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CONTENTS OF VOLUME 1 (1981)

TREE PHYSIOLOGY AND ANATOMY

Response of Strobilus Production to Gibberellin and Fertilizer Treatment in a Young Western Hemlock Clone Bank on Western Vancouver Island.—Enhancement of strobilus production in west coast conifers through treatments with gibberellins has been achieved in Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, (Puritch et al., Can. J. Forest Res. 9:193–200, 1979) and western hemlock, *Tsuga heterophylla* (Raf.) Sarg., (Ross et al., Can. J. Forest Res. 11:90–98, 1981). Experiments reported for these species were conducted on seed orchards or clone banks located in the Drier Maritime Coastal Douglas-fir Subzone (Klinka et al., Rep. B.C. Min. For., 1979) of Vancouver Island, B.C. This area is highly suitable for seed orchards because of the combination of warm dry summers and mild winters. However, seed orchards have been located in wetter areas on Vancouver Island, and the question arises: Can flowering be enhanced with gibberellins in young conifers growing under conditions less favorable than those in the drier subzone?

Recent experiments with western hemlock have also revealed that the response to gibberellin may be enhanced by calcium nitrate (Ross et al., 1981); the combination of gibberellin $A_{4/7}$ and this fertilizer is employed as a standard treatment for strobilus induction (Pollard and Portlock, Can. For. Serv. Res. Notes 1:21, 1981). Thus, this experiment incorporated a basic combination treatment that has proved to be effective elsewhere. A fertilizer-only treatment was added because of the ease with which calcium nitrate could be applied. The novel features of this investigation were the moister climatic subzone of the test site and the grafted origin and large size (up to 6 m) of the experimental material.

The test site for this study was a grafted clone bank of western hemlock established in the field by the Tahsis Company at Gold River in 1970. The clone bank is located in the Drier Maritime Coastal Western Hemlock Subzone (Klinka et al., 1979) at an elevation of about 100 m. Three grafts were selected from each of 12 clones on the basis of uniform height and diameter. Grafts within clones were assigned at random to one of two treatments or as controls.

The main treatment consisted of gibberellin injection combined with calcium nitrate fertilization. A solution of 100 ppm gibberellin $A_{4/7}$ mixture was applied by the method described by Ross et al. (1981). Powdered $A_{4/7}$ was dissolved in a small quantity of ethanol, to which distilled water was added. The solution was gravity-fed continuously, beginning 26 May 1979, from inverted 1-L polyethylene bottles taped 50 cm above 3-mm holes drilled into the stems. The position of the holes on the stems varied between 15 and 100 cm from ground level; in four ramets, the hole was beneath the graft union. Each hole was drilled through the stem radially until pressure was felt from the drill bit under the bark on the opposite side. Gibberellin solution was fed into the stem via plastic tubing fitted with a plastic intravenous spigot pushed into the hole. Reservoir bottles were wrapped in aluminum foil and mounted on the north side of the stem. The solution was checked weekly and replenished as necessary; bottles were removed 10 September 1979. Calcium nitrate was applied to each gibberellin-treated tree and to a duplicate set of ramets (providing a treatment of fertilizer alone). Each tree received a single application on 26 May 1979 of 126 g, spread over a 1-m diameter area on the ground around the stem.

The strobili count was made on 26 April 1980, during emergence of male and female strobili. Numbers of strobili are presented in Table 1. All three ramets of one clone died during the test for no reason that could be associated with the experiment. Of the 11 remaining clones, all but one responded to application of $A_{4/7}$ and $Ca(NO_3)_2$ with production of female strobili; five clones also produced male strobili with this treatment. Only two control and two fertilized-only ramets produced female strobili and none of the control or fertilized-only ramets produced males. The differences between $A_{4/7}$ and other treatments were highly significant.

TABLE 1
Production of strobili in gibberellin-treated ($A_{4/7}$) and fertilized ($Ca(NO_3)_2$) western hemlock grafts

	Male Strobili		Female strobili	
	Number of ramets with strobili	Mean number of strobili (n=11)*	Number of ramets with strobili	Mean number of strobili (n=11)*
$A_{4/7}$ + $Ca(NO_3)_2$	5	74	10	189
$Ca(NO_3)_2$ alone	0	0a	2	19a
Control	0	0a	2	10a

*Numbers of strobili followed by a are not significantly different (t-test, p = 0.01).

The quantities of flowers produced were extremely variable, ranging from 2 to 500 males and from 3 to 600 females. The variation might be attributable to several factors, including genetically based differences, differences in vascular elements affected by random drilling, and effective uptake and utilization of $A_{4/7}$ and calcium nitrate. Of these, only absolute uptake of $A_{4/7}$ as gauged from replenished solution was readily measured; it showed very little correlation with response. For example, the number of female strobili produced was weakly and negatively correlated (r = -0.36) with total uptake recorded by 17 July 1979 (approximating the end of the response period reported by Ross et al., 1981). The quantity taken up varied from 50 to 575 mL; the ramet showing greatest response (500 male, 600 female strobili) absorbed only 200 mL of solution, containing 20 mg of $A_{4/7}$. However, as McMullan (Can. J. Forest Res. 10:405-422, 1980) has indicated, the quantities of experimentally supplied gibberellins absorbed by trees may far exceed the total quantities normally residing in buds. It is probable, therefore, that only a small fraction of supplied gibberellin actually affects the reproductive response. The position of the drilled injection hole did not influence response to treatment.

The experiment was completed with samples of cones collected from ramets in September 1980. Cones and seeds appeared normal, although the percentage of filled seeds was low in all three groups (controls, 32%; fertilized-only, 31%; fertilized plus $A_{4/7}$, 32%). These percentages probably reflect conditions for pollination; there was no evidence of peculiarities among treated ramets.

The quantities of female strobili produced would have been sufficient for the conduct of numerous controlled crosses in most clones. Production of male strobili was less abundant. However, since the combination of $A_{4/7}$, high temperature, and $Ca(NO_3)_2$ resulted in more abundant male strobili in growth-room trials with this species (Pollard and Portlock, Can. For. Serv. Res. Notes, 1:21, 1981), small refinements in field techniques should facilitate conduct of controlled crosses at an early age. The experiment demonstrated that seed production can be enhanced in large, young western hemlock grafts under field conditions less conducive to strobilus initiation than those prevailing in the Drier Maritime Coastal Douglas-fir Subzone of Vancouver Island.—D.F.W. Pollard and F.T. Portlock, Pacific Forest Research Centre, Victoria, B.C., and H. Jensen, British Columbia Ministry of Forests, Victoria, B.C.

ENTOMOLOGY

Measurement of Needle Area Consumed by Larvae of *Choristoneura fumiferana*.—Bacterial or viral insecticides function only after ingestion of the toxicant/infective agent. In the forest these agents are applied as droplets emitted from aircraft to impinge on the target needles. The number of droplets accumulated on a unit surface area of a needle is small and so it becomes important to know the surface area consumed by a larva in order that application dosage can be optimized to deliver a lethal dose to feeding larvae. In our efforts to develop such information for the application of *Bacillus thuringiensis* insecticides against the spruce budworm, *Choristoneura fumiferana* Clem., we have measured the surface area consumed by fourth instar larvae, the target instar in aerial applications.

Newly-moulted fourth instar larvae of *C. fumiferana* that had been reared on an artificial diet (Grisdale, Can. Entomol. 102:1111-1117, 1970) were starved for 24 h and then placed on flushed but tender balsam fir (*Abies balsamea* [L.] Mill.) buds. The length and width of each needle had been measured by a micrometer eyepiece to aid in determining the amount of feeding that had occurred. About eight needles were provided to each larva and individual larvae were placed directly on the needles in a tube with damp facial tissue in the bottom and a loose cotton plug in the top. Larvae were then placed in an environmental chamber at 20° C and 70% relative humidity, and with a 16h:8h light:dark cycle for 24 h. If the damp facial tissue was omitted, the needles dried out and curled so that photography was difficult.

After the 24-h feeding period, the needles and larvae were removed from the tube and those needles that had been fed upon were photographed with a Zeiss OPMI-6 dissecting microscope fitted with a Nikon body. Electronic flash was used because normal illumination caused the needles to dry out and curl. Technical pan film was exposed 1/60 sec @ f45. All exposures included a 1.6 mm diameter black dot as a standard.

Negatives were enlarged approximately 26 times and printed on 210 mm x 297 mm paper and photocopied. The area that had been fed upon, as well as the standard dot, was cut from the photocopies with scissors and weighed. Attempts to measure area directly on the photographic prints, either with a planimeter or by cutting out photographic prints, gave more variable results than the method finally chosen. Areas fed upon were calculated from:

$$\frac{\text{weight of area eaten}}{\text{weight of dot}} \times \text{area of dot} = \text{area of needle consumed}$$

When larvae had eaten right through both surfaces of a needle the area thus consumed was doubled. The method yielded coefficients of variation (CV) of $<2\%$ for a series of consumed areas.

In all, 78 insects were set up. Eight did not feed and feeding of 16 was not measurable. The 54 remaining larvae consumed, on average, 14.4 ± 1.2 (Standard Error) mm^2 of needle. Feeding of individual larvae ranged from 3.5 mm^2 to 39.9 mm^2 (Fig. 1).

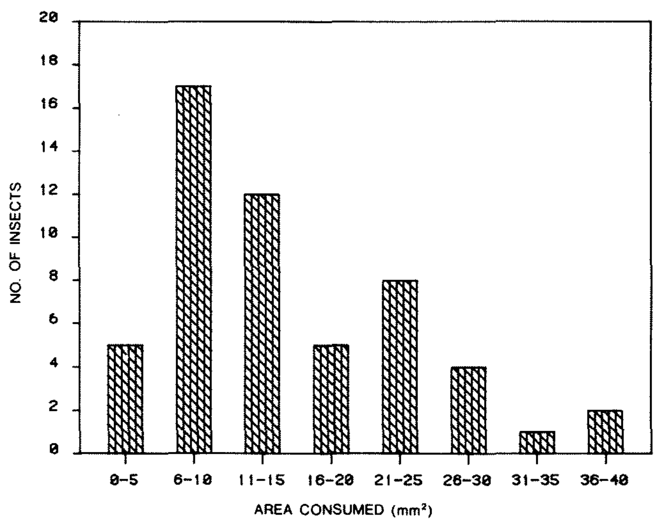

Figure 1. Individual larvae feeding range.

Utilizing unpublished data on frass production by larvae of various instars (S.A.H. Davis, supplied by C. Miller, Maritimes Forest Res. Cent.), the average feeding rates of other larval instars can be calculated. A third instar larva feeds about 0.17 times as much as a fourth, or 2.4 mm^2; a fifth consumes twice as much as a fourth, or 29 mm^2; and a sixth consumes approximately 13.5 times as much as a fourth, or 194 mm^2 (about 2 cm^2).

These areas consumed are approximate and under forest conditions in June feeding is likely to be considerably less than these values because of lower and fluctuating temperatures. Studies on feeding rates of spruce budworm larvae now being carried out in the Forest Pest Management Institute will permit more realistic estimates of area consumed from our base data.

From the foregoing, it can be concluded that a lethal dose must be contained within $<$14.4 mm^2 if a fourth instar larva is to have a reasonable chance of obtaining such a dose within 24 h.—Paul G. Fast, Forest Pest Management Institute, Sault Ste. Marie, Ont.

Observations on the Development of the Gypsy Moth, *Lymantria dispar* (L.), on Douglas-fir and Western Hemlock.—A study was conducted, at the request of Agriculture Canada and with the cooperation of the Pacific Forest Research Centre, to determine whether the gypsy moth, accidentally introduced into British Columbia in 1978, would consume foliage of two western Canada conifers, Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) and western hemlock (*Tsuga heterophylla* [Raf.] Sarg.).

This insect prefers hardwood trees, especially oak. Forest trees subject to gypsy moth infestation have been grouped into five classes (Houston, USDA Agric. Handb. 542, 1979). Conifers fall into class four, intermediate hosts such as the genera *Tsuga* and *Pinus*, and class five, the least vulnerable group, comprising the genera *Abies* and *Picea*.

The insects were reared at room temperature by the following method. Douglas-fir and western hemlock seedlings, averaging 35 cm in height, were planted individually in earthenware pots (14 cm in diameter) and used for rearing larvae. Ten neonate larvae were deposited on each of 10 seedlings (five of each tree species); the development of these larvae was observed daily until the pupal stage was reached. A Dacron sleeve, held to the pot by an elastic band, covered each seedling. The mortality rate was estimated from daily observations of both groups of five seedlings. Moreover, the weight in grams of the first 50–60 pupae from each of the species was assessed, taking into account the sex of each specimen; weighing was done 24–48 h after pupation and only the weights of viable pupae, i.e. those resulting in the emergence of adult moths, were recorded.

For comparison purposes, gypsy moth larvae were also reared on red oak (*Quercus rubra* var. *borealis* [Michx. f.] Farw.). The rearing method consisted of feeding larvae the foliage from red oak stems (measuring some 17 cm in length) that were kept in a 450-mL glass jar containing water, topped with a cover through the centre of which a hole had been made to accommodate the tip of the stem; this immersion in water preserved the turgidity of the foliage. The foliage was encased in a glass bubble resting on the lid of the jar; the top of this bubble was closed with a screen cover. The foliage was replaced every 3 or 4 days.

If high larval mortality occurred on the softwood species during the first and second instar, all of the larvae were replaced by specimens of the next stage that had been reared on red oak foliage. The duration of larval development, from the time rearing of the initial larval instar commenced to the time of pupation, was noted. The average duration was determined from the date when 50% of the larvae reached the pupal stage. All of the larvae used in this experiment came from a single egg mass.

The survival rates of the individual gypsy moth larval instars on the three tree species studied are depicted in Table 1. The neonate larvae reared on Douglas-fir were unable to reach the second larval stage and death by starvation occurred in fewer than 10 days. The foliage suffered little damage and no insect growth occurred, indicating an inability to feed on this species, probably because of the hardness of the foliage. An estimated average survival rate of 64% among first-instar larvae reared on western hemlock indicates that the insect can develop on this species from the start of its larval development. The survival rate of larval instars reared on western hemlock did not become comparable to that of larvae reared on red oak foliage until the third larval instar. The survival rate of second-instar larvae reared on Douglas-fir was high and comparable to results at the second larval stage on red oak. Mortality recorded after the second larval instar for the three species was mainly attributable to an entomopathogen (probably a viral disease) and to injuries inflicted in the periodic handling of larvae.

TABLE 1

Survival percentages of the various larval instars of laboratory-reared gypsy moths on the three forest species

	Larval instars (% of survival)					
Species	I	II	III	IV	V	VI
Western hemlock	64.0	72.1	90.0	82.9	97.1	100.0
Douglas-fir	0	94.0	93.0	88.5	96.0	98.0
Red oak	79.4	93.7	91.5	94.5	99.2	96.7

The duration of larval life (Table 2) was the same for the larvae reared on both conifers, but about 6 days shorter for the larvae reared on red oak. The average weights of male and female pupae from larvae reared on western hemlock and red oak were similar. However, pupae from larvae reared on Douglas-fir weighed, on the average, significantly less (0.10 g for males and 0.40 g for females) than pupae from larvae reared on the other species.

TABLE 2
Duration of gypsy moth larval development on the three forest species

Species	Number of larvae	Duration of larval development (days)		
		Minimum	Maximum	Average
Western hemlock	39	28	46	33
Douglas-fir	42	29	52	34
Red oak	46	25	34	28

TABLE 3
Average weight of male and female pupae obtained from the laboratory breeding of gypsy moth larvae on the three forest species

Species	Number of pupae		Average weight (g)	
	♂	♀	♂	♀
Western hemlock	20	17	0.48 ± .06	1.27 ± 0.18
Douglas-fir	19	18	0.39 ± .06	0.89 ± 0.27
Red oak	21	19	0.49 ± .06	1.28 ± 0.30

These results, although fragmentary, show that the gypsy moth has a preference for western hemlock foliage and that it is seemingly impossible for the insect to start its development on Douglas-fir. Starting from the second larval instar, however, the insect can develop on Douglas-fir, although its weight (measured at the pupal stage) will be significantly less than those of pupae developed on the other two species. Finally, the duration of larval development was found to be the same for both conifers, i.e. 6 days longer than the duration on red oak foliage.—L. Jobin, Laurentian Forest Research Centre, Ste. Foy, Que.

Damage to Aspen Regeneration in Northern Ontario by the Ghost Moth, *Sthenopis quadriguttatus* Grote.—In 1977 the Forest Insect and Disease Survey conducted a survey of the pests of trembling aspen (*Populus tremuloides* Michx.) regeneration in northern Ontario.

Each of nine survey field technicians assigned to the northern district of Ontario sampled five randomly selected stands of young aspen. All stands were younger than 10 years of age and composed of at least 50% aspen that originated as root suckers. Ten sample plots were selected at random in each stand. On each plot the first aspen tree was dug out and the roots were examined for abnormalities. Roots were sectioned progressively in increment lengths of 5 cm from root extremities toward the main stem. Sectioning stopped whenever rot or stain was encountered along a root. The remaining root portions were shipped to the Great Lakes Forest Research Centre in Sault Ste. Marie for detailed examination and analysis, including the culturing of organisms to determine root-rotting fungi present, and for the rearing of larvae of the insects present. In total, 45 stands and 450 root systems were examined.

Root-boring activity by the ghost moth, *Sthenopis quadriguttatus* Grote, indicated by characteristic larval tunnels (Fig. 1 and 2) or larval captures, was found in 37 (8%) of the 450 root systems sampled and in 21 (47%) of the stands sampled (Fig. 3). Tunnels had been excavated primarily in the central part of the root and were about

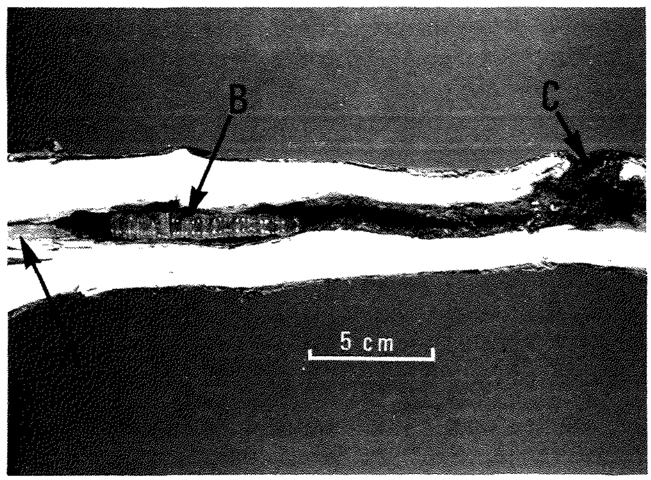

Figure 1. Longitudinal section of a trembling aspen root showing the tunnel excavated by ghost moth larva. (A) Associated wood rot and stain. (B) Larva. (C) Access hole.

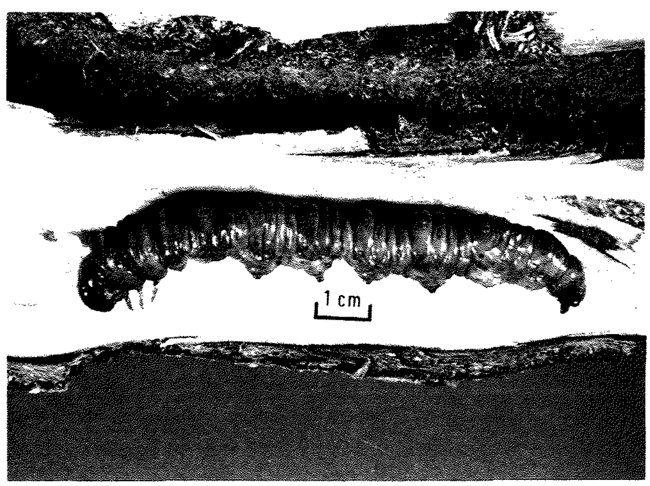

Figure 2. Closeup of ghost moth larva and a portion of its tunnel.

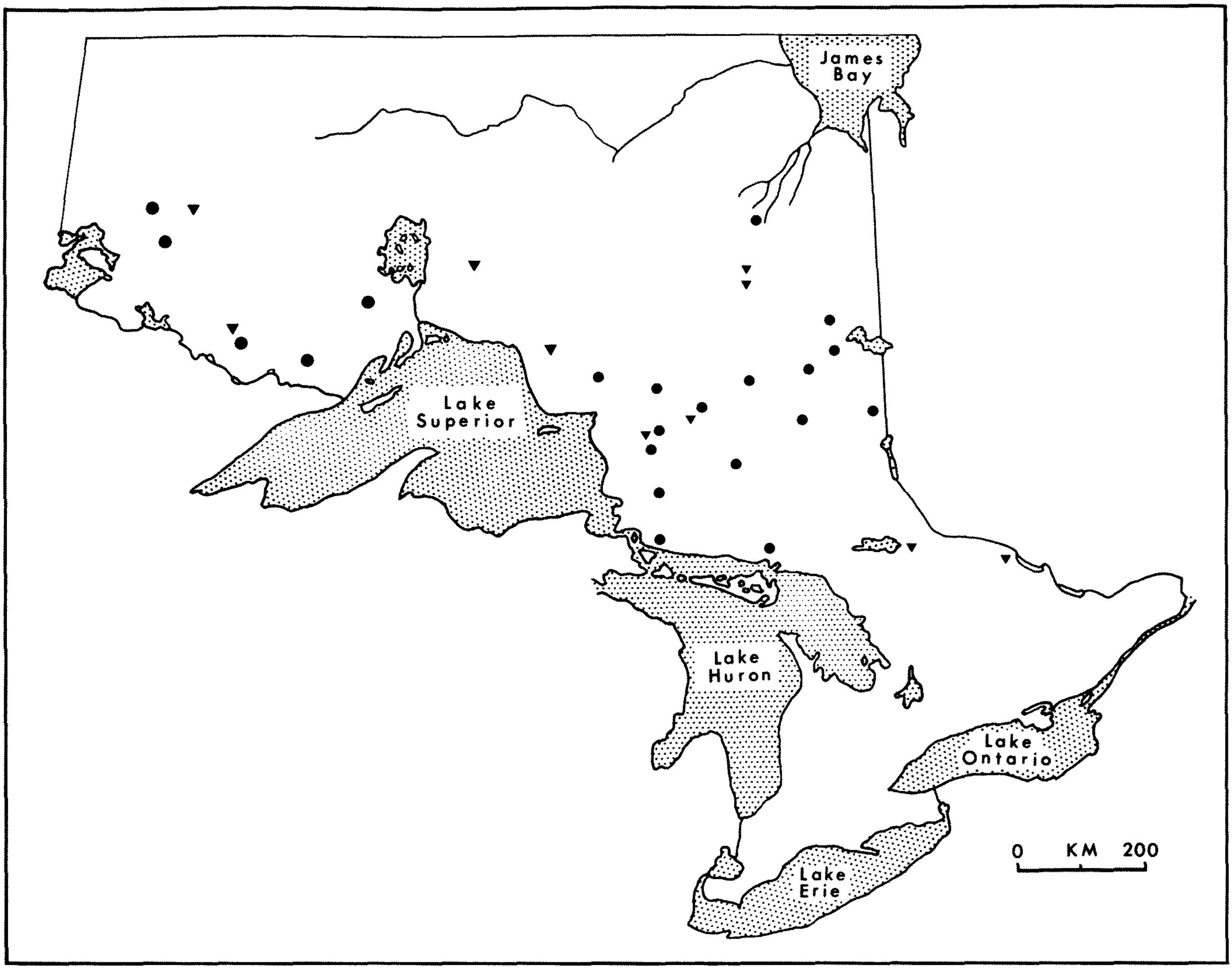

Figure 3. Known distribution of ghost moth in Ontario based on characteristic damage or larvae (●) and light trap catches (▼).

0.5–1.0 cm in diameter and up to 70 cm in length. The distribution of these finds agreed generally with the known distribution of *S. quadriguttatus* that is based on light trap catches of adult moths recorded previously by the Forest Insect and Disease Survey (Fig. 3).

Stained wood was associated with all of the tunnels and 47% of the tunnels also contained rot. Isolations from the associated rot or stained tissue yielded fungi (97%), bacteria (69%), and yeasts (11%). Fungi identified included *Penicillium* sp., *Penicillium thomii* Maire, *Phialophora alba* van Beyma, *Trichoderma viride* Pers., and *Verticillium* sp. No fungus considered capable of causing rot was recovered, probably because of the constant association of the previously-mentioned isolates. However, the association of rot with about half of the tunnels indicated that activity by *S. quadriguttatus* larvae probably predisposed trees to attack by root-rotting fungi.—H.L. Gross and P.D. Syme, Great Lakes Forest Research Centre, Sault Ste. Marie, Ont.

The Utility of Baskets Fitted to Pole Pruners for the Collection of Spruce Budworm Larval Samples.—A 45-cm branch end from the mid-crown of host trees is the most commonly used part of the foliage for sampling spruce budworm larval and pupal populations in connection with assessments of aerial forest spraying effectiveness in Canada. The usual sampling equipment is a set of heavy-duty pole pruners capable of reaching 8 m or more, fitted with a clamp at the cutting head to hold the severed branch end, and sometimes a metal hoop fitted with a cloth basket to catch the foliage together with insects that may become dislodged. The basket and its contents are lowered by disassembling the pruners. Without the basket the sample may be lowered in the same way while keeping the cutting clamp closed, or by leaving the pruners assembled, swinging the sample away from the crown and releasing it over a drop sheet on the ground. Insects dislodged into the basket or onto the drop sheet are counted along with those remaining on the foliage.

The basket technique was adopted as standard practice when assessments of forest spraying effectiveness began in New Brunswick in 1952. With experience, investigators began to question whether the advantages of the method were not outweighed by its cumbersomeness, particularly during the earlier stages of larval development when larvae are not readily dislodged from feeding sites. For a time, baskets were retained for sampling the later instars when some larvae tended to abandon feeding sites at slight provocation and to spin down. In subsequent years the basket was abandoned for routine sampling in the belief that, even at the later stages, the disadvantages of the basket outweighed its advantages. However, as the basket method continued to have supporters elsewhere, a reinvestigation of the relative merits of the two systems (with basket and without basket) was conducted in 1980. The author was then a student at Macdonald Campus, McGill University and a seasonal employee of Forest Protection Limited (FPL) in New Brunswick. Staff of the university, FPL, and the Maritimes Forest Research Centre, Canadian Forestry Service, assisted in the analysis of data and preparation of this report.

The test was conducted on balsam fir and red spruce, two of the principal hosts of spruce budworm in New Brunswick. Foliage and larval development on fir usually outpaces that on red spruce and this, together with the more closely compacted nature of spruce shoots, produces a tendency for larvae to be less readily dislodged from spruce than from fir when the shoots begin to flare. Samples were taken at four stages: when the budworms were predominantly in the fourth, fifth, and sixth instars and as pupae. On each occasion a branch sample was collected with and without the basket from the same height on each of 30 relatively accessible trees of each species. The branch samples were cut up and bagged along with dislodged larvae for larval and pupal counts later in the laboratory. A time study was made of the steps in the process.

The data were analysed using the Statistical Analysis System of the McGill computer; insect counts were found to follow a normal distribution. The following results are based on t-test comparisons.

Differences in counts obtained by the two methods proved to be slight, inconsistent, and statistically nonsignificant except for the ultimate-instar (L_6) count on fir where the count without the basket proved to be approximately 40% lower (Table 1).

TABLE 1
Total number of budworms collected from 30 branch samples on balsam fir and red spruce at four stages of development, with and without basket

	Balsam fir		Red spruce	
	Basket	No Basket	Basket	No Basket
L_4	436	422	182	178
L_5	427	379	223	195
L_6	518	303**	148	158
Pupa	194	199	112	141

**Significantly less than with basket, probability 0.01.

Differences in time required to process field samples in the laboratory were not detected. The time required to collect and bag the samples in the field, however, was significantly greater for the basket method (64%) at all stages of development (Table 2).

TABLE 2
Time (minutes) required to collect and bag 30 samples

	Balsam fir		Red spruce	
	Basket	No Basket	Basket	No Basket
L_4	40.6	26.0**	52.9	37.2**
L_5	69.1	37.4**	52.8	29.1**
L_6	64.1	32.5**	39.8	31.8**
Pupa	45.5	26.7**	31.6	21.2**

**Significantly less than with basket, probability 0.01.

Assuming that higher counts reflect more accurate estimates of population, the results of this study suggest that the use of a basket provides marginal or no advantage except for ultimate-instar (L_6) samples on balsam fir. Against this must be weighed significantly greater field time required to use the basket, and other considerations. The addition of the basket requires greater physical strength and manipulative skill on the part of the field worker, a factor that increases markedly with tall trees, and in wet, windy weather. With the trees selected for this study, manipulation of the pole and basket between tree crowns was relatively easy and disturbance to the intended sample branch and adjacent branches while getting the basket into position was minimal. In denser stands, the risk of losing insects from the sample branch, or gaining them from others, while manipulating the basket into place, is often much greater. This study provides no measure of the influence of these factors on the representativeness of counts obtained under such conditions.—Joe Churcher, Forest Protection Ltd., Fredericton, N.B.

MISCELLANEOUS

Chemosystematic Studies in the Genus *Picea*. V. Leaf Oil Terpene Composition of White Spruce from the Yukon Territory.—In earlier studies it was shown that the terpene composition of the steam-volatile oil of conifer leaves is under strict genetic control and that it can be used as a qualitative and quantitative measure of geographic variability in natural populations of many species, as well as a measure of introgression and hybridization (von Rudloff, Biochem. Syst. and Ecol. 2:131-167, 1975). Recently, a high degree of geographic variability was found in the leaf oil composition of lodgepole pine, *Pinus contorta* var. *latifolia* Engelm., from the Yukon Territory (von Rudloff and Nyland, Can. J. Bot. 57:1367-1370, 1979). To obtain further insight into terpene variation in conifer populations from the extreme north, we have now analyzed the leaf oils of white spruce, *Picea glauca* (Moench) Voss, from the Yukon Territory, including samples from trees of the smooth-barked variety, *P. glauca* var. *porsildii* Raup, and from many trees along the Dempster Highway, north of the Arctic Circle.

Previously, we analyzed the leaf oil terpenes of white spruce from eastern, central, and western Canada up to the foothills of Alberta (von Rudloff, 1975; von Rudloff, Can. J. Bot. 45:1703–1714, 1967) as well as populations from the Rocky Mountains that are introgressing with Engelmann spruce, *P. engelmannii* Parry (Ogilvie and von Rudloff, Can. J. Bot. 46:901-908, 1968). In all of these western populations the same 22–24 monoterpenes and 6–8 sesquiterpenes were found and distinctive quantitative terpene patterns were recorded for eastern white spruce (EWS) and western white spruce (WWS). Eastern white spruce was characterized by approximately equal amounts of camphor and bornyl acetate (15–30% each), whereas western white spruce contained mainly camphor (40–55%) and less bornyl acetate (7–15%). Intermediates (IWS) between the two were found and clinal variation appears to exist in some areas. Similar results were obtained with the terpenes found in the cortical oleoresin (Wilkinson et al., Forest Sci. 17:83–90, 1971). The introgressing populations from the Rocky Mountains had a much larger tree-to-tree variability and large deviations from the typical terpene percentages of western white spruce leaf oil were recorded. The terpenes of the smooth-barked Porsild variety that occurs only in the northwest (Raup, Arnold Arbor. 27(1):1–85, 1946; Wright, Forest Sci. 1:319–349, 1955) have not been investigated before.

This report briefly outlines results obtained in the leaf oil terpene analysis of white spruce samples from the Yukon Territory, including trees of the smooth-barked Porsild variety (*see* Table 1). All collections of the foliage samples were made during the fall or winter to eliminate possible differences caused by seasonal variation. Such differences can be large in early summer (von Rudloff, Can. J. Bot. 50:1595–1603, 1972). The leaves were separated from the twigs, steam-distilled for 6 h, and the recovered volatile oil was analyzed by gas chromatography.

The trees sampled along the Dempster and Klondike Highways (*see* Table 1), mainly from well-drained, south-facing slopes or sites where permafrost did not cause the stunted or dwarfed growth (no higher than 30 m for 200–300-yr-old trees), appeared as vigorous as those south of the Arctic circle, indicating that the northernmost trees have adapted to continuous daylight during the growing season. Their bark varied from smooth to rough, but none was as rough as that of mature white spruce from Alberta. Cone scales varied from the typical entire, smooth-margined ones to paper-thin, erose ones as found in *P. glauca* x *engelmannii* hybrids.

First, we compared the leaf oil terpene compositions of five typical white spruce trees with those of five trees of the smooth-barked Porsild variety from locations near Tagish Lake and Liard River (Table 1). The terpene patterns of the smooth-barked trees were similar in all respects to those of the rough-barked ones. Both sets of trees from Liard River contained one tree with the IWS pattern. Hence, it is concluded that the Porsild variety cannot be distinguished on the basis of leaf oil terpenes.

The second group (Table 1) of samples, from southern and central Yukon, also showed the typical WWS terpene pattern, except for one tree with the IWS pattern, from South Canol Road, and one with the EWS

TABLE 1
Number of white spruce trees found with the western (WWS), intermediate (IWS), and eastern (EWS) terpene patterns

Areas	Sample No.	Location	Terpene pattern WWS	IWS	EWS	Remarks
1.	1 - 5	Tagish Lake Road	5	—	—	Smooth-barked Porsild
	6 - 10	N. of Tagish Road	5	—	—	Rough-barked
	11 - 15	Liard River	4	1	—	Rough-barked
	16 - 20	Liard River	4	1	—	Smooth-barked Porsild
2.	21 - 25	Whitehorse	5	—	—	
	26 - 30	Haeckel Hill	5	—	—	
	31 - 40	Kusawa Lake	10	—	—	
	41 - 45	South Canol Road (km 20)	4	1	—	
	46 - 50	West of Watson Lake	4	1	—	
	51 - 55	Carmacks area	4	—	1	
	56 - 60	Stewart Crossing	5	—	—	
		Dempster Highway				
3.	61 - 70	km 70.5 and 86	6	2	2	Intergrading rough to smooth bark (see text)
	71 - 80	km 115 and 134	7	2	1	
	81 - 90	km 160 and 188.5	9	—	1	
	91 - 100	km 236 and 292	10	—	—	
	101 - 110	km 372 and 380	7	3	—	
	111 - 120	km 399 and 406.5	9	1	—	
	121 - 130	km 410 and 426	8	1	1	
	131 - 140	km 438 and 443	10	—	—	
		Klondike Highway				
	141 - 145	km 532	5	—	—	
	146 - 150	km 600	4	1	—	
	151 - 155	km 669	4	1	—	

pattern, from east of Carmacks. Whereas the IWS pattern was encountered before in the occasional tree in western Canadian populations, the finding of the EWS pattern is new. The yield of volatile oil (1–2%) was higher than in trees from Alberta, Saskatchewan, or eastern Canada, and a few trees had a camphor content of 55–63%. The leaves of such trees could serve as a good source of this fairly valuable monoterpene.

As is evident from Table 1, the terpene patterns of the northernmost trees are more variable, 11 trees having the IWS pattern and five trees the EWS pattern. Again, no noteworthy differences in the terpene composition of rough-barked or smooth-barked trees were recorded, and no affinity toward Engelmann spruce was found. Also, several trees contained more than 60% camphor; however, since this amount was also found in two trees from the Tagish Lake area and one tree from Haeckel Hill, this appears to be only an extreme form of the WWS type.

It is possible that a clinal variation of the camphor content exists in western Canada as the trees from Saskatchewan generally contain less than 45% camphor. More important from the phylogenetic and population points of view is the finding of trees with the EWS terpene pattern. This finding indicates not only a richer genepool in Yukon populations (similar to our findings with lodgepole pine leaf oil terpenes) but also that the eastern type is part of the genetic makeup of the populations that may have been derived from those that survived the last ice age in northern refugia.

Raup, 1946, reports that there were no extensive forests in central or southern Alberta or Saskatchewan in late Wisconsin times and that white spruce could not reestablish itself in the previously glaciated areas until about 7000–9000 yr ago. It is assumed that reinvasion occurred from southern refugia, such as the Black Hills of South Dakota. In the Yukon Territory, both southern and northern refugia could be involved (*see also* Halliday and Brown, Ecology 24:353–373, 1943). If the trees with the EWS pattern found in northern Yukon regions represent the eastern genotype, then it appears possible that this genotype is a remnant from much earlier times before this type established itself as the dominant one in eastern Canadian regions.—E. von Rudloff, National Research Council; E.T. Oswald, Pacific Forest Research Centre, Victoria, B.C.; and Edo Nyland, Yukon Lands and Forest Services, Whitehorse, Y.T.

ERRATA

1. This table appeared on page 10, column 1, of vol. 1, no. 2 (April-June 1981) with symbols missing after words in the column headed "Lure". These symbols are now shown.

TABLE 1
Numbers of *C. oregonensis* males trapped.

			No. Caught/Trap		
Year	Site	Lure	Mean	Max	Min
1979	Dewdney	Virgin ♀	6.9a*	27	1
		Virgin ♂	1.2b	8	0
		♀ + ♂	6.2a	28	0
		Control	0.4b	1	0
1980	PFRC	Virgin ♀	13.2a	31	6
		Virgin ♂	0.6b	2	0
		Mated ♀	0.5b	2	0
		Mated ♂	0.4b	2	0
		Control	0.1b	1	0

*Data transformed by $\log_{10}(x+1)$ before analysis; untransformed means reported. Means in same year followed by different letters are significantly different, Student-Newman-Keuls' test $P \leq 0.01$ in 1979, $P \leq 0.001$ in 1980.

2. On page 16, column 2, line 10, of vol. 1 no. 3 (July-September 1981) the temperature -25°C should read -2.5°C.

3. On page 18, column 2, lines 2 and 3 of the article "Effect of additives on the presence of aminocarb in conifer foliage," in vol. 1, no. 3 (July-September 1981) should read — Aminocarb (Matacil®), 4-dimethylamino-m-tolyl N-methylcarbamate.

RECENT PUBLICATIONS — OCTOBER-DECEMBER 1981

7 **Arnott, J.T. 1981.** Survival and growth of bullet, styroplug and bareroot seedlings on mid-elevation sites in coastal British Columbia. For. Chron. 57:65–70.

3 **Bonga, J.M. 1981.** Organogenesis in vitro of tissues from mature conifers. In Vitro. 17:511–518.

4 **Cauchon, René, and D. Lachance. 1980.** Recherche de crytopicnides, pour un diagnostic précose de *Gremmeniella abietina.* Can. J. Plant Pathol. 2:232–234.

3 **Eidt, D.C. 1981.** Recovery of aquatic arthropod populations in a woodland stream after depletion by fenitrothion treatment. Can. Entomol. 113:303–313.

7 **Fiddick, R.L. 1981.** Mid-season summary of forest pest conditions in British Columbia and Yukon. Can. For. Serv., Victoria, B.C.

9 **Grant, G.G. 1981.** Mating behavior of the white-marked tussock moth and role of female scabs in releasing male copulatory attempts. Ann. Entomol. Soc. Am. 74:100–105.

9 **Grant, G.G., D. Frech, L. MacDonald, and B. Doyle. 1981.** Effect of additional components on a sex attractant for the oak leaf shredder, *Croesia semipurpurana* (Lepidoptera: Tortricidae). Can. Entomol. 113:449–451.

3 **Little, C.H.A., and P.F. Wareing. 1981.** Control of cambial activity and dormancy in *Picea sitchensis* by indol-3-ylacetic and absisic acids. Can. J. Bot. 59:1480–1493.

7 **Nijholt, W.W., L.H. McMullen, and L. Safranyik. 1981.** Pine oil protects living trees from attack by three bark beetle species, *Dendroctonus* spp. (Coleoptera: Scolytidae). Can. Entomol. 113:337–340.

7 **Pollard, D.F.W. 1980.** *Pinus contorta* as an exotic species. Pages 313–327 *in* Proc. IUFRO Working Party Meeting on *Pinus contorta* provenances, Res. Note No. 30.

7 **Puritch, George S. 1981.** Pesticidal soaps and adjuvants — what are they and how do they work? Proc. 23rd Annual Lower Mainland Horticultural Improvement Association Growers' Short Course. Abbotsford, B.C. 11–13 Feb., 1981.

7 **Puritch, George S., and Eleanore E. McMullan. 1981.** A cut-branch technique for introducing solutions into conifers. Can. J. Forest Res. 11:218–222.

7 **Puritch, George S., W.C. Tan, and J.C. Hopkins. 1981.** Effect of fatty acid salts on the growth of *Botrytis cinerea.* Can. J. Bot. 59:491–494.

2 **Roberts, B.A., and A.W. Robertson. 1980.** Palsa bogs, sand dunes and salt marshes, environmentally sensitive habitats in the coastal region southeastern Labrador. Paper presented at workshop on research in the Labrador coastal and offshore region, Goose Bay, Labrador, 4–6 Sept., 1980.

4 **Robitaille, G. 1981.** Heavy-metal accumulation in the annual rings of balsam fir, *Abies balsamea* (L.) Mill. Environ. Pollut. (Ser. B) 2:193–202.

7 **Ross, Richard L.M., and George S. Puritch. 1981.** Identification, abundance, and origin of moss, liverwort, and algal contaminants in greenhouses of containerized forest nurseries. Can. J. Forest Res. 11:356–360.

7 **Sutherland, Jack R., Ute Rink, E.E. McMullan, and T.A.D. Woods. 1981.** Isozyme characteristics of *Caloscypha fulgens* infested and pathogen-free spruce seed samples and use of alkaline phosphatase activity for qualitative and quantitative disease incidence assays. Can. J. Forest Res. 11:200–205.

9 **Wilson, G.G. 1980.** Effects of *Nosema fumiferanae* (Microsporida) on rearing stock of spruce budworm, *Choristoneura fumiferana* (Lepidoptera: Tortricidae). Proc. Entomol. Soc. Ont. 3:115–116.

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