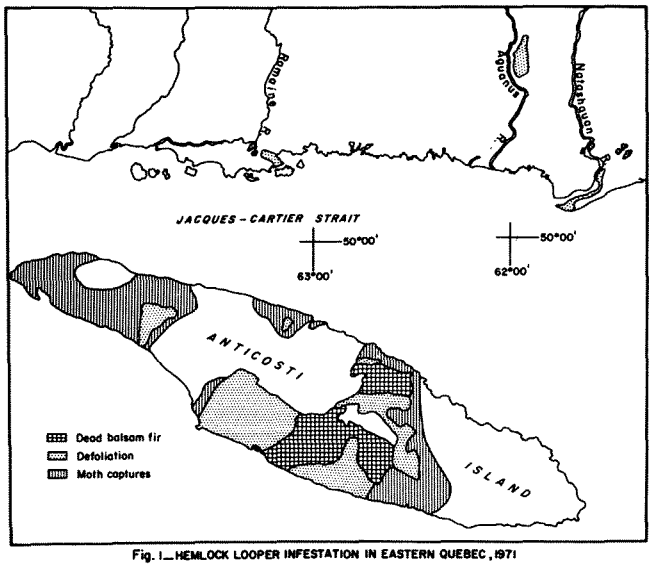

Fig. 1—HEMLOCK LOOPER INFESTATION IN EASTERN QUEBEC, 1971

Figure 1. Hemlock looper infestations in eastern Quebec, 1971.

moderate on 10,000 acres, severe on 230,000 acres, and trees destroyed on an additional 210,000 acres. Defoliation on the North Shore was severe around Hâvre Saint-Pierre and in the Aguanus and Natashquan watersheds. On 440,000 acres located beyond the affected areas on Anticosti Island, moths were captured in late summer 1971, and defoliation is expected in these areas in 1972 (Fig. 1).—Paul Benoit, Laurentian Forest Research Centre, Quebec, and R. Desaulniers, Conservation Branch, Quebec Lands and Forests, Quebec, P.Q.

Field Trials for Synergism and Inhibition of *trans*-11-tetradecenal, Sex Pheromone of the Eastern Spruce Budworm.—Weatherston *et al.* (Can. Entomol. 103:1741-1747, 1971) have shown that *trans*-11-tetradecenal is the sex pheromone of the eastern spruce budworm [*Choristoneura fumiferana* (Clem.)]. In addition to the field trials demonstrating that this compound attracts male budworm, trials were also conducted in 1971 to identify chemicals that might have synergistic or inhibitory properties when mixed with the attractant. The choice of chemicals, (subject to their availability) was largely based upon the findings of Roelofs and Comeau (J. Insect Physiol. 17:435-448, 1971). Synergists were looked for among saturated compounds having a carbon-chain length between 11 and 14. Inhibitors were looked for among 14 carbon-chain compounds with unsaturation in the 11-position.

Aliquots of 0.1 μl of each chemical in ethereal solution were placed in polyethylene vial stoppers and the ether was allowed to evaporate. Where mixtures were being tested 0.1 μl of each chemical was placed in the same stopper. The stoppers were placed in green Sectar I[1] insect traps, suspended at head height in the interior of spruce-fir stands infested by the budworm in Ontario.

Table 1 contains the list of chemicals and the trapping results. None of the potential synergists (the saturated compounds, Table 1) produced a significant increase in catches over the attractant alone, suggesting that efforts to increase catches with the synthetic attractant should be aimed at optimizing the release rate, rather than searching for a synergist.

Among the potential inhibitors (mono-unsaturated 14 carbon-chain compounds, Table 1), *trans*-11-tetradecen-1-ol and *trans*-11-tetradecenyl acetate showed significant activity. Similar results were obtained when the attractant and inhibitor were placed in separate polyethylene stoppers instead of both in the same stopper. Inhibition by the geometrical isomer, which has been demonstrated in several other species (Roelofs and Comeau, Nature 220:600-601, 1968; Science 165:398-400, 1969; Klun and Robinson, Ann. Entomol. Soc. Amer. 64:1083-1086, 1971), was not evident in the spruce budworm; and contrary to expectation, all the isomers of tetradecenal tested attracted some male budworm, indicating less chemical specificity in budworm than in many other species. In the case of *cis*-11-tetradecenal, the attractiveness may have been due to contamination by the *trans* isomer. Thin-layer chromatography indicated a trace ($< 5\%$) of the *trans* isomer contaminating *cis*-11-tetradecenal while gas chromatography showed all the isomers to be better than 99% pure aldehyde.

Field testing in Geneva, N.Y., of *trans*- and *cis*-11-tetradecenal gave similar results to those from Ontario, but the *cis* isomer was found to be less pure than that used in Ontario, containing between 5 and 15% of the *trans* isomer. Further testing was therefore carried out in Geneva, with *cis*-11-tetradecenal purified by double thin-layer chromatography. Trapping techniques were similar to those used in Ontario except that the traps were placed on ornamental spruces.

The results (Table 2) show that the attractiveness of the impure *cis* isomer was largely due to contamination with the *trans* isomer (treatment 5 vs. 6), and that pure *cis* alone was only slightly attractive. Mixtures of the *cis* and *trans* isomers resulted in reduced catches (treatment 1 vs. 2 and 3 vs. 4), but the differences were not significant.

[1]Trade name, 3M Co., St. Paul, Minn.

TABLE 1

Catches of male eastern spruce budworm in traps baited with various chemicals used alone and in mixture with sex pheromone of the budworm, *trans*-11-tetradecenal. Catches are expressed as percentages of catches with pure *trans*-11-tetradecenal so that several experiments could be combined. Probabilities refer to "t" tests on original data

		Chemical alone (0.1 μl)	Chemical mixed with *trans*-11 aldehyde (0.1 μl + 0.1 μl)
Mono-unsaturated	Aldehyde		
14 carbon-chain	*trans*-10	77	23
	trans-11	100	100
compounds	*cis*-11	35*	55
	trans-12	11*	77
	cis-12	78	100
	Alcohol		
	trans-11	3**	4*
	Acetate		
	trans-11	0**	6*
Saturated	Undecanal		72
	Undecanol		75
compounds	Undecyl acetate		113
	Dodecanal		69
	Dodecanol		142
	Dodecyl acetate		88
	Tridecanal		27
	Tetradecanal		27
	Tetradecanol		100
	Tetradecyl acetate		23

* Significantly different from catch with *trans*-11 aldehyde at 0.01 probability level.

** Significantly different from catch with *trans*-11 aldehyde at 0.05 probability level.

TABLE 2

Comparison of catches of male eastern spruce budworm over an 8-day period in traps baited with various concentrations of sex pheromone of the budworm, *trans*-11-tetradecenal, and the *cis* isomer. The impure *cis* isomer contained between 5 and 15% of the *trans* isomer

Treatment	Chemical	Average catch (5 replicates)	"t" value, df = 8
1	*trans* 1.0 μl	55.0	1.41
2	*trans* 1.0 μl + *cis* (pure) 1.0 μl	22.6	
3	*trans* 0.1 μl	10.6	1.39
4	*trans* 0.1 μl + *cis* (pure) 0.9 μl	5.4	
5	*cis* (pure) 1.0 μl	3.2	2.91*
6	*cis* (impure) 1.0 μl	12.4	

* Significant at 0.05 probability level.

Since the two isomers were mixed together in the same polyethylene stoppers, the inactive *cis* isomer may have competed with the active *trans* in diffusing through the polyethylene and catches were reduced because of a slower rate of the *trans* isomer. Thus, there is no evidence that the *cis* isomer, in addition to being only slightly attractive, inhibits the response of male budworm to the *trans* isomer.

It is therefore feasible that mating behavior of the eastern spruce budworm may be disrupted by the alcohol or acetate inhibitors as well as by the attractant itself, whereas the efficiency of traps is more likely to be increased by an optimum concentration of attractant alone, rather than by adding a synergist.—C. J. Sanders, Great Lakes Forest Research Centre, Sault Ste. Marie, Ont.; R. J. Bartell, C. S. I. R. O., Canberra, Australia; and W. L. Roelofs, N. Y. State Agric. Exp. Stn., Geneva, N.Y.

Masking of Female Sex Pheromone of the Eastern Spruce Budworm by Excised Female Abdomen Tips.—In investigations of lepidopterous sex pheromones, it has been widely reported that biologically active fractions can be obtained by excising the tips of female abdomens, where the sex pheromone producing gland is located, and macerating them in an organic solvent, such as methylene chloride or ether. However, the eastern spruce budworm [*Choristoneura fumiferana* (Clem.)] appears to be an exception to this rule, and extracts of excised female abdomen tips fail to evoke a response in males, even after partial chromatographic separation (Sanders, Science 171:911-913, 1971; Can. Entomol. 103:631-637, 1971). Biologically active fractions can be obtained by leaving virgin female moths inside jars for one or more nights, and then rinsing out the jars with ether (Sanders, *loc. cit.*). Sufficient material was obtained by this method to identify the sex pheromone of the budworm as *trans*-11-tetradecenal (Weatherston *et al.*, Can. Entomol. 103:1741-1747, 1971).

Further investigations have indicated that extracts of excised abdomen tips, when mixed with either the active washes or the synthetic attractant, reduce male response in the laboratory.

In the first of two experiments, solutions of excised female abdomen tips and washes were made up in ether. Portions of each of these were then mixed or diluted where appropriate to give three solutions for bioassaying: (1) excised tips at a concentration of 10 female equivalents (FE) per ml; (2) washes at a concentration of 10 female nights (FN) per ml (1 FN being equivalent to 1 female left for 1 night); (3) a mixture containing 10 FN plus 10 FE per ml. Bioassays were carried out as described previously, by taking up 0.5 ml of the solution in a medicine dropper, expelling it, and then after the solvent had evaporated expelling air into boxes containing 2-day-old virgin males (Sanders, *loc. cit.*; Weatherston *et al.*, *loc. cit.*). The results (Table 1) indicate a good male response to the wash but virtually no response to the excised tips. Mixing the excised tips with the wash reduced its activity by two-thirds.

Apparently the two solutions must be intimately mixed before male response is reduced. Thus there was no loss in the activity of the wash when it was blown into the bioassay chamber separately, 30 sec after the excised tips (Table 1). But, in further experiments the wash was inactivated when drawn up into the medicine dropper to a height of 1 inch, expelled and then followed by the excised tips drawn up to a height of 0.5 inch.

TABLE 1

Male spruce budworm response in laboratory bioassays to extracts of excised female abdomen tips and to ether washes of jars that had contained virgin females, showing inactivation of the washes by the excised tips. Each solution was bioassayed against at least 100 males.

	Conc/ml	Male response (%)
Excised tips.....(T)	10 FE[a]	4
Wash.....(W)	10 FN[b]	53
T + W.....	10 FE + 10 FN	17
W 30 sec after T....		51

[a] Female equivalents.

[b] Female nights.

TABLE 2

Male spruce budworm response in laboratory bioassays to extracts of excised female abdomen tips and to synthetic attractant, *trans*-11-tetradecenal (tdal), showing inactivation of the tdal by the excised tips. Each solution was bioassayed against 40 males.

	Conc/ml	Male response (%)
Excised tips.....(T)	5 FN[a]	2.5
Tdal.....	5×10^{-8} g	55.0
T + tdal.....	5 FN + 5×10^{-8} g	20.0

[a] Female nights.

In the second experiment, a further three solutions were made up: (1) 5 FE excised tips per ml; (2) 5×10^{-8} g *trans*-11-tetradecenal (tdal) per ml; (3) a mixture containing 5 FE + 5×10^{-8} g tdal per ml. The results (Table 2) show that the activity of the attractant was considerably reduced when mixed with the excised tips. Further observations have indicated that activity can be restored by increasing the concentration of the synthetic attractant in the mixture.

How and where inactivation takes place is unknown. It may occur at the male receptor site, i.e., the excised tips may contain a natural inhibitor, possibly a precursor of the attractant itself such as *trans*-11-tetradecen-1-ol, which is a known inhibitor (unpublished data). It is also possible that chemical inactivation is involved; certainly it is apparently necessary for the two solutions to be in an intimate mixture before male response is affected. Further research is currently underway to determine the nature of this phenomenon.—C. J. Sanders and G. S. Lucuik, Great Lakes Forest Research Centre, Sault Ste. Marie, Ont.

Energy Resources of a Diseased *Acleris gloverana* (Wals.) in British Columbia.—An infestation of *Acleris gloverana* (Wals.) was examined in stands of *Pseudotsuga menziesii* (Mirb.) Franco, near Victoria, B.C., for the presence of virus disease.

Although the infestation was only in its second year, 70,000 of the 250,000-acre infested area were severely defoliated. Observations were carried out in the epicenter of the infestation, and in the upper Nanaimo River region (Jump Creek area), in the southern part of Vancouver Island. Five sample points, about 1 to 1.5 miles apart, were established. At the time of observation 95% of the larvae had pupated, 4% of the population was in the larval stage, and 1% had emerged as adults.

Examination of the specimens immediately after sampling revealed the present of a typical nuclearpolyhedrosis virus in the population.

The virus principally invaded the hypodermal cells and fatty tissues of late instar larvae and pupae. Diseased larvae were creamish-yellow and brittle. Pupae were also brittle, and filled with a milky white liquid.

The disease was first reported in 1941 when Prebble and Graham (B.C. Lumberman, March 1945) reported a viral disease as an important factor in the reduction of populations of *A. gloverana* in the Cascade Creek region of the Lower Fraser Valley. Graham (Can. Entomol. 86: 546-548, 1954) described the symptomatology of the viral disease and the active role of the virus in the reduction of the *A. gloverana* populations.

Our observations in the field, and the microscopical examinations, revealed that only a small percentage of the *A. gloverana* larvae were infected by virus. At that stage it was impossible to determine the degree of virulence of the disease and make predictions on the possible appearance of a viral epizootic. However, an assessment of the energy reserves of the insect, through biochemical analyses of pupae, was used to determine the physical condition of these populations.

The results of biochemical analyses of *A. gloverana* pupae were:

A. *Activity of certain enzymes — expressed in mμ/gm*

1. Transaminases: Metabolism of amino acids	
Glutamic oxaloacetic transaminase (GOT)	6.7 mμ/gm
Glutamic pyruvic transaminase (GPT)	nil
2. Dehydrogenase: Respiratory cycle	
Isocitrate dehydrogenase (ICDH)	18.8 mμ/gm
Glutamic dehydrogenase (GLDH)	9.0 mμ/gm
3. Phosphatase	
Alkaline phosphatase	100 mμ/gm
Acid phosphatase	50 mμ/gm
4. Cholinesterase: Control of acetyl-cholin	70.2 mμ
5. Aldolase	13.2 mμ

B. *Amount of certain metabolites*

Chloride	6 mEq/kg
Glycerol	29.7 mg/100
Total lipids	5.2%

When compared with similar analyses carried out on pupae of *Choristoneura fumiferana* (Clemens) from a population on the increase, the results obtained indicate observed populations of *A. gloverana* have a high metabolism rate.

Cytolysis was low (low activity of the transaminases) and activity of the dehydrogenases and phosphatases was high (high respiratory cycle and normal metabolism of phosphates). Control of acetyl-cholin by cholinesterase was normal and the amount of each metabolite (chloride, total lipids, glycerol) was comparable to that registered for healthy larvae of *C. fumiferana*.

These analyses tend to indicate populations of *A. gloverana* observed were in an optimum physiological condition characteristic of a population on the increase.

It would be an advantage to this study if measurements of energy resources in the *A. gloverana* populations were continued and compared with previous data. The knowledge obtained from the comparison could be useful in general studies of the dynamic population of this insect. Also, it would indicate the presence of a virus epizootic before manifestation is apparent.—W. A. Smirnoff, Laurentian Research Centre, Canadian Forestry Service, P.O. Box 3800, Ste. Foy, Que.

FOREST PRODUCTS

White Spruce Poles with Improved Permeability to Creosote: Industrial Experience in Newfoundland.—While studying the feasibility of the commercial application of ponding as a means of increasing the penetrability of white spruce roundwood [*Picea glauca* (Moench) Voss], a group of poles of this species was brought to our attention which were highly permeable to creosote in a pressure impregnation process as applied by the Newfoundland Hardwood Limited, Clarenville, Newfoundland. Because of possible implications for our research program and for wood preservation practice, we examined these poles for depth of penetration and for the cause.

In May 1967, 78 poles (42 ft, class 4) were prepared from freshly-cut white spruce trees near Goose Bay, Labrador. They were immediately put into Lake Melville, where they floated in a single layer for 10 weeks. The poles were then shipped to the treating plant at Clarenville, Nfld. within 4 days. At Clarenville they were kept in a solid pile for 10 days (early August 1967); finally, they were machine-shaved and seasoned outdoors in an open pile for 22 months.

Water temperatures during the floating period were not measured. According to the weather stations in Goose Bay and in St. John's Torbay, 70 miles southeast of Clarenville, mean monthly air temperatures in the warm period (June to Sept.) of 1967 and 1968 averaged 59°F and 53°F, respectively, for both the floating and for air seasoning areas (normal for both about 56°F). The total monthly precipitation in the air seasoning area averaged 3.1 inch in Aug. - Sept. 1967 (normal 4.4 inch), and 4.2 inch in June - Sept. 1968 (normal 3.9 inch).

In June 1969 the poles were treated with creosote (AWPA Standard P1-65) in two charges by the following 12-hr boiling plus Rueping process: Boiling in creosote (180°F, 18 inch vacuum, 4 hr); preliminary air pressure (25 psi, 10 min); pressure period (150 psi, 4 hr, 40 min); expansion bath (190°F, 45 min); final vacuum (25 inch, 45 min).

The retention, measured by gauge, was 8.5 lb creosote/cu ft of wood (gross absorption 16.1 lb/cu ft). This is within the range

of the retention levels specified in standards for poles (CSA 080.4; AWPA C4-63).

The depth of penetration was measured on three increment borings taken at mid-length on each pole from points evenly spaced around the circumference. The penetration was very deep for spruce but varied considerably between poles (grand mean of three means: 1.4 ± SD 0.43 inch). Full sapwood penetration, however, as obtained in ponding tests carried out on debarked roundwood with thin sapwood in Ontario, (Unligil, H.H., J. Inst. Wood Sci., in press), was not reached. Variation within poles (SD: 0.30 inch) was also considerable and was not correlated with the depth of penetration (correlation coef.: 0.104). Cross sections, cut 10 feet from the butt end of four different poles, are shown in Figure 1. Specimen No. 1 represents the poorly penetrated poles and No. 4 the well penetrated poles; specimens No. 2 and No. 3 are intermediate with irregular penetration. While in No. 1 the creosote was restricted to a narrow layer, in No. 4 it apparently reached the heartwood boundary.

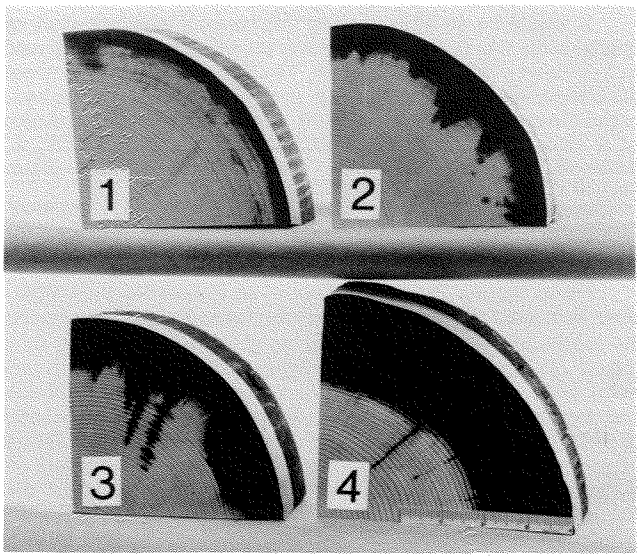

Figure 1. Quadrants from cross sections of four different white spruce poles after creasoting by a 12-hr boiling plus Rueping process.

The specimens shown in Fig. 1 were examined by microscope after extracting the creosote with toluene. They contained fungal hyphae in the rays and in the longitudinal tracheids. The cell walls had been penetrated by hyphae (Fig. 2) which were septate but without the clamp connections typical of the Basidiomycete class. No hyphae were detected in the sapwood that was not penetrated by creosote. Bacteria were absent in all specimens examined.

These examinations do not permit a definite conclusion on the causes for the unusually high permeability of the material. They indicate, however, that it was caused by fungi rather than by bacteria, although bacteria are normally considered to be the principal agents responsible for increased permeability of spruce roundwood that is ponded after debarking (Bauch *et al.*, Holzforschung 24:199-205, 1970; DunLeavy and McQuire, J. Inst. Wood Sci., 5:20-28, 1970, and others).

Fungi, also, may increase the penetrability of spruce (Schultz. Forest Prod. J. 6:77-80, 1956). The fungi probably penetrated into the sapwood during outdoor storage. The higher than normal summer temperatures in 1967 may have favored rapid fungal

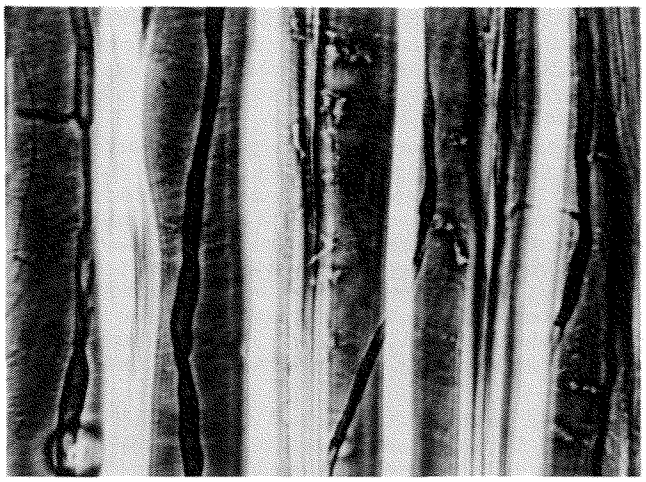

Figure 2. Fungal hyphae in sapwood area penetrated by creosote (specimen No. 3, Fig. 1).

growth. Aufsess and Pechmann have shown (Forstwiss. Clb., 89:64-70, 1970) that water-stored spruce is apparently more susceptible to fungal invasion during outdoor storage than freshly cut spruce. It is also known (Schultz, G. Material and Organismen, 3:177-184, 1968) that overwintering outdoors, even for one season, may increase the permeability of spruce poles to such an extent that their retention of a water-borne preservative, in a pressure process, may not differ much from that of poles previously ponded.

We thank Newfoundland Hardwoods Limited for their cooperation and for permission to publish this report. — H.H. Unligil and J. Krzyzewski, Eastern Forest Products Laboratory, Ottawa, Ont.

MENSURATION

Canopy Density and Stand Height Estimated on 1:160,000 scale Aerial Photographs.—Since early 1970, the Forest Management Institute of the Canadian Forestry Service, has been engaged in research aimed at evaluating the potential forestry applications of ultra-small-scale aerial photography. As part of the Canadian Remote Sensing Programme, a considerable amount of 70-mm aerial photography has been obtained using reconnaissance cameras aboard a CF-100 aircraft flying at altitudes of 40,000 feet. Studies to date indicate that color-infrared film is best for the identification of forest cover types. Deciduous and coniferous forest, some of the more common forest associations, and indeed in a few cases, individual forest species have been successfully recognized on photography at a scale of 1:160,000. Some of these findings have already been published (Nielsen and Wightman, Dep. Environ., Can. Forest. Serv., Forest Manage. Inst., Inform. Rep. FMR-X-35. 25 p., 1971).

The purpose of this note is to report on the results of a study of estimating canopy density and stand height from this ultra-small-scale photography.

Twenty-three mixed stands with a predominance of coniferous species were selected at random in the vicinity of Maxam Lake (15 miles southeast of Temagami, Ont.). Their canopy density and mean height were independently estimated by two interpreters familiar with small-scale photography, but neither of whom had any previous acquaintance with the study area.

For estimates undertaken on the 1:160,000 scale photography, stand height and canopy density are defined respectively

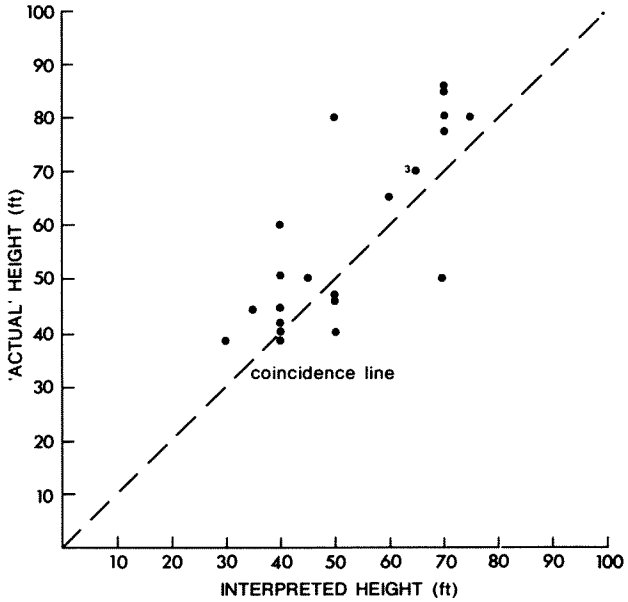

Figure 1. Stand Height Estimates: Interpreter A
Mean of differences: — 5.3 feet
Standard deviation of differences: ± 10.05 feet

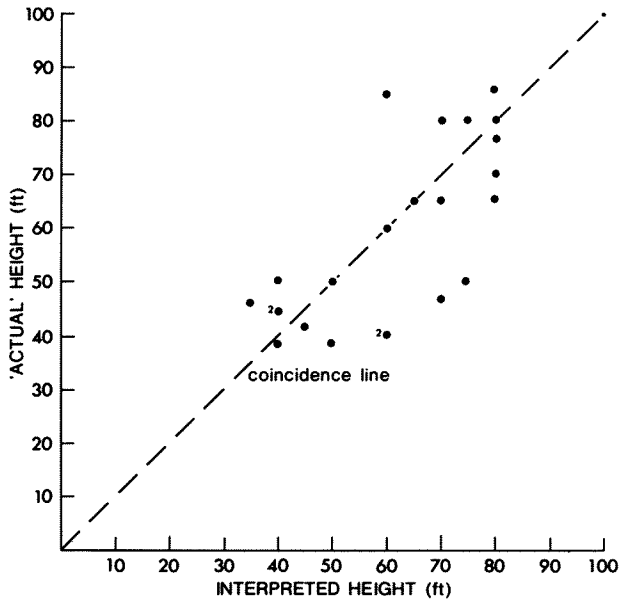

Figure 2. Stand Height Estimates: Interpreter B
Mean of differences: — 2.7 feet
Standard deviation of differences: ± 12.33 feet

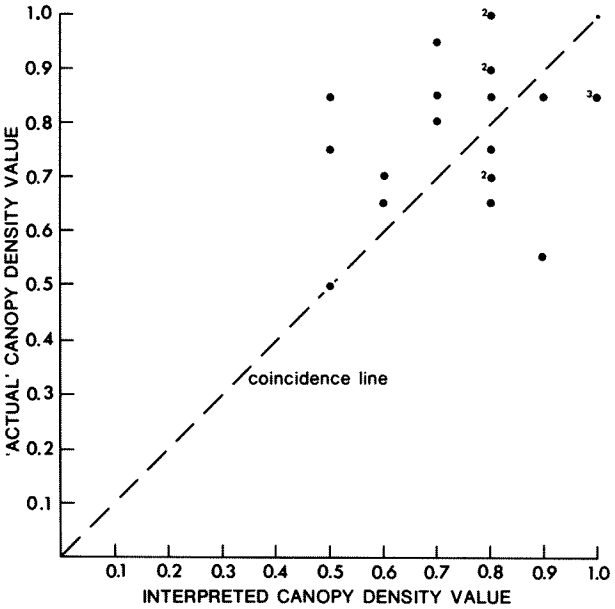

Figure 3. Canopy Density Estimates: Interpreter A
Mean of differences: — 0.03
Standard deviation of differences: ± 0.169

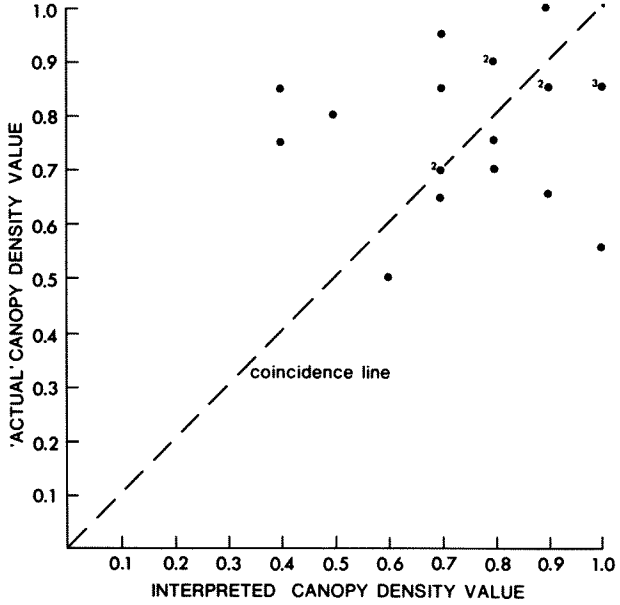

Figure 4. Canopy Density Estimates: Interpreter B
Mean of differences: — 0.01
Standard deviation of differences: ± 0.203

as the total mean height of the dominant canopy layer and the percent of tree-crown area covering the total area of the ground supporting the stand. With a flying height of 40,000 feet, the standard 0.01-mm unit of parallax would be equivalent to about 18 feet in height. Since a skilled interpreter cannot detect parallax differences much smaller than 0.03 mm, he would only be able to measure heights in 50-foot units. Stand height was therefore estimated in relation to the largest trees in the area, which were assumed to be about 85 feet tall. Since individual medium-and large-sized crowns were resolved on the film, the estimation of canopy density was possible. These estimates were made on the original positive color-infrared transparencies under a zoom stereoscope, usually at a magnification of about 15X.

The results of these estimates were tabulated against "actual" canopy density and stand height estimates which had been independently obtained from coincident low-altitude color-infrared

photography at a contact scale of 1:6,800. "Actual" canopy density was estimated to the nearest 10%, while "actual" stand height was *measured* with a parallax bar. Scatter diagrams (Figures 1 to 4) indicate the relationship of the interpreted estimates to the "actual" estimates. The mean differences between the estimates, and their standard deviations were calculated, and accompany the appropriate figure.

While no apparent bias was indicated for either interpreter when estimating canopy density, interpreter A tended to underestimate, and interpreter B to overestimate, stand height. Bearing in mind that there were errors inherent in the "actual" estimates, the authors conclude that it would be feasible to delineate 25-foot height classes with about 70% confidence.

Considering the limitation of the samples of canopy density (no data below 50%) it appears that a classification in three density classes is possible with a confidence of approximately 65%. However, increased accuracy would be achieved by utilizing interpretation keys such as comparable stereograms of known canopy density. — U. Nielsen and J.M. Wightman, Forest Management Institute, Ottawa, Ont.

The Use of Current Stand Characteristics in the Prediction of 10-Year Growth.—The purpose of this study is to test how accurately gross basal-area growth can be predicted using a diameter-prediction equation developed from current stand characteristics. The test was carried out with data from unmanaged stands of black spruce [*Picea mariana* (Mill.) B.S.P.] growing on a range of sites (Table 1, and Evert and Lowry, Pulp Pap. Res. Inst. Can., Woodlands Rep. WR/24: 31, 1971).

A previous study (Evert, Bi-Mon. Res. Notes 27: 30-31, 1971; Errata, Bi-Mon. Res. Notes 27: 36-37, 1971) indicated that the quadratic mean diameter (d_g), its growth (Δd_g) and, consequently, the basal area per acre (G) and its growth (ΔG) could be predicted in managed stands growing on a single site from Lorey's height (h_L), stand age (T) and number of trees per acre (N). This study also indicated that a diameter-prediction equation derived from data in one stand could be successfully applied in another stand. The diameter-prediction equation is even more useful in forest inventories when estimates of gross growth per acre and of future gross growth can be used for evaluating forestland capability. For instance, gross basal-area growth per acre

$$\Delta G = .005454154\ N_1\ (d_{g_2}^2 - d_{g_1}^2) \qquad \text{I}$$

(subscripts 1 and 2 denote the initial and end value respectively) can be predicted using only the initial number of trees and the estimated initial and end quadratic mean diameters.

The same approach of predicting the quadratic mean diameter that was used in the above-noted publication by Evert was tried first. The scatter-diagram, however, showed very poor agreement with Equation II, "Evert, *loc. cit.*":

$$d_g = b_o + b_1 \sqrt[4]{h_L\ T/N} \qquad \text{II}$$

TABLE 1
Black spruce data summary

Variable	Mean	Range
d_g	3.86	1.2-6.9 in.
h_L	35.0	12.3-63.9 ft
N	2190.0	423-6833 trees/acre
T*	71.3	31-244 yr
Site Index	28.0	7-52 ft at 50 yr

*The average age at root collar of 10 dominant and codominant trees per plot.

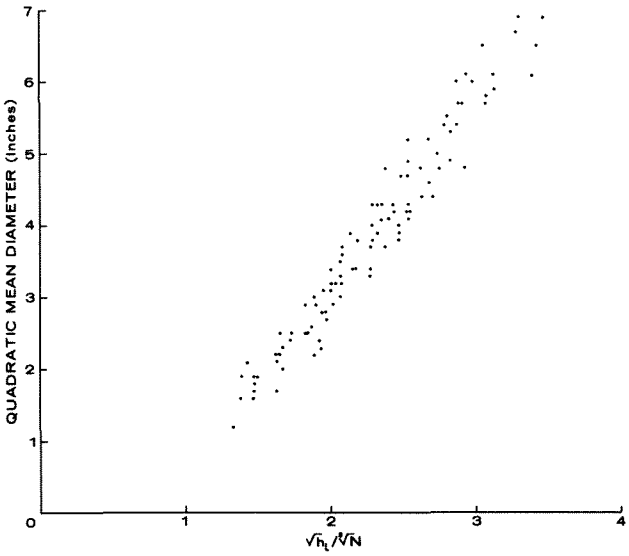

Figure 1. The relationship of the quadratic mean diameter to height-spacing expression.

In fact, the fit appeared much poorer than that obtained with the same data using Equation III

$$d_g = b_o + b_1 h_L + b_2\ (1/N) \qquad \text{III}$$

($R^2 = 0.94$ and standard error of estimate SE = ±0.34 in.)

Equation III, however, despite its good fit, cannot be meaningful in the prediction of diameter growth because it shows growth to be independent of the initial number of trees (N_1), as follows:

$$\Delta d_g = d_{g_2} - d_{g_1} = b_1\ (h_{L_2} - h_{L_1}) \qquad \text{IV}$$

Equation II, on the other hand, is meaningful because it shows

TABLE 2
Measured 10-year basal-area increment and two predictions (sq ft per acre)

Increment range	Number of plots	Meas'd increment mean	Prediction (i)	Diff. meas'd −pred'd	Number of plots	Meas'd increment mean	Prediction (ii)	meas'd −pred'd
1-10	9	6.5	7.8	−1.3	9	6.5	9.3	−2.8
11-20	22	16.0	15.2	0.8	18	16.4	15.3	1.1
21-30	36	25.4	26.3	−0.9	33	25.4	25.4	—
31-40	24	35.1	38.8	−3.7	24	35.1	36.3	−1.2
41-50	16	43.9	46.9	−3.0	16	43.9	50.2	−6.3
51+	17	63.5	55.8	7.7	17	63.5	63.7	−0.2
All plots	124	31.8	32.1	−0.3	117*	32.6	33.8	−1.2

* Seven plots were unusable in the second prediction because of the limitations of the height/age curves used.

the predicted growth to be inversely related to the initial number of trees, as follows:

$$\Delta d_g = d_{g_2} - d_{g_1} = b_1 \sqrt[4]{(h_{L_2}T_2 - h_{L_1}T_1)/N_1} \qquad V$$

Subsequent investigation indicated that since the data, "Evert, *loc. cit.*", involving the combined variable $\sqrt[4]{h_L T/N}$ came from a single site, stand age could be substituted for Lorey's height since the two variables are closely correlated because of their close association. This proposition was found to be true following tests using the variable $\sqrt{h_L}/\sqrt[4]{N}$ with the previous data; the same variable with the black spruce data, however, still gave a poorer fit than previously obtained with Equation III ($r^2 = 0.89$ *vs* $R^2 = 0.94$).

Further investigation with the black spruce data showed that the relationship of expression $\sqrt{h_L}/\sqrt[8]{N}$, to quadratic mean diameter approximates a straight line (Figure 1), which is described by the following regression:

$$d_g = -2.10 + 2.61\sqrt{h_L}/\sqrt[8]{N} \qquad VI$$

($r^2 = 0.949$ and standard error of estimate SE = ±0.31 in.)

For direct computer calculation, Equation I, when substituted with the predicted diameters from Equation VI, becomes

$$\Delta G = N_1 \left\{ -0.0598\ (\sqrt{h_{L_2}} - \sqrt{h_{L_1}})/\sqrt[8]{N_1} + 0.0372(h_{L_2} - h_{L_1})/\sqrt[4]{N_1} \right\} \qquad VII$$

Equation VII was tested twice, using tallied initial number of trees of the test plots and their measured initial heights, and (i) measured 10-year height increment of test plots, and (ii) estimated 10-year height increment using height/age curves of another study (Evert, Forest Sci. 16(2):183-195, 1970). Measured basal-area growth of the test plots had been determined from discs cut from every tree at dbh.

The results of both tests proved that there was good agreement between the measured and predicted gross basal-area increment by 10-square-foot measured increment classes as well as by overall means. The largest error was 7.7 square feet; most errors are substantially below this figure (Table 2). — F. Evert, Forest Management Institute, Ottawa, Ont.

PATHOLOGY

Douglas-fir, a New Host for Hemlock Dwarf Mistletoe.— Hemlock dwarf mistletoe [*Arceuthobium tsugense* (Rosend.) G.N. Jones], most damaging to western hemlock [*Tsuga heterophylla* (Raf.) Sarg.] and mountain hemlock [*T. mertensiana* (Bong.) Carr.], can parasitize at least 16 other species included in the genera *Tsuga, Pinus, Picea, Abies* and *Larix*. There has been no reported infection of Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] by hemlock dwarf mistletoe, even though Douglas-fir commonly grows in mixture with infected western hemlock trees throughout much of its range in coastal western North America. Douglas-fir has therefore been considered immune to infection by hemlock dwarf mistletoe. This note details the successful infection ot Douglas-fir by hemlock dwarf mistletoe resulting from artificial inoculations.

Hemlock mistletoe seeds were collected in October from western hemlock and lodgepole (shore) pine [*Pinus contorta* Dougl.] on Vancouver Island, British Columbia, by clipping off infections with ripe fruit and discharging the seeds into paper bags. The seeds were transferred to petri dishes and stored at 5 C for 2 to 4 weeks before inoculation, in late October and early November. Inoculations consisted of briefly wetting the seeds and placing them singly at the bases of needles and buds on 1- and 2-year-old branches. Three hundred and twenty seeds from each host were placed on Douglas-fir trees growing in a plantation at Victoria. Half of the trees were the Coastal form of Douglas-fir [var. *menziesii*] and the remainder were the Interior form [var. *glauca*] (Hosie, Native Trees of Canada, Queen's Printer, Ottawa, 1969).

As indicated by branch swellings, six infections were produced, all on the Interior form. Five of the infections resulted from inoculations with hemlock dwarf mistletoe from lodgepole pine, an infection rate of 3.1%. Only one resulted from inoculations with hemlock dwarf mistletoe from western hemlock. For two infections, swellings were first observed in the second year after inoculation; for the others, they were not evident until the third or fourth year. Following the pattern of other less common host-parasite combinations, the swellings were more globose (length: width = 2.5:1) than those associated with normal parasitism of western hemlock by hemlock mistletoe (Smith, Can. Dep. Fish Forest, Bi-Mon. Res. Notes 26(2):14, 1970). The rate of longitudinal enlargement of the swellings was 10 mm per year, considerably less than the rates of 28 and 19 mm per year attained in the same plantation by hemlock dwarf mistletoe on western hemlock and Douglas-fir dwarf mistletoe [*Arceuthobium douglasii* Engelm.] on the Interior form of Douglas-fir, respectively. During the fourth year after inoculation, single aerial shoots emerged from two of the infections. By the end of the fifth year, these two infections each possessed two aerial shoots. The largest shoot (24 mm in height) bore male flowers in the fifth year and anthesis proceeded normally.

The Interior form of Douglas-fir is thus shown to be susceptible to hemlock dwarf mistletoe, while the Coastal form appears immune or, at least, less susceptible. Since the Interior form is not naturally exposed to the disease, and the Coastal form appears to be immune, the absence of records of hemlock dwarf mistletoe on Douglas-fir might thus be explained. However, examination of Douglas-fir trees growing with infected western hemlock would possibly reveal successful parasitism, particularly at the eastern fringe of the range of hemlock mistletoe where Douglas-fir has some characteristics of the Interior form. Detection of natural infection would require very close inspection of branches because of low frequency and small size of infections, scarcity or lack of aerial shoots, and absence of conspicuous host damage. — R.B. Smith and E.F. Wass, Pacific Forest Research Centre, Victoria, B.C.

Simple and Inexpensive Modification for Doubling the Workload of Gyratory Shaking Machines.—Gyratory shakers are frequently used to enhance growth and metabolic processes of micro-organisms in liquid cultures. Several years ago, we were using four machines (New Brunswick Gyrotory Shakers — Model G10) to produce an antifungal metabolite with which we were experimenting. Other workers became interested in our compound and requested samples, thus presenting an immediate problem of production. The purchase of additional machines to resolve this, apparently short-term, problem seemed unduly expensive and their acquisition would have created a serious space problem. Similarly, the cost of modifying our equipment by installing commercially available parts could not be justified since the workload would not have been substantially increased. We therefore decided to attempt modifications of our own. The following is a description of the changes that were made.

The shaker platform (24 x 36 inches) was replaced by a ¾-inch sheet of fir plywood (36 x 48 inches) in which eight carriage bolts (¼ x 4 inches) were set 6 inches in from the edge and spaced 18 inches apart. One additional bolt was set in the center of the platform. The platform was then covered by a 1-inch piece of plastic foam which in turn was covered with polyethylene sheet. Nine holes, ¼ inch in diameter, were also bored in a sheet of

5/16-inch plywood (36 x 48 inches) in locations similar to the position of the bolts which were set in the platform. To accommodate 1-liter Erlenmeyer flasks, holes slightly smaller than the bottom diameter of the flasks were cut in the 5/16-inch plywood sheet in such a manner that the holes were evenly spaced about 1 inch apart. This procedure resulted in the 5/16-inch plywood sheet having 48 holes each with a diameter of 4¾ inches. The platform could accommodate 48 one-liter Erlenmeyer flasks held in position by the 5/16-inch sheet of plywood which was lowered over the flasks and bolts and made fast by affixing wing nuts to the bolts. The variation in the diameter amongst 48 flasks could be disregarded because the plastic foam ensured a snug fit by exerting an upward force upon the bottom of each flask. For our purposes, each flask contained 600 ml of liquid culture making an initial workload of about 125 lbs. (46.6 kg) counting the glassware, platform, and other appurtenances.

In addition, 26 spring steel clamps (125-ml flask size) were removed from the original platform and attached to the 5/16-inch sheet of plywood between the holes which held the flasks in place. This enabled small scale fermentation experiments to be conducted without interrupting large scale production of fungal metabolites (Fig. 1).

Figure 1. New Brunswick Gyratory Shaker (Model G10) with a platform installed to accommodate a workload of more than double that possible on commercially available equipment.

The alterations described can be effected without changing the variable pitch pulley used in machines sold before 1970. However, it is strongly recommended that the pulley be replaced if one speed is desired during the course of the fermentation period. It was found that the additional workload caused abnormal wear of the belts and resulted in increased speed of the shakers when the variable pitch pulley was used. However, belt wear was practically eliminated and a constant speed of about 150 strokes per minute was maintained by replacing the variable pitch pulley with a 1-inch steel pulley. Other size pulleys may be used to achieve different but constant speeds.

A variety of other flasks and containers can easily be accommodated on these platforms by fashioning additional holding covers from 5/16-inch plywood. It is also possible to tilt the flasks by inserting strips of wood on the surface of the platform. This tends to shorten the fermentation period by promoting aeration.

The total cost (labour and materials) of modifying the four machines was about $100.00. The workload was doubled at the expense of a slight increase in floor space. To do the same amount of work with conventional equipment would have required the purchase of four additional machines (Model G10) which in addition to cost would have created a space problem.

One might even substantially increase the workload beyond what is described here. Preliminary investigation in this direction has shown that this could only be accomplished by increasing the size of the platform. Addition of a second platform above caused serious vibration and would probably have resulted in damage to the motor and mechanical apparatus.

Our machines were modified as described above over 1 year ago. They have since been operating continuously at a speed of about 150 strokes per minute with maximum loads and minimal maintenance costs.

The New Brunswick Scientific Co. Inc. are aware of this modification to the machine and further information may be obtained from them. — M.A. Stillwell, Maritimes Forest Research Centre, Fredericton, N.B.

***Kabatina thujae* on Yellow Cedar in British Columbia Nurseries.**—Severe dieback on young ornamental yellow cedars [*Chamaecyparis nootkatensis* (D. Don) Spach] occurred in several nurseries in the Fraser valley in the summer of 1969. The apparent cause of the disease was *Kabatina thujae* Schneider & Arx (Phytopath. Z. **57**:176-182, 1966), which fruited in freshly killed shoots. The fungus was recently reported as the cause of a similar disease of *Thuja, Chamaecyparis* and *Cupressus* in Europe (Morelet, Soc. Linn. Lyon **39**:213-216, 1970). While other fungi have been reported in the Fraser valley outbreak by Plant Protection Division inspectors, *viz. Phomopsis juniperovora,* the finding of *Kabatina thujae* is a new record for North America and of interest because of its occurrence on an important native species. The fungus is also a potential threat to ornamental Cupressaceae in Canada.

The diseased trees, grown from cuttings of a mother tree of the blue form (*glauca* cultivar) of yellow cedar imported from Holland, were 7 years old and approximately 6 to 8 ft high in 1969. They were planted in rich agricultural soil at Pitt Meadows, adjacent to rows of the drooping form (*pendula* cultivar) of yellow cedar. None of the latter was diseased except for a few branchlets in which *K. thujae* was found. In a nursery approximately 30 miles away, a few trees of the *lutea* cultivar were lightly infected.

The dieback affected mostly branch tips and new shoots and was particularly severe in the upper part of the tree. The bole and thick branches were not affected by dieback although cankers were formed at the base of infected branchlets arising from them. Vigorous adventitious shoots grew abundantly around the base of infected trees and these usually became infected. In the nurseries, all trees of the *glauca* cultivar were infected, most had 40 to 50% of shoots and branch tips browned by the disease.

The cankers that formed on the main branches usually did not girdle or spread extensively. Most appeared to be annual, with sloughing of killed bark and extensive healing of the lesion in the same year.

The disease was first reported and studied in August 1969, but, according to the nursery manager, there had been some dieback from the time of outplanting. It is not known whether *K. thujae* was associated with the early disease manifestations. Predisposition to the severe attack in 1969 could have come from extreme low temperatures of the previous winter. Although little is known of the ecology of the *glauca* cultivar, trees would be subject to greater water stress in the Fraser valley than in the usual habitat of yellow cedar.

Differential susceptibility of the varieties of yellow cedar is demonstrated by the almost total absence of damage to the *pendula* cultivar growing on the same site. It is possible that the wild form is completely resistant to *K. thujae*. There has been no opportunity to test pathogenicity of this fungus on the *glauca* cultivar, but its close association with the disease and the known pathogenicity to species of *Thuja* and *Cupressus* are taken as evidence, not proof, of its causal role in this dieback. Pathogenicity tests on potted wildlings of yellow cedar at Victoria were negative.

The acervuli of *K. thujae* were found on dead leaves and branches of yellow cedar but other fungi were also found. *Pestalotia funerea* Desm., a fungus of doubtful pathogenicity, was quite common. An unidentified *Cucurbitaria* sp. was occasionally mixed with *K. thujae*. Two branches were apparently killed by *Cytospora abietis* Sacc., a facultative parasite, indicating perhaps a weaking of the host by climatic conditions.

It is not known if *Kabatina thujae* is introduced, or native, to Canada. The simultaneous occurrence of outbreaks in Canada and Europe makes this a difficult question because definite precedence cannot be established. In the Fraser valley, simultaneous outbreaks occurred at several widely separated points, suggesting that some form of predisposition triggered the outbreak of the already present disease. A survey of this area indicates that none of the native, naturally growing Cupressaceae are infected by *Kabatina*.

We thank Dr. J. A. von Arx, Centraalbureau voor Schimmelcultures, Baarn, for confirming identification of the fungus.—
A. Funk and A. C. Molnar, Pacific Forest Research Centre, Victoria, B.C.

Infection of Amabilis Fir by Larch Dwarf Mistletoe.—In nature, larch dwarf mistletoe [*Arceuthobium laricis* (Piper) St. John] occasionally attacks alpine fir [*Abies lasiocarpa* (Hook.) Nutt.] and grand fir [*A. grandis* (Dougl.) Lindl.] and, as our host-specificity studies show, it can also infect amabilis fir [*A. amabilis* (Dougl.) Forbes].

Larch dwarf mistletoe seeds were collected each year in September from southeastern British Columbia and stored in petri dishes at 5 C until used in inoculations in late October. Over a period of 4 years, 144 seeds were planted on eight amabilis fir growing in a plantation at Victoria, B.C. Seeds were wetted briefly and placed singly at the bases of needles and buds on 1- and 2-year-old branches.

A single, successful infection was first observed early in the third year after inoculation as a branch swelling with 14 small dwarf mistletoe aerial shoots. Several of these shoots produced female flowers in the fourth year, but all shoots were dead by the fifth, thus preventing development of fruit. The maximum height attained by the aerial shoots was 15 mm. The infection, still alive at the end of the fifth year after inoculation, had not produced any new aerial shoots. By this time, the swelling was 70 mm long and 19 mm wide.

Because the ranges of amabilis fir and western larch [*Larix occidentalis* Nutt.] do not coincide in British Columbia, this host-parasite combinttion will not occur naturally here. However, despite the low rate of infection indicated in the trials, the combination might be found in nature in the United States, since there is considerable overlap of the ranges of amabilis fir and western larch, particularly in Washington (Collingwood and Brush, Knowing your trees, Amer. Forest Ass., 1964). In the Mt. Adams area of south-central Washington and in north-central Oregon, the two species are reported as constituents of the same *Abies amabilis* zone (Franklin and Dyrness, U.S.D.A., Forest Serv., Res. Pap. PNW 80, 1969). Furthermore, larch dwarf mistletoe has been reported from these same general areas (Gill, Trans. Conn. Acad. Arts and Sci., 32: 111-245, 1935.)—
R. B. Smith and E. F. Wass, Pacific Forest Research Centre, Victoria, B.C.

Relative Susceptibility of Coastal and Interior Western Hemlock to Hemlock Dwarf Mistletoe *(Arceuthobium tsugense).*—Hemlock dwarf mistletoe [*Arceuthobium tsugense* (Rosend.) G. N. Jones] is restricted to coastal western North American forests. In British Columbia, it has been recorded up to 120 miles inland along main east-west valleys. Its principal host, western hemlock [*Tsuga heterophylla* (Raf.) Sarg.], has a much wider distribution and is found commonly in southeastern British Columbia in the Interior Western Hemlock Zone (Krajina, Ecol. West. Nor. Amer. 2(1):1-147, 1969), eastern Washington, northern Idaho and northwestern Montana. The reasons for the lack of hemlock dwarf mistletoe in interior areas has never been fully explored, though it has been demonstrated that western hemlock from southeastern British Columbia is not immune (Smith, Can. Dep. For., Bi.-Mon. Prog. Rpt. 21(6):3-4, 1965). As these early tests were not designed to discover whether differences in degree of susceptibility existed between interior and costal provenances of western hemlock (hereafter referred to as "interior hemlock" and "coastal hemlock", respectively), a new experiment was initiated.

Hemlock mistletoe seeds were obtained in early March 1968, by collecting seeds, already dispersed and germinating, from hemlock trees in a severely infected young stand near Cowichan Lake, Vancouver Island. Small twigs with seeds adhering to the needles and bark were clipped off, soaked in water, and the seeds gently removed with forceps. Since the seeds were no longer naturally sticky, inoculations were conducted by smearing a small amount of lanolin paste on twigs near needles. Seeds were placed singly on the paste with the radicles pointed toward the needle bases. In this manner, 12 seeds were planted on each of 15 interior hemlock and 15 coastal hemlock trees growing in pots in a greenhouse compartment. Temperatures within the compartment were kept as near as possible to the outside ambient temperatures. To reduce water loss from the seeds, the trees were given a water-mist treatment once a day during the first spring and summer. In nature, this moisture is provided by rain and dew. After 2 years, the potted trees were placed in an unheated shade-house.

Forty-three infections were produced on coastal hemlock and 40 on interior hemlock. One of the coastal hemlock trees died before infection could take place; thus, the inoculum was reduced from 180 to 168 seeds. By using this modified number of seeds for coastal hemlock, the rates of infection were 25.6% on coastal and 22.2% on interior hemlock. The only marked difference in host response was a more rapid development of symptoms and signs on interior hemlock than on coastal hemlock. During the first year after inoculation, swellings on interior hemlock were observed in 13 infections, during the second year, in the remaining 27. In contrast, only two swellings appeared on coastal hemlock during the first year, 35 during the second and six in the third year. Similarly, aerial shoots were slower to emerge from infections on coastal than on interior hemlock; 39 infections on interior hemlock and 17 on coastal hemlock bore aerial shoots in the second year. On all infections, shoots emerged by the end of the third year after inoculation.

The relatively advanced development on interior hemlock was short-lived. By the end of the fourth year, swellings on both provenances averaged 11.0 cm in length, and the average number and maximum height of aerial shoots differed only slightly. However, the earlier initial emergence of shoots on interior hemlock may have been the cause of the larger first fruit crop (500 per fruit-bearing infection) than that produced on the coastal hemlock (178 per fruit-bearing infection). Knowing that in other respects infections on coastal hemlock eventually equalled those on interior hemlock, it is assumed that fruit production would also become comparable in subsequent years.

There are thus no apparent differences in the susceptibility of interior and coastal hemlock to hemlock dwarf mistletoe that can explain the absence of hemlock mistletoe in interior areas. The earlier response to infection of interior hemlock would have, if anything, a favorable effect on the establishment and growth of hemlock mistletoe. Any explanation for the lack of dwarf mistletoe on hemlock in the Interior Western Hemlock Zone must lie, therefore, in present biological, geographic or climatic barriers, in historical events, or in some combination of these

factors. Hemlock mistletoe may never have colonized the interior because of adverse climate, or it may have existed but was eliminated during a change in climate. Since the parasite spreads much more slowly than its host, recolonization might be simply a matter of time, or recolonization might be checked by barriers such as belts of immune tree species, barren land or adverse climate. Some of the preceding explanations may be eliminated as results from current inoculation trials in the field become available.—R. B. Smith, Pacific Forest Research Centre, Victoria, B.C.

Is Decay Volume Strongly Related to Number of Knots and Log Volume in Poplar?—Seams, holes, conks, broken branches, unsound and rotten knots have all been used as indicators of decay presence in standing trees (Lavallée and Lortie, Forest. Chron. 44(4):5-10, 1968; Stayton *et. al.*, Forest. Prod. J. 20:55-58, 1970), however, estimating the amount of decay has posed problems mainly because qualitative classifications based on these indicators cannot always be described in quantitative terms. In addition, assessing the relationship between any one indicator and the decay volume presents problems. Sampling is affected because it is difficult to find and select trees having only one type of indicator. Most sample trees will have two or more indicator types and separating the effects of each is often not possible.

To solve these problems some investigators combine all indicators into counts (Ware, Proc. Soc. Amer. Forest. 211-217, 1964), whereas others choose only those which most affect the resulting product volume (Barger and Ffolliott, U.S. Dep. Agr., Forest. Serv., Res. Pap. RM-57, 1970). This note presents an analysis of poplar [*Populus tremuloides* Michx.] trees at two locations in Ontario and provides some indication of the relationships existing among decay volume, number of unsound knots and log volume.

Fifty-six trees were sampled at the Petawawa Forest Experiment Station, Chalk River, and fifteen trees were taken at the Larose Forest near Bourget, Ontario. On each tree, breast-height diameter, stump age and total height were measured. After felling, the merchantable bole was bucked into 16-foot logs to a 3-inch top diameter inside bark, the last merchantable log being equal to or shorter than 16 feet. Each log was diagrammed and all indicators on the log surface, easily recognizable by visual inspection, were identified and recorded by their type, frequency, size and location. Furthermore, each log was sectioned into 2-foot lengths to examine the discoloration and/or decay patterns on the cross-sectional areas, and to measure section and decay diameters.

From these data, 114 logs— 75 from Petawawa and 39 from Larose Forest— having unsound knots as the only type of decay indicator were selected for further analyses. The distribution of the number of logs within the tree was as follows:

Location	1st log	2nd log	3rd log	Total
Petawawa	18	28	29	75
Larose	15	12	12	39

In this study, an unsound knot was defined as: "A knot not solid across its face or else softer than the surrounding wood, due to decay or other defects" (Terminology of Forest Science, Technology, Practice and Products, Soc. Amer. Forest., 1971). The relationships of decay volume with number of unsound knots and log volume were investigated using the regression equation $Y = b_o + b_1X$. The dependent variables were decay volume in cubic feet, and decay volume as a percent of log volume, whereas the independent variables were log volume in cubic feet, the number of unsound knots, and the number of unsound knots per square foot of log-surface area.

Table 1 shows the results of the regression analyses. In every case the contribution of the unsound knots in explaining the variation in decay volume and decay volume percent was non-significant at the 5% significance level. For the Petawawa sample only, the cubic foot log volume was significant in explaining the variation in decay volume but not in decay volume percent.

On the basis of this small study it appears that the frequency and distribution of unsound knots shows no relationship with the decay volume present in the log. While log size was related to decay volume in the Petawawa sample, its importance as a variable for estimating purposes might depend upon geographic location. Additional data are required to substantiate these findings. — I.S. Alemdag and T.G. Honer, Forest Management Institute, Ottawa.

TABLE 1

Statistics for relationships of decay volume and decay volume percent with log size, number of knots, and number of knots per square foot of surface area

Dependent variable	Independent variable	First 16-ft log			All 16-ft logs of 1st-3rd positions		
		Total variation accounted for %	Significance of X variable	SE% of mean	Total variation accounted for %	Significance of X variable	SE% of mean
(a) Petawawa data							
Decay volume of a log in cu ft	Log volume—cu ft	39.18	S	148	19.77	S	131
	No. of knots on log	0.73	NS	189	0.09	NS	146
	No. of knots per sq ft	9.34	NS	181	3.73	NS	143
Decay volume of a log in %	Log volume—cu ft	5.05	NS	128	1.01	NS	119
	No. of knots on log	4.47	NS	129	0.13	NS	120
	No. of knots per sq ft	10.93	NS	124	0.00	NS	120
(b) Larose data							
Decay volume of a log in cu ft	Log volume—cu ft	0.11	NS	184	4.02	NS	171
	No. of knots on log	10.32	NS	174	0.21	NS	174
	No. of knots per sq ft	10.99	NS	173	0.02	NS	174
Decay volume of a log in %	Log volume—cu ft	1.30	NS	201	<0.01	NS	158
	No. of knots on log	7.88	NS	194	0.28	NS	158
	No. of knots per sq ft	8.08	NS	194	0.23	NS	158

SILVICULTURE

A Progeny Test of Rapidly Grown White Spruce Seedlings.—To produce a white spruce seedling suitable for field planting normally takes 4 years from sowing in a nursery. This report describes one application of a method for accelerating growth to produce seedlings suitable for field planting in 1 year, and examines 17 progenies from a superior white spruce [*Picea glauca* (Moench) Voss] seed source grown by this method.

Progenies of 17 trees from the Beachburg area of eastern Ontario were used in testing the method of growth acceleration. Progenies from this area grow rapidly in many plantations from the Atlantic to Western Ontario (Teich. Proc. Twelfth Meeting Comm. Forest Tree Breeding Can: 95-100, 1969). Seed was collected in 1970, stratified for 3 weeks and sown on 5 January 1971 in Turface (a calcined clay chip) in 300-ml white plastic pots in a greenhouse (Fig.1). The experimental design was 1 seedling per pot, 10 pots per plot, 3 replications, and 17 seedlots. Light intensity was maintained at about 20000 lux at plant level by supplementing daylight with 10 high-output fluorescent lamps over each replicate during a 16-hr photoperiod. Temperature varied from 62 F at night to 78 F during the day. Every 6 hours seedlings were fed about 25 ml of Ingestad nutrient solution (Fourteenth IUFRO Cong. 3:275-278, 1967) through an automatic watering system (Pollard, Can. Forest. Serv. Inf. Rep. PS-X-28, 5 pp, 1971).

On 3 June 1971 seedlings were transferred to a growth room, maintained at 20000 lux under a 10-hr photoperiod at a constant temperature of 70 F, and kept under the same nutrient regime. Apical growth stopped and on 28 June seedlings were potted in compost, and placed in shaded, outdoor nursery beds (Fig. 2). Shades were removed in August. (For production of seedlings for outdoor experiments, peat and vermiculite (3:1) is recommended as an initial rooting medium as it facilitates repotting and transplanting.)

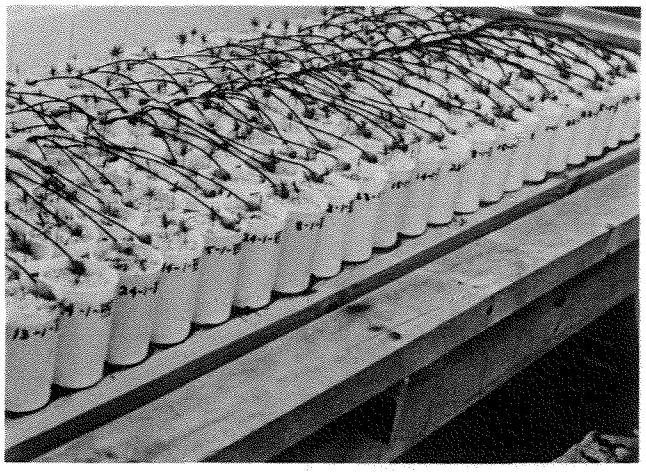

Figure 1. White spruce progeny test in progress, 5 weeks after sowing (photo: 11 February 1971).

TABLE 1

Seedling height of white spruce progenies from Beachburg, Ont. (Seedlots with no common letter differ significantly, P = 0.05)

Progeny seedlot number	Mean heights (cm) of seedlings (Weeks after sowing) Week 18	Week 25*
70061	16.6a	26.6a
70059	16.4a	26.8a
70057	14.6 b	22.7abcde
70066	14.2 b	25.3ab
70072	13.5 bc	24.5abc
70068	13.0 bc	21.4 bcdef
70060	12.9 bc	21.3 bcdef
70073	12.8 bc	20.9 bcdef
70069	12.7 bc	24.3abcd
70056	12.7 bc	22.7abcde
70058	12.2 cd	21.6abcdef
70067	12.1 cd	21.1 bcdef
70055	12.0 cd	19.5 def
70070	11.7 cd	19.2 def
70062	11.6 cd	19.9 cdef
70071	11.6 cd	19.0 ef
70063	10.7 d	16.9 f
mean	13.0	22.0

*Sample size reduced from 30 to 18 because progenies were sampled for other purposes.

Figure 2. White spruce progeny test in overwintering bed, after completing 21 weeks of accelerated growth and a similar period of hardening (photo: 27 October 1971).

Figure 3. Overwintered white spruce seedlings from earlier experiment. Seedlings were sown 4 May 1970, hardened and transferred to nursery after 12 weeks. (photo: June 1971; seedlings in 12.5-cm pots).

The seedlings were measured 18 and 25 weeks after sowing (Table 1). At 25 weeks (29 June 1971) they appeared large enough for field planting in the following spring, 3 years earlier than if grown routine nursery techniques. Had they been sown earlier, say in November 1970 rather than January 1971, they would have been ready for planting in the spring of 1971.

A previous study (unpublished) indicated that seedlings grown by this accelerated method were winterhardy. Following 3 months of accelerated growth, white spruce (and jack pine) were repotted and placed in a nursery in August 1970. All plants survived the winter and grew normally in the spring of 1971 (Fig. 3).

Variation among the progeny of the 17 Beachburg trees indicates a considerable potential for improving an already excellent population. The two best progenies exceeded the population mean by 28% at 18 weeks and 22% at 25 weeks. There was little relation between seed weight and seedling heights, the correlation being only 0.21 at 18 weeks and 0.16 at 25 weeks. In other studies early seedling height had been found useful in estimating tree growth rate (King, Nienstaedt and Macon, USDA Forest Serv. Res. Note LS-66. 1965). If the observed progeny variation persists, a large-scale program of improving Beachburg white spruce will be warranted. Quite apart from their potential in early screening, growth acceleration techniques will offer increased efficiency in this improvement program by reducing the time required to conduct experiments. D.F.W. Pollard and A.H. Teich, Petawawa Forest Experiment Station, Chalk River, Ont.

(Continued from back cover)

Retnakaran, Arthur. 1971. Thiotepa as an effective agent for mass sterilizing the spruce budworm, *Choristoneura fumiferana* (Lepidoptera: Tortricidae). Can. Entomol. **103**:1753-1756.

Safranyik, L. and C. Vithayasai. 1971. Some characteristics of the spatial arrangement of attacks by the mountain pine beetle, *Dendroctonus ponderosae* (Coleoptera: Scolytidae), on lodgepole pine. Can. Entomol. **103**:1607-1625.

Shaw, D. D. 1971. Genetic and environmental components of chiasma control. I. Spatial and temporal variation in *Schistocerca* and *Stethophyma*. Chromosoma. **34**:281-301.

Shen, K. C. 1971. Evaluating particleboard properties by measuring saw-cutting force. Forest Prod. J. **21**:46-52.

Shields, J. K., W. Thornber, and T. S. McKnight. 1971. How researchers are combatting eastern hardwood strain problem. Can. Forest Ind. (November 1971).

Smirnoff, W. A. 1971. An immersion oil dispenser for microscopes. Can. J. Med. Tech. **33**:243-244.

Smirnoff, W. A. 1971. Effect of chitinase on the action of *Bacillus thuringiensis*. Can. Entomol. **103**:1829-1831.

Smirnoff, W. A. 1971. Mouvements du potassium et du soufre chez la larve de *Neodiprion swainei* (Hymenoptera-Tenthredinidae) au cours de l'infection virale (Polyédrie Nucleaire). Rev. Can. Biol. **30**:301-305.

Stranks, D. W. and Jadwiga Bieniada. 1971. A rapid test for cellulolytic activity. In. Biodetn. Bull. **7**:109-111.

Syme, Paul D. 1972. The influence of constant temperatures on the non-diapause development of *Hyssopus thymus* (Hymenoptera: Eulophidae). Can. Entomol. **104**:113-120.

Syme, Paul D. 1971. The life history and biology of *Hyssopus thymus* (Hymenoptera: Eulophidae), a parasite of the European pine shoot moth (Lepidoptera: Olethreutidae) in Ontario. Can. Entomol. **103**:1691-1696.

Tostowaryk, Walter. 1972. The effect of prey defense on the functional response of *Podisus modestus* (Hemiptera: Pentatomidae) to densities of the sawflies *Neodiprion swainei* and *N. pratti banksianae* (Hymenoptera: Neodiprionidae). Can. Entomol. **104**:61-69.

Vithayasai, C. 1971. Runs of healthy and diseased trees in transects through an infected forest: statistical and computational methods. Biometrics. **27**:1003-1016.

Von Althen, F. W. 1971. Extended stratification assures prompt walnut germination. Forest. Chron. 47(6). (December 1971).

Warren, W. G. 1971. Correlation or regression: Bias or precision. J. Royal Statist. Soc. Series C. **20**:148-164.

Warren, W. G. 1971. The center-satellite concept as a basis for ecological sampling. Statist. Ecol. **2**:87-118.

Weatherston, John. 1971. Aspects of the chemical defenses of millipedes. Proc. 2nd IUPAC Internat. Congr. Pesticide Chem. **3**:183-193.

Weatherston, J., D. Tyrrell and J. E. Percy. 1971. Long chain alcohol acetates in the defensive secretion of the millipede *Blaniulus guttulatus*. Chem. Phys. Lipids. **7**:98-100.

Weatherston, J., W. Roelofs, A. Comeau and C. J. Sanders. 1971. Studies of physiologically active arthropod secretions. X. Sex pheromone of the eastern spruce budworm, *Choristoneura fumiferana* (Lepidoptera: Tortricidae). Can. Entomol. **103**:1741-1747.

Whitney, H. S. 1971. Association of *Dendroctonus ponderosae* (Coleoptera: Scolytidae) with blue stain fungi and yeasts during brood development in lodgepole pine. Can. Entomol. **103**:1495-1503.

MAY — JUNE

Angus, T. A. 1970. Implications of some recent studies of *Bacillus thuringiensis* — A personal purview. *In* Proc. IV Int. Colloq. Insect Pathol., College Park, Md. pp. 183-189.

Althen, von F. W. 1972. Stock age, planting method and weed control in red oak afforestation. Forest. Chron. 48 (February)

Aplin, E. N. 1972. Stiffness-graded eastern spruce laminated beams. Forest Prod. J. **22**(1):26-31.

Atkins, Michael D. 1972. Developmental variability among laboratory reared balsam woolly aphid (Hemiptera: Chermidae). Can. Entomol. **104**:203-208.

Bergin, E. G. and V. Godin. 1971. Durability of wood adhesives in birch plywood after 15 years indoor aging. Dep. Environ., Can. Forest. Serv. Pub. 1307. 8 p.

Bloomberg, W. J. and Jack R. Sutherland. 1971. Phenology and fungus-nematode relations of corky root disease of Douglas-fir. Ann. Appl. Biol. **69**:265-276. With 1 plate.

Bohlen, J. C. 1972. Laminated-veneer lumber — Development and economics. Forest Prod. J. **22**(1):18-26.

Bousquet, D. W., W. W. Calvert and R. M. Nacker. 1972. Conversion surplus: measure of profit from sawing hardwood. Can. Forest Ind. (February).

Brace, L. G. 1971. Effects of white pine weevil damage on tree height, volume, lumber recovery and lumber value in eastern white pine. Dep. Environ., Can. Forest. Serv. Pub. 1303.

Brace, L. G. 1972. Weevil control could raise value of white pine by 25%. Can. Forest Ind. (January).

Bradley, G. A. 1972. Transplanting *Formica obscuripes* and *Dolichoderus taschenbergi* (Hymenoptera: Formicidae) colonies in jack pine stands of southeastern Manitoba. Can. Entomol. **104**:245-249.

Brix, H. 1971. Effects of nitrogen fertilization on photosynthesis and respiration in Douglas-fir. Forest Sci. **17**:407-414.

Calvert, W. W. and A. L'Ecuyer. 1972. Pretreatment allows debarking at below-zero temperatures. Can. Pulp Pap. Ind. (February).

Cameron, J. W. MacBain. 1971. Insect pathogens and their potential for regulation of insect populations. *In* Proc. Tall Timbers Conf. Ecol. Anim. Contr. by Habitat Manage. February 25 - 27, 1971. pp. 267-277.

Carlisle, A. and A. H. Teich. 1971. The costs and benefits of tree improvement programs. Dep. Environ., Can. Forest Serv. Pub. 1302.

Cserjesi, A. J. and E. L. Johnson. 1972. Methylation of pentachlorophenol by *Trichoderma virgatum*. Can. J. Microbiol. **18**:45-49.

Cunningham, J. C. 1971. Polyhedrosis viruses infecting the eastern hemlock looper, *Lambdina fiscellaria fiscellaria*. *In* Proc. IV. Int. Colloq. Insect Pathol. 5 p.

Dobie, J. and W. J. Sturgeon. 1972. An assessment of the economic benefits of double-cut headrigs. Forest Prod. J. **22**(2):22-24.

Donaghue, T. P. and Y. Hayashi. 1972. Cytoplasmic polyhedrosis virus (CPV) of *Malacosoma disstria*: RNA polymerase activity in purified free virion. Can. J. Microbiol. **18**:207-210.

Fogal, W. H. and M.-J. Kwain. 1972. Uric acid excretion by midgut epithelium in *Gilpinia hercyniae* (Htg.) Can. J. Zool. **50**:143-145.

Gagnon, J. D. and M. Boudoux. 1971. Statut nutritif de l'épinette noire (*Picea mariana* (Mill.) BSP) en relation avec l'indice de site. Ecol. Plant. **6**:371-381.

Hatton, John V. and K. Hunt. 1972. Effect of prolonged outside chip storage on yield and quality of kraft pulps from *Picea glauca* and *Pinus contorta* chips. Tappi **55**:122-126.

Hatton, John V. and Maria Samkova. 1972. Relationship between bulk and handsheet physical properties for kraft pulps. 1. Tree components of *Picea glauca*. Tappi **55**:93-96.

Hayashi, Y. and J. Krywienczyk. 1972. Electrophoretic fractionation of cytoplasmic polyhedrosis virus genome. J. Invertebr. Pathol. **19**:160-162.

Hayashi, Y., T. Kawarabata and F. T. Bird. 1970. Possible function of viroplasm in the replication of eytoplasmic-polyhedrosis virus. *In* Proc. IV Int. Colloq. Insect Pathol., College Park, Md., pp. 105-115.

Hulme, M. A. and D. W. Stranks. 1971. Regulation of cellulase production by *Myrothecium verrucaria* grown on non-cellulosic substrates. J. Gen. Microbiol. **69**:145-155.

Magasi, Laszlo P. 1972. First record of *Scleroderris lagerbergii* in New Brunswick, Canada. Plant Dis. Rep. **56**:245-246.

Marshall, Valin G. and Evert E. Lindquist. 1972. Notes on the genus *Nalepella* (Acarina: Eriophyoidea) and the occurrence of *N. halourga* on black spruce in Canada. Can. Entomol. **104**:239-244.

Miller, D. G. 1972. Combining radio-frequency heating with kiln-drying to provide fast drying without degrade. Forest Prod. J. **21**(21):17-21.

Morgenstern, E. K. 1972. How to develop relevant breeding programs and apply the results. Forest. Chron. **48** (February).

Morris, Oswald N. 1971. Metabolic changes in diseased insects. IV. Radioautographic studies on protein changes in nuclear polyhedrosis, densonucleosis, and *Tipula* iridescent virus infections. J. Invertebr. Pathol. **18**:191-206.

Newnham, R. M. 1972. Simulation studies in the logging development program of the Canadian Forestry Service. Forest. Chron. 48 (February).

Outram, I. 1972. Effects of synthetic juvenile hormone on adult emergence and reproduction of the female spruce budworm, *Choristoneura fumiferana* (Lepidoptera: Tortricidae). Can. Entomol. **104**:271-273.

Park, J. Y. 1971. Preparation of mycorrhizal grain spawn and its practical feasibility in artificial inoculation. *In* Proc. First North Amer. Conf. Mycorrhizae — April 1969 — Misc. Pub. 1189. U.S. Dep. Agri. — Forest Serv. pp. 239-240.

Pollard, D. F. W. 1971. Mortality and annual changes in distribution of above-ground biomass in an aspen sucker stand. Can. J. Forest Res. **1**:262-266.

Price, Peter W. 1972. Immediate and long-term effects of insecticide application on parasitoids in jack pine stands in Quebec. Can. Entomol. **104**:263-270.

Puritch, G. S. and R. P. C. Johnson. 1971. Effects of infestation by the balsam woolly aphid, *Adelges piceae* (Ratz.) on the ultrastructure of bordered-pit membranes of grand fir, *Abies grandis* (Doug.) Lindl. J. Exp. Bot. **22**(73):953-958.

Puritch, G. S. and J. A. Petty. 1971. Effect of balsam woolly aphid, *Adelges piceae* (Ratz.), infestation on the xylem of *Abies grandis* (Doug.) Lindl. J. Exp. Bot. **22**(73):946-952.

Salamon, M. and S. McIntyre. 1971. How to dry lodgepole pine under the new lumber rules. Can. Forest. Ind. (December).

Smirnoff, W. A. 1972. Effects of volatile substances released by foliage of *Abies balsamea*. J. Invertebr. Pathol. **19**:32-35.

Smith, Roger S. 1971. Maintenance of fungal cultures in presterilized disposable screw-cap plastic tubes. Mycologia. LXIII:1218-1221.

Smith, Roger S. and John V. Hatton. 1971. Economic feasibility of chemical protection for outside chip storage. Tappi **54**:1638-1640.

Sohi, S. S., F. T. Bird and Y. Hayashi. 1970. Development of *Malacosoma disstria* cytoplasmic polyhedrosis virus in *Bombyx mori* ovarian and tracheal tissue cultures. *In* Proc. IV. Int. Colloq. Insect Pathol. College Park, Md. pp. 340-351.

Sohi, S. S. and J. C. Cunningham. 1972. Replication of a nuclear polyhedrosis virus in serially transferred insect hemocyte cultures. J. Invertebr. Pathol. **19**:51-61.

Sohi, S. S. and Y. Hayashi. 1971. Metabolism of *Aedes aegypti* cells grown in vitro. II. Determination of cell viability. In Vitro. 7:146-151.

Stiell, W. M. 1971. Comparative cone production in young red pine planted at different spacings. Dep. Environ. Can. Forest Serv. Pub. 1306. p. 8.

Unligil, H. H. 1972. Tolerance of some Canadian strains of wood-rotting fungi to wood preservatives. Forest Prod. J. **22**:40-45.

Watson, J. A. 1971. Survival and fecundity of *Dendroctonus ponderosae* (Coleoptera: Scolytidae) after laboratory storage. Can. Entomol. **103**:1381-1385.

Whitney, R. D. 1971. Mycorrhiza studies in Manitoba and Saskatchewan. Proc. First North Amer. Conf. Mycorrhizae — April 1969 — Misc. Pub. 1189. U.S. Dep. Agri. — Forest Serv. pp. 241-242.

Wong, H. R. 1972. *Dioryctria banksiella* (Lepidoptera: Pyralidae) in the western gall rust, *Endocronartium harknessii* (Basidiomycetes: Uredinales). Can. Entomol. **104**:251-255.

Yeatman, C. W. and M. J. Holst. 1972. Hardiness of jack pine hybrids and provenances in the boreal forest. Forest Chron. 48 (February).

Yule, W. N. and A. F. W. Cole. 1971. Measurement of insecticide drift in forestry operations. Proc. 4th Int. Agric. Aviat. Congr. (Kingston, 1969).

recent publications

MARCH — APRIL

Barton, G. M. 1972. New C-methyl flavanones from Douglis-fir (*Pseudotsuga menziesii* (Mirb.) Franco). Phytochemistry. **11**:430-432.

Cech, M. Y. and D. R. Huffman. 1971. High-temperature kiln-drying of spruce joists. Forest Prod. J. **21**:55-60.

Dionne, J.-C. 1971. Vertical packing of flat stones. Can. J. Earth Sci. **8**:1585-1591.

Dionne, Jean-Claude, 1971. Polygonal patterns in muddy tidal flats. J. Sediment. Petrol. (September 1971). 838-839.

Edwards, D. G. W. 1971. The kinetics of water absorption in stratifying and nonstratifying noble fir (*Abies procera* Rehd.) seeds. Can. J. Forest Res. **1**:235-240.

Embree, D. G. and G. R. Underwood. 1972. Establishment in Maine, Nova Scotia, and New Brunswick of *Olesicampe benefactor* (Hymenoptera: Ichneumonidae), an introduced ichneumonid parasite of the larch sawfly, *Pristiphora erichsonii* (Hymenoptera: Tenthredinidae). Can. Entomol. **104**:89-96.

Feihl, O. 1971. Design and performance of roller pressure bars for veneer lathes. Dep. Environ., Can. Forest Serv. Pub. 1225. 21 p.

Heger, L. 1971. Confidence interval for site index using curves based on stem analyses. Can. J. Forest Res. **1**:241-245.

Hocking, D. 1971. Effect and characteristics of pathogens on foliage and buds of cold-stored white spruce and lodgepole pine seedlings. Can. J. Forest Res. **1**:208-215.

Honer, T. G. 1971. Crown shape in open- and forest-grown balsam fir and black spruce. Can. J. Forest Res. **1**:203-207.

Hulme, M. A. 1971. Viscometric determination of carboxymethylcellulase in standard international units. Archives Biochem. and Biophys. **147**:49-54.

Johnston, J. S. and A. St-Laurent. 1971. A portable mechanical force-displacement recorder. Experimental Mechanics. (December 1971).

Keith, C. T. 1971. The anatomy of compression failure in relation to creep-inducing stresses. Wood Sci. **4**:71-82.

Lachance, Denis. 1971. Inoculation and development of *Eutypella* canker of maple. Can. J. Forest Res. **1**:228-234.

Lawko, Carol M. 1971. A double replica method for counting ommatidia in curved compound eyes. Can. Entomol. **103**:1849-1850.

Lipa, J. J. and W. A. Smirnoff. *Crithidia cimbexi* sp. n., a new flagellate parasite of *Cimbex americana* Leach (Hymenoptera, Tenthredinidae). Bull. de L'Académie Polonaise des Sci. XIX:269-274.

Logan, K. T. 1971. Monthly variations in photosynthetic rate of jack pine provenances in relation to their height. Can. J. Forest Res. **1**:256-261.

Manners, Gary D. and Eric P. Swan. 1971. Isolation and structure of a dilignol rhamnoside from the leaves of *Thuja plicata* trees. Can. J. Chem. **49**:3607-3611.

McGuffin, W. C. 1971. Descriptions of larvae of two eastern species of *Lygris* (Geometridae). J. Lepidop. Soc. **25**:262-264.

McGuffin, W. C. and K. Bolte. 1971. Variation in larval colour patterns of *Itame ribearia* (Geometridae). J. Lepidop. Soc. **25**:266-270.

McIntosh, J. A. 1971. Muirhead tree cutter put to the test. British Columbia Lumberman. (November 1971).

Morris, R. F. 1971. The influence of land use and vegetation on the population density of *Hyphantria cunea*. Can. Entomol. **103**:1525-1536.

Payandeh, Bijan and Alan R. Ek. 1971. Observations on spatial distribution and the relative precision of systematic sampling. Can. J. Forest Res. **1**:216-222.

Percy, J. E. and J. Weatherston. 1971. Studies of physiologically active arthropod secretions IX. Morphology and histology of the pheromone-producing glands of some female Lepidoptera. Can. Entomol. **103**:1733-1739.

Philogène, Bernard J. R. and Daniel M. Benjamin. 1971. Temperature and photoperiod effects on the immature stages and adults of *Neodiprion swainei* (Hymenoptera: Diprionidae). Can. Entomol. **103**:1705-1715.

Powell, J. M. 1971. Daily germination of *Cronartium comandrae* aeciospores. Can. J. Bot. **49**:2123-2127.

Price, Peter W. 1972. Behavior of the parasitoid *Pleolophus basizonus* (Hymenoptera: Ichneumonidae) in response to changes in host and parasitoid density. Can. Entomol. **104**:129-140.

Price, Peter W. 1971. Niche breadth and dominance of parasitic insects sharing the same host species. Ecology. **52**:587-596.

Puritch, G. S. 1971. Water permeability of the wood of grand fir (*Abies grandis* (Doug.) Lindl.) in relation to infestation by the balsom woolly aphid, *Adelges piceae* (Ratz.). J. Exp. Bot. **22**:936-945.

Rand, R. P., D. O. Tinker and P. G. Fast. 1971. Polymorphism of phosphatidylethanolamines from two natural sources. Chem. Phys. Lipids. **6**:333-342.

Raske, A. G. 1972. Immature stages, genitalia, and notes on the biology of *Coenopoeus palmeri* (Coleoptera: Cerambycidae). Can. Entomol. **104**:121-128.

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