bi-monthly research notes

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ENTOMOLOGY

Survival of European Pine Shoot Moth on Cut Christmas Trees.—The European pine shoot moth [*Rhyacionia buoliana* (Schiff.)] is a threat to native pine forests of British Columbia, and already is established in oranamentals and exotic nursery stock in southern coastal areas. Until this study was completed, the movement of cut Christmas trees, *Pinus* spp., into and within British Columbia was permitted without treatment on the assumption that the insect could not overwinter on cut trees. As there was no experimental evidence to indicate the behavior of *R. buoliana* on such material, a study was made to determine possible survival.

Twenty-two infested Scots pine [*P. sylvestris* L.], a typical commercial species, were cut 30 Nov 1971, near Seattle, Wash., and brought to Victoria. They were treated as Christmas trees, without benefit of preservative, nutrient or protection, and set upright outdoors on a northern exposure, with bases in about 8 cm (3 inches) of sand. These conditions were considered the optimum likely circumstances for trees remaining outside as decor, or discarded and partly buried in earth-fill or garbage. Trees averaged 1.2 m (4 feet) in height, and had about 350 tips, of which approximately 30% were infested at the time of collection. About one-quarter of larvae were third instar, the remainder fourth. Three control trees were checked twice-weekly for moisture stress by "bomb test" (Scholander *et al.* Sci. 148:339-346, 1965). Healthy potted lodgepole pine [*P. contorta* Dougl.] were placed with the Scots pine to determine if larvae could transfer.

Three trees, including one control, were taken indoors for the Christmas season (12 days) and kept without water at normal room temperature and humidity. Larvae on these trees began active feeding, and about 10% attained fifth instar. However, as the trees dehydrated, about half the larvae left the buds and died and most of the remainder, including those in fifth instar, died soon after they were returned outdoors. A few lived until March, by which time the trees had lost nearly all their needles, and the moisture stress had increased to 16 from 2 atm.

Two outdoor trees were dissected each month to assess the insect population (Table 1). By the end of January, most of the larvae had become fourth instar without significant mortality. During the winter's coldest 5-day period, 24-28 Jan 1972, the average minimum temperature was 18 F, and the wind chill factor for one day averaged −12 F. Although relatively cold for the area, this would have had little effect on normally overwintering *R. buolina* that may withstand temperatures of −20 F. By the end of February approximately 44% of larvae had died, while some of the living larvae had developed to fifth instar. No appreciable mortality occurred in March, but during April 83% of the remaining larvae died, leaving about 10% of the original population alive. During May, the larvae developed to ultimate instar with little further mortality. Final bud dissections in early June revealed 14 mature larvae and 27 healthy pupae on the five remaining trees, a 12% survival of the original larval population estimated for five trees. Eleven adults emerged before the material was destroyed to prevent possible contamination; they appeared normal and no check was made of their fecundity.

TABLE 1
Survival of *R. buoliana* on outdoor trees

Date	No. of trees examined	Avg no. living insects/tree	Instars present
Nov. 30	2	101	III, IV
Dec. 31	2	98	III, IV
Jan. 31	2	95	III, IV
Feb. 29	2	56	III, IV
Mar. 30	2	52	IV, V
May 1	2	10	V, VI
June 12	5	8	VI, pupae

The first significant larval mortality, during February, was likely due to the rapidly deteriorating food and shelter conditions that forced the larvae to leave the buds and subsequently succumb to the inclement weather. The second mortality crest in April probably resulted indirectly from warming daytime temperatures that encouraged the larvae to move about in a futile search for food and more adequate shelter, that normally would have been readily available. At that time, larvae moved onto adjacent potted lodgepole pine that had been included to test this possibility. Most of these "transferred" larvae survived on the living trees.

There is no doubt that *R. buoliana* may survive and successfully develop on cut trees left outdoors, even though the experiment coincided with local conditions relatively favorable for the insect, i.e., few dehydrating periods of wind or warmth. Larvae on cut trees can transfer to adjacent living pine. Insect survival might be higher in cooler regions where snow cover could provide added protection, and on less heavily infested trees that would presumably retain food-shelter value longer. Christmas trees taken indoors offer little chance for larvae to complete development. It must be stressed that any insect survival, no matter how minimal, is critical.

As a result of this study, quarantine regulations were adjusted to include mandatory fumigation and seasonal restrictions (Can. Dep. Agr., Plant Prot., Export Control Circ. No. 17C, 1972. B.C. Laws, Statutes, etc. 1972; Order in Council, minute No. 3748).—David Evans, Pacific Forest Research Centre, Victoria, B.C.

Evaluation of Residual Toxicity of Six Insecticides for Control of Sitka Spruce Weevil.—The most recent study on chemical control of Sitka spruce weevil [*Pissodes strobi* (Peck) (= *Pissodes sitchensis* (Hopkins)] was conducted in British Columbia during 1961-1964 by Silver (Can. Ent. 100:93-110, 1968). He suggested that control is possible but uneconomical on a large scale, unless applied as aerial spray. Accordingly, six candidate insecticides, Gardona®, propoxur, benzene hexachloride (gamma isomer), phosphamidon, Methyl Trithion®, and fenitrothion, were tested in 1970 and 1971 to determine the residual toxicity for weevil control under West Coast conditions. In laboratory tests, the latter four insecticides had previously shown promise for controlling Sitka spruce weevil (Nigam, Can. Forest. Serv., Inf. Rep. CC-X-3, 1969, 9 pp.).

Sitka spruce [*Picea sitchensis* (Bong.) Carr.] saplings, 1-2 m tall, were transplanted in February 1970 from the Port Renfrew area to a 1.5 x 1.8 m spacing outdoors at the Pacific Forest Research Centre, Victoria. The 1969 leaders averaged 50.3 cm in length (range 35-61 cm), 8.4 mm mid-point diameter, and 133 cm^2 bark surface area. Five trees were assigned randomly from each of the six test groups and a control.

Each leader was isolated by a polyethylene sheet and sprayed during still-air conditions during the morning of 6 July, 1970. Insecticides were formulated as water-based emulsions containing 10% active ingredient (a.i.), except benzene hexachloride (5% a.i.). Application was made with a "Spray on Jet-Pack Sprayer" (Sprayer Product Inc., Los Angeles, California), depositing about 0.01 ml/cm^2 (about to the point of run-off). Test weevils used until August 18 were field collected in May and June and held on fresh host material in a refrigerator until used; thereafter, weevils emerging from currently infested leaders were used. Until that date all weevils were sexed (Harman and Kulman, Ann. Ent. Soc. Amer. 59: 315-317, 1966). Twenty-four hours after spraying and at 2-week intervals thereafter, four adult weevils (2 males and 2 females) were introduced into a screen-sleeve cage (1 mm mesh) placed over each leader. On August 18, a comparison of mortality between males and females, and old (field-collected) and young (newly emerged) adults showed no significant differences, and subsequently the weevils were not sexed.

Within 24 hours after the first introduction, about 90% mortality had occurred in all groups except propoxur (50%) and the control (0% to the end of the tests). Mortality for the seven introductions assessed 48 hours after each introduction is shown in Fig. 1. The insecticides, in descending effectiveness, were: Gardona®, Methyl Trithion®, fenitrothion, benzene hexachloride, propoxur and phosphamidon.

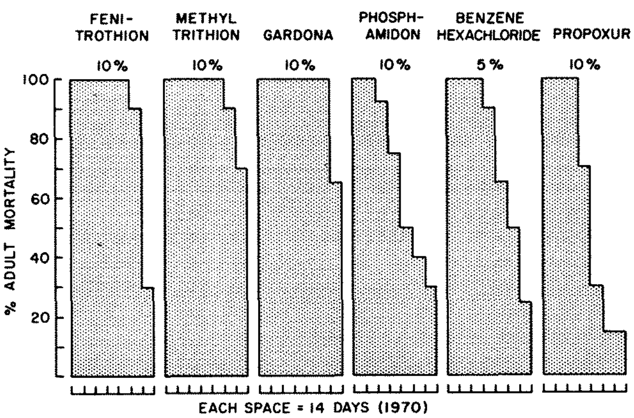


Figure 1. Residual toxicity of various insecticides over 14 weeks, showing percent mortality of weevils within 48 hr of introduction on to pre-sprayed trees.

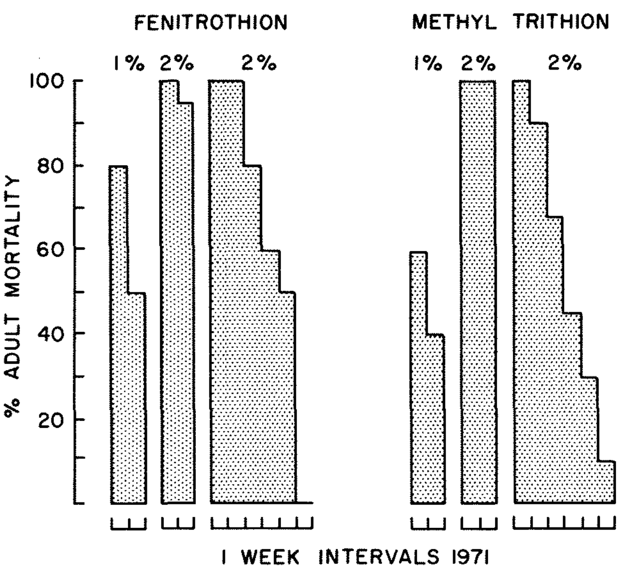


Figure 2. Percent mortality of weevils 48 hr after introduction at different periods of time following insecticide application.

Further tests, conducted in 1971, used the more effective insecticides, Methyl Trithion® and fenitrothion, at more ecologically acceptable levels (1 and 2% a.i.). Gardona® was eliminated because it was thought to be toxic to fish (Tech. Bull. Gardona Insecticide, Shell Chemical Co., New York), but this decision needs to be reconsidered because another report (Thompson, Agricultural Chemicals Book I Insecticides 1972 revision) indicates that the insecticide is relatively non-hazardous to fish. The same methods and materials as in 1970 were used, except that introduction of weevils was weekly instead of biweekly. The interval was changed from 1970 because lower concentrations of insecticides were used, and reduced residual toxicity was anticipated. Tests started on June 28, with new groups of trees, indicated that only 2% concentrations were effective (Fig. 2); mortality on unsprayed trees was nil. On July 12 additional groups of trees were sprayed with 2% concentrations. The early mortality was similar to that of the prior test and the residual toxicity gradually decreased after the first week (Fig. 2). Reduction in toxicity of fenitrothion was more gradual than Methyl Trithion® in the early period after application, but the latter retained some toxicity to the end of the 6-week test period.

These results show that of the insecticides tested, fenitrothion and Methyl Trithion® at 2% minimum concentrations were the most promising for control of the Sitka spruce weevil. They appear suitable for further testing in ground application and aerial spray under field conditions.—S. Ilnytzky, Pacific Forest Research Centre, Victoria, B.C.

Establishment and Survival of Balsam Woolly Aphid on Second Growth Amabilis Fir at Intermediate Elevations.— Regeneration of many cutovers at intermediate elevations to amabilis fir [*Abies amabilis* (Dougl.) Forbes] is desirable in British Columbia in view of the frequent failure of other species, e.g. Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] at these elevations. However, planting of *Abies* ceased in 1966, when the province imposed quarantine regulations on the commercial growing and transport of *Abies*. These regulations resulted from the threat of the balsam woolly aphid [*Adelges piceae* (Ratz.)], an insect pest of *Abies* for which there is no practical control. Although the aphid is now concentrated in high-value, old-growth stands, the possibility of dispersal into regenerated stands is increasing as the supply of old-growth trees dwindles. Whether it will establish and survive on young second-growth amabilis fir at elevations above 2000 ft (610 m) is uncertain.

Three study areas, located at various elevations within the aphid infestation zone, were selected in the Haslam Creek watershed west of Ladysmith, B.C. The forest cover was predominantly second-growth amabilis fir, 15-30 yr old. Table 1 shows the size of sample, elevation and stand characterestics in the three areas. In an initial crown sampling and stem inspection of all trees in July 1969, no aphids were found. In August, pieces of aphid-infested bark, each bearing approximately 50 eggs, were collected from low elevation grand fir [*A. grandis* (Dougl.) Lindl.] near Ladysmith and used to infest the study trees. On each tree, two pieces were taped to the stem, one at breast height and one 12 ft (3.7 m) above the ground, and two pieces were tied to twig ends in the mid-

TABLE 1
Characteristics of second-growth amabilis fir stands selected for study

No. of trees	Elevation ft	(m)	Stocking (stems/acre)	Dbh inch	(cm)	Height ft	(m)	Aspect
18	2300	(701)	200	8-10	(20-25)	30-40	(9.1-12.2)	NW
36	2850[a]	(869)	450	4-8	(10-20)	25-35	(7-6-10.7)	W
18	3500	(1067)	900	4-8	(10-20)	20-30	(6.1- 9.1)	E

[a] Range of elevtation 2700-3000 ft (825-918m).

crown, thereby exposing four sites per tree to the aphid. Infestations on the stem were located so they were not exposed to direct sunlight. Plastic flagging tape was tied around the stem about 6 inches (15 cm) above each piece of bark. Since these trees were uniformly smooth-barked, the tape served to simulate lichen or moss under which future generations of aphids could gain protection. When the bark pieces were removed in September, aphids had settled on all trees and at all 288 sites.

Each infestation was observed annually but the plastic tapes were not removed for aphid counting until 1972. For twig infestations, the entire internode was checked; on the stem, the bark within 4 inches (10 cm) of the infestation center was checked. Aphids were counted at the end of a generation when the population was mostly wool-bearing adults, and each infestation was classified as either 0, 1 (light; 1-10 aphids), 2 (moderate; 11-50) or 3 (heavy; > 50). Each tree was rated, using these infestation categories, e.g. a tree with two light and two moderate infestations was rated 6. From these tree ratings, an Infestation Index was calculated for each elevation to provide a cumulative measure of initial establishment, survival and population change.

$$\text{Infestation Index} = \frac{\text{sum of maximum tree infestation ratings } (=4\times3\times\text{no. trees})}{\text{sum of individual tree infestation ratings}} \times 100$$

In 1970, at the end of the summer generation, infestations at 2300 ft and 2850 ft were 65-69% of maximum but only 53% at 3500 ft (Table 2), indicating that establishment in 1969 and/or 1970 population growth was less at the higher elevation. The count in mid-July 1971, at the end of the overwintering generation, indicated that winter mortality increased with elevation. The Infestation Index decreased, 68% at 2300 ft, 74% at 2850 ft, and 78% at 3500 ft. By August 1972, at the end of the summer generation, all exposed infestations on the twigs and stems had died out. The aphids, however, did survive in protected areas. When the plastic tapes were removed from the stems, aphids were found on most trees (Table 2). Furthermore, examination of twig nodes adjacent to the infestation sites revealed that progeny of the initial twig infestation had settled under old bud scales and survived. Thus aphids survived in protected sites on the majority of trees for at least 3 years, with infestation ratings 20-32% of maximum. Although the populations were relatively low on all trees in 1972, they may have been increasing when counted. Continued observation was impossible, since the aphids had to be eradicated in 1972 to prevent possible spread into the surrounding stand.

Aphids infesting exposed sites on twigs or bark apparently have little chance for success. No tree exhibited an increase in infestation rating from year to year, regardless of elevation. The initial stem populations, which in 1970 were confined to an area about 2 inches (5 cm) square, did not disperse except to protected sites under the tape. Likewise, the only dispersal of twig populations was to the protection of bud scales.

The balsam woolly aphid will apparently establish and survive in twig nodes of second-growth fir at intermediate elevations. However, the lower Infestation Index and incidence of crown attack at 3500 ft indicates that populations may be less viable at that elevation. This has important implications, since a crown infestation normally produces offspring which infest the stem and tree mortality in British Columbia is associated mainly with stem attack. Furthermore, aphids infesting the stem have difficulty surviving unless protected sites, e.g. lichen, moss, bark fissures, etc., are a common feature of the stand. At 3500 ft, low winter temperatures are undoubtedly a major factor limiting aphid survival, but the summer drought which frequently occurs at higher elevations may be equally important. Results of a recent study at this laboratory (unpublished) indicate that, on trees receiving a reduced water supply, balsam woolly aphid survival is decreased and development is delayed.

TABLE 2

Survival of balsam woolly aphid and infestation trends on second-growth amabilis fir at intermediate elevations

	2300 ft (701 m)	2850 ft (869 m)	3500 ft (1067 m)
Exposed sites			
1969			
Trees infested: crown	18	36	18
stem	18	36	18
1970			
Trees infested: crown	18	35	18
stem	18	36	18
Infestation Index	65	69	53
1971			
Trees infested: crown	8	15	3
stem	17	30	13
Infestation Index	21	18	12
1972			
Trees infested: crown	0	0	0
stem	0	0	0
Infestation Index	0	0	0
Protected Sites			
1972			
Trees infested:			
crown (bud scales)	13	22	5
stem (under tape)	14	30	14
Infestation index	31	32	20

Before any recommendations can be made regarding amabilis fir regeneration, the development of aphids at intermediate elevations and their impact on second-growth stands must be assessed over a longer time period.—J. R. Carrow, Pacific Forest Research Centre, Victoria, B.C.

Effect of Cold Treatment on Post-diapause Spruce Budworms.—In rearing post-diapause larvae and pupae of spruce budworm [*Choristoneura fumiferana* (Clem.)] at diurnal fluctuating temperatures of amplitude 16.7°C with means of 10.0°, 12.8°, 15.5°, and 18.3°C, we have found that survival was drastically reduced in the lower temperature regimes (unpubl.). Survival was particularly poor at a mean of 10°C (range 1.7° to 18.3°C) among larvae and female pupae. The surviving adults had deformed wings and failed to produce progeny. The experiment had not given a good measure of pupal survival because the pupae had been selected and preconditioned by the low larval rearing temperature. The cool temperature regime did not simulate the sort of day that people generally regard as cool, which would be humid, cloudy, and have a narrow temperature range. The temperature range of 16.7°C is typical of the clear, dry, sunny days found in continental air masses over central and northern New Brunswick during June and July. Such weather is regarded as favorable for spruce budworm survival (Greenbank, Mem. Entomol. Soc. Can. 31: 19-23, 1963). Our observations led us to ask if survival is more effectively reduced when any particular post-diapause stage is exposed to the cool temperature regime with broad amplitude, and if survival is affected by the duration of the treatment.

Spruce budworm larvae were collected from an epidemic field population near Juniper, N.B. by dislodging larvae from excised branches of balsam fir [*Abies balsamea* (L.) Mill.] onto a white sheet. The larvae were in the third to fifth instars, but most were in the fourth. They were immediately transferred to 1 oz. plastic cups with corrugated sides, waxed cardboard covers, and a supply of artificial insect diet (McMorran, Can. Entomol. 97: 58-62, 1965) in the bottom. Five larvae were placed in each cup. Extremely large or small larvae were rejected and larval size bias was avoided within cups by stocking several simultaneously. The cups were selected for treatment at random. The cups with larvae were then stored in an ice chest until put into the experimental situation cabinets 24 hours later. Larvae that failed to establish in the next 2 days were replaced; larvae later found to harbor parasites (about 3% *Apanteles fumiferanae* Viereck and *Glypta fumiferanae* Viereck) were rejected.

When not undergoing treatment, larvae were reared in a controlled environment cabinet, with a mean of 18.3°C programmed to fluctuate on a sine curve between 10° and 26.7°C. This is the regime we had previously found most satisfactory for growth and survival. The cool temperature treatment had a mean temperature of 10°C (range 1.7° to 18.3°C) in a similar cabinet. Both of these regimes approximate daily fluctuations that normally occur during the late larval and pupal development of the spruce budworm in the spruce-fir forests of New Brunswick.

The larvae were divided into four lots of 150 (5 larvae in each of 30 cups) according to when the cool treatment was to begin. The first lot was placed in the cool treatment immediately; the other three lots were placed in the cool treatment 1, 2, and 3 weeks later. Each lot was divided into three sub-lots of 50 larvae (10 cups) which were treated for 1, 2, and 3 weeks. Thus there wer budworms subjected to three durations of cool treatments begun at four different times or stages of development.

Moths were mated and females oviposited in the 10°-26.7°C cabinet. Females were invariably paired with males from the same treatment.

As expected, the duration of development increased as the duration of the cool treatment was increased (Table 1). To emergence, the duration increased about 4 days for each week of cool treatment. Most budworms treated 3 weeks after the beginning of the experiment had already pupated, thus mean larval development was faster and mean pupal development was slower than in the other treatments. However, mean development time to emergence of those treated after most had pupated was significantly less than those treated before pupation (Table 1); the heat of development above 6.1°C was generally about 22 degree-days less (in the 10°-26.7°C cabinet, heat accumulated at the rate of 12.2 degree-days/day).

TABLE 1
Mean development times from collection to eclosion (in days) of spruce budworms reared in a cool temperature regime for various durations at various times

Duration (weeks)	Weeks before cold treatment 0	1	2	3
1	36.1**	35.7**	38.8**	33.1
2	41.5*	41.5**	$39.7^{n.s.}$	38.0
3	44.1*	45.0**	46.5**	41.3

Differences significant at 1% level (**) or 5% level (*) from those treated after pupation for same duration using Student's *t* test.

Larval survival among treatments was between 63 and 78%, pupal survival was between 81 and 100%, and overall survival was between 53 and 71%. There was no relationship between survival and duration of time of cool treatment.

Mean pupal weights of female budworms first subjected to the cool treatment in the third week after collection (106-113 mg) were 40 to 66% higher than those in other treatments (68-81 mg). Likewise pupal weights of male budworms (65-76 mg) were 18 to 43% higher than those in other treatments (53-56 mg). There were no differences in pupal weight where treatment began immediately, 1 week, and 2 weeks after the experiment began. The duration of the cool treatment did not affect the mean pupal weight.

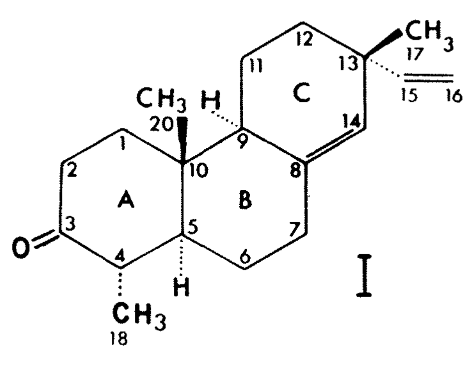
The sex ratio varied from .36 to .59 with no apparent relationship to treatment. Data on fecundity and hatch were not obtained because mating success was not measured. However, among those pairs treated before pupation, the proportion of pairs producing progeny tended to increase with increasing duration of the cool treatment. The opposite trend occurred among pairs treated after pupation.

We cannot account for the fact that rearing fourth- to sixth-instar larvae and pupae of spruce budworm at a cool temperature regime for up to 3 weeks had no effect on survival although survival had been poor when the cool temperature regime was continuous. Nor can we explain why there was greater delay of overall development when the cool treatment was applied to larvae than when it was applied to pupae, except to speculate that the larvae are more sensitive. Some moths emerged in the cool regime, and their pupae thus had a curtailed treatment, but their numbers were insufficient to affect the data.

Pupal weight was much lower when the cool treatment was applied to larvae rather than pupae probably because of interruption of normal feeding and growth. Projections from this experiment on the size of the next generation were difficult to interpret because the contributions of mating success, fecundity, and fertility were unknown. We did not analyze for possible effects on the moisture content or quality of the diet but there were no visible differences among treatments. Miller (Can. J. Zool. 35: 1-13, 1957) found among fiield-collected pupae that high pupal weight is correlated with high fecundity. Our results suggest that survival to the next generation is affected by low temperature acting on the males or females, or both, and the effect may be powerful enough to mask any correlation with pupal weight.—D. C. Eidt and Margaret D. Cameron, Maritimes Forest Research Centre, Fredericton, N.B.

FOREST PRODUCTS

19-Norisopimara-8(14), 15-dien-3-one in *Thuja plicata* **Bark**—Previously the isolation of 4α- and 4β-hydroxy-19-norsopimara-8(14), 15-dienes, together with an unidentified ketone, from the petroleum ether extract of western red cedar [*Thuja plicata* Donn] bark has been reported (Quon and Swan, Can. J. Chem. 47:4389-92, 1969). The unidentified compound has now been identified as 19-norisopimara-8(14), 15-dien-3-one (I). This compound (in amounts insufficient for characterization) has been isolated from the bark of *Pinus sylvestris* (Norin and Winnell, Acta Chem. Scand. 25:611-13, 1971), together with its 13-epimer in larger amounts. Also, it was synthesized during a sequence of reactions on a related compound by Grant and Minto (Tetrahedron Letters: 3729, 1965).



I

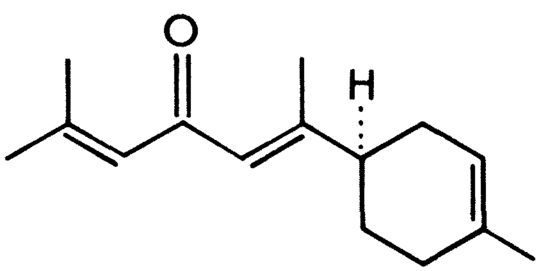
Compound I, isolated by chromatographic techniques from the bark extract in 0.04 percent yield (o.d. bark) had m.p. 52-54° and $[\alpha]_D^{20} = -52.4°$ (c 1.4 chloroform); its physical constants were not given by Norin and Winnell, and Grant and Minto (*op. cit.*) gave only m.p. 46-48°. Compound I reacted with ethylene glycol and acid catalyst to yield the 3-ethylene ketal derivative, m.p. 112-114°, with a m.w. (mass spectrum) of 316.2400 (calc. for $C_{21}H_{32}O_2$ 316.2401). The proton magnetic resonance (p.m.r.), infrared (i.r.) and mass spectra of these compounds were consistent with structure I and its 3-ethylene ketal.

Other data supporting the structure were as follows: The i.r. spectra of I, 19-norpimara-8(14), 15-dien-3-one and isopimara-8(14),15-dien-3-one were almost identical, as were their thin-layer chromatography R_f's and color reactions. The p.m.r. spectra of these three compounds were practically identical, except for the extra methyl signal at 8.95 τ in the spectrum from isopimara-8(14),15-dien-3-one and the different appearance of the vinyl signal in the spectrum from 19-norpimara-8(14),15-dien-3-one (ABX signal in I with AB centered at 5.15 τ, X centered at 4.27 τ with J_{AX}17.5, J_{BX}10.0, and J_{AB}2.5 Hz; in 19-norpimara-8(14,), 15-dien-3-one AB centered at 5.0 τ, X centered at 4.14 τ with J_{AX}17.5, J_{BX}10.5 and J_{AB} 2.5 Hz).

The carbonyl group of I was reduced with sodium borohydride and the vinyl group reduced with hydrogen on palladium catalyst. The product was a mixture of two alcohols, the major product having spectra very similar to 4α-hydroxy-19-norisopimar-8(14)-ene. The alcohol from the reduction was dehydrated to a mixture of two hydrocarbons, one of which (presumably 19-norisopimara-3,8(14)-diene) was chromatographically identical with a hydrocarbon in a mixture previously obtained (Quon and Swan *op. cit.*) by lead tetraacetate oxidation of isopimar-8(14)-en-18-oic acid (formerly known by the trivial name of dihydrosandaracopimaric acid). Compound I should be tested for physiological activity because of its similarity to steroid structure.

We thank Prof. T. Norin, Stockholm, for the gift of a sample of 19-norpimara-8(14), 15-dien-3-one.—H. S. Fraser and E. P. Swan, Western Forest Products Laboratory, Vancouver, B.C.

Isolation of α-Atlantone from the Heartwood Extractive of Alpine Fir—Several years ago, the existence of two unknown sesquiterpene ketones in alpine fir [*Abies lasiocarpa* (Hook) Nutt.] was noted (Swan, Can. J. Chem. *45*:1588-1590, 1967). We now report the identity of these two compounds as the Z- and E-isomers of α-atlantone, the latter is shown as I.



I

Compound I and its Z-isomer were isolated from the petroleum ether extract of alpine fir heartwood by column chromatography, followed by purification on silica gel G by preparative layer chromatography (CH_2Cl_2 solvent). The E-isomer is present in the largest amount and is the more stable, the Z-compound gives the E upon heating or prolonged standing at room temperature. This behavior and the data for the infrared (i.r.), proton magnetic resonance (p.m.r.) and mass spectra found by us were identical to data previously reported (Pande *et al.*, Tetrahedron 841-844, 1971). However, we found slightly higher values for the ultraviolet absorption and optical rotation: Z-isomer, λ_{max} (ϵ) 267 (16,100), $[\alpha]_D^{25}$ +53°; E-isomer, λ_{max} (ϵ) 269 (26,800), $[\alpha]_D^{25}$ +108° versus 266 (10,210), rotation not given; 266 (16,900), $[\alpha]_D^{25}$ +1.2° given by Pande *et al.* We found that the parent ion m/e was 218.1706 for the high-resolution mass spectrum (calculated for $C_{15}H_{22}O$, 218.1670). Furthermore, oxidation of I with permanganate-periodate gave acetone; base cleavage of I gave the expected 4-(4'-methyl-3'-cyclohexenyl)-3-penten-2-one (Pfau, Helv. Chim. Acta *15*, 1481-1483, 1931, *et seq.*). Finally, the synthesis of I has recently been reported (Crawford *et al.*, J. Amer. Chem. Soc. *94*:4298-4310, 1972). The i.r. and p.m.r. spectra of synthetic I E-isomer had identical spectra to natural E-isomer.

Since the work of Pande *et al.* (*op. cit.*) was on the extractives of *Cedrus deodara* and *C. atlanticus*, we obtained these species from the laboratory collection. Extraction of wood from both species with benzene, followed by work-up gave crude E-I, identical chromatographically with I from *A. lasiocarpa*. The absence of Z-I was attributed to its lability and the age of the *Cedrus* sp. samples.

Acknowledgement: We thank Dr. R. J. Crawford, Proctor and Gamble Co., Cincinnati, Ohio, for the i.r. and p.m.r. spectra of α-atlantone, and Dr. R. M. Kellogg for the *Cedrus deodara* and *C. atlanticus* samples.—H. S. Fraser and E. P. Swan, Western Products Laboratory, Vancouver, B.C.

SILVICULTURE

Rapid-Growing Precocious White Spruce Provenances.—Two white spruce [*Picea glauca* (Moench) Voss] provenances were found which grow rapidly and produce abundant cones precociously. These provenances are potentially valuable in producing genetically superior seed for silviculture, and in hybridizing with other provenances to combine their rapid growth and early and high seed productivity with other desirable properties of pollen parents.

First indications of precocity were observed in 1972 during routine inspection of the 12-year-old field trial of 54 provenances. Two provenances had many trees bearing flowers and cones from the previous year, the eleventh year from seed, while most other provenances had few if any trees bearing cones or flowers. Similar experiments (2 years older) planted at Chalk River and elsewhere (Table 1) allowed us to determine the extent that precocity is influenced by provenance and by environment, and if precocity is associated with rate of height growth.

The field experiments are described in previous publications (Nicholson, Can. For. Serv., Info. Rep. N-X-52 1970; Corriveau and Boudoux, Can. For. Serv. Info. Rep. Q-F-X-15 1971; Teich, Proc. 12th Meeting Comm. For. Tree Breeding Can. p. 95-100, 1971). From 25 to 54 provenances out of a collection of 62 provenances were planted at each site.

At all locations (Table 1) provenances varied significantly ($P < .001$) in frequency of cone-bearing trees. Provenance 2442 (from Winchester, Ont., near Ottawa) had the highest frequency in the two locations where it was planted, and was 26% and 9% taller than the experimental averages at Chalk River (M) and Owen Sound, respectively. Provenance 2447

TABLE 1
Frequencies of trees with cones, provenance heights, and experimental means (precocious and non-precocious provenances)

	North Pond, Nfld.		Chalk River, Ont. D-1		Chalk River, Ont. M		Owen Sound, Ont.	
Provenance	trees with cones-%	height % of mean	trees with cones-%	height % of mean	trees with cones-%	height % of mean	trees with cones-%	height % of mean
2442	—	—	—	—	33.0	109	66.9	126
2447	3.9	117	19.7	115	9.6	121	16.9	93
Experiment mean 1969	0.6	100 (92 cm)	3.9	100 (116 cm)	1.5	100 (72 cm)	12.2	100 (51 cm)
Height of tallest provenance as percent of experiment mean		124		116		121		126

(from near Grand Mère, P.Q.) had the second highest frequency and was much taller than average in three out of four experiments. Flowering frequencies at Kapuskasing and Grand Mère (spot checks of only this provenance) were 10% and 2%, respectively.

Precocious provenances were taller than average (Table 1) and trees with cones were taller than trees without cones in the same plots:

	Height of Trees 1972	
	with cones	without cones
Location	cm	cm
Grand Mère	192	167
Chalk River M	222	180
Chalk River D-1	272	241

However, locations with the most height growth did not have the most cone production.

Cone counts, as distinct from the number of trees with cones, were not made, but it was evident that the higher the frequency of trees with cones, the more cones there tended to be on each tree.

Late age at first flowering slows white spruce genetic improvement, prolongs breeding and delays seed production. White spruce normally begins to flower between 10 and 20 years of age from seed (Holst, Recent Advances in Bot. 2:1654-1658, 1959) and 6 years from grafting. This extended period of juvenility makes a breeding program extending over more than one generation impractical. The provenances discovered in this study, flowering as early as in the eleventh season, while only moderately precocious, are valuable because, as they grow rapidly, no generations are required to combine precocity with rapid growth, and the precocity facilitates further improvement.

The rapid growing, precocious provenances have been incorporated into the white spruce breeding program at the Petawawa Forest Experiment Station. The prospects are good that these early flowering selections may play a role in the development of highly productive white spruce strains.

Individual trees of provenance 2447 have been selected for above-average growth and cone production, and hybridized with local plus trees for the establishment of pilot-scale seedling seed orchards. If progeny tests confirm the apparent value of these selections, appreciable quantities of seed will soon be available to increase white spruce productivity.

We gratefully acknowledge Mr. Mark Holst of this Station, who established the field experiments, and Dr. M. A. K. Khalil of the Newfoundland Forest Research Centre for providing the data from North Pond, Newfoundland. — A. H. Teich and D. F. W. Pollard, Petawawa Forest Experiment Station, Chalk River, Ont.

The effect of Squirrel Damage on Norway Spruce (*Picea abies* **(L.) Karst.**).—The red squirrel [*Tamiasciurus hudsonicus* (Erxleben)] damages Norway spruce by clipping the leading shoot and branches of the first whorl or by consuming axillary and lateral buds of this shoot. The injury is largely confined to healthy trees with large, well developed buds; suppressed and unhealthy trees are avoided. At Petawawa squirrel damage in 1968 to a Norway spruce provenance was severe, particularly in a provenance of German origin. It appeared that this damage could inhibit height growth and affect the analysis and interpretation of experimental results.

Total height growth of trees in this German provenance was sampled in two ways: (1) by measuring 20 uninjured trees, and (2) by measuring 20 non-classified trees, as a combination of injured and uninjured trees. The sample contained 12 injured and 8 uninjured trees. All samples were randomly selected and measurements were repeated over a 3-year period, 1968-70, at the end of each growing season. No further injury was observed on the samples during the 3-year period. The mean height of the uninjured sample increased from 217 to 329 cm. (85.4-129.5 inches) in the 1968-70 period while the mean height in the non-classified sample increased from 209 to 286 cm. (82.3-112.6 inches).

The analysis of variance (Table 1) provides for one degree of freedom between the two samples. The significance test utilizes the within-sample mean square. It is seen that differences in total height between the two samples were not

TABLE 1
Analysis fo variance of random samples taken from uninjured trees from a plot compared with all trees of the plot (injured and uninjured). Calculations based on 1968-1970 height and height increment measurements

Year of observation	Source	DF	Mean Square	F Test
1968 heights	Among samples	1	680.62	0.35
	Within samples	38	1947.07	
	Total	39		
1969 heights	Among samples	1	6125.62	2.99
	Within samples	38	2047.60	
	Total	39		
1970 heights	Among samples	1	18062.50	6.53*[a]
	Within samples	38	2765.20	
	Total	39		
1968-1970 height	Among samples	1	11730.62	
	Within samples	38	761.55	15.40***[a]
	Total	39		

[a] Significance levels: * $P = 0.05$; *** $P = 0.001$

significant in 1968 as expected, due to great variation in that provenance (height range of sample 190 cm., 74.8 inches); but they were significant ($P = 0.05$) in 1970. The differences in 3-year height increment were very highly significant ($P = 0.001$).

The results indicate that squirrel injury can seriously affect the analysis and interpretation of Norway spruce experiments. Decapitation of terminal shoots significantly inhibits subsequent height growth in Norway spruce. It is unlikely that damage is equally distributed, and the interpretation of data must take this into account.—Paul Viidik, Petawawa Forest Experiment Station, Chalk River, Ont.

SOILS

Comparisons of Four Methods of pH Determination in Peat Soils.—Four frequently used methods of pH determination were compared and their correlation examined. Over 70 peat samples were collected from several locations in northern Ontario. Determinations were made with a Zeromatic II Beckman pH meter equipped with separate glass and reference electrodes and automatic temperature compensation. Where necessary, pastes were made by rewetting peat samples to their liquid limit, i.e., the upper plastic limit as suggested by Krupskyi *et al.* (Soviet Soil Sci. 3:342-349, 1969).

Values of pH determined in oven-dry peat (OP) plus distilled H_2O served as the independent variable X_1 because, in the course of the author's previous work, it was found to be the least variable method. The dependent variables were pH values determined as follows:

Y_1 = in (OP) plus N/100 $CaCl_2 \cdot 2H_2O$;

Y_2 = in field-moist peat (FU);

Y_3 = in peat squeezed by hand (SP) plus N/100 $CaCl_2 \cdot 2H_2O$.

Results are shown in Table 1 and regression lines in Fig. 1. The relative position of the regression lines demonstrates that oven-drying and the addition of extractants lower the pH value. The highest pH values were obtained in field-moist peat and the lowest in oven-dry peat rewetted with N/100 $CaCl_2 \cdot 2H_2O$.

Analyses of covariance testing the differences in terms of levels and slopes between linear regressions indicated no significant differences in slopes, but highly significant differences in levels of regressions. Values of pH in oven-dry peat plus distilled H_2O are highly significantly different from pH values in field-moist peat. The pH values of (OP) and (SP) with N/100 $CaCl_2$:$2H_2O$ are not significantly different and could be safely combined. In comparison with field-moist peat of pH 7.0, the regressions suggest the points of pH: (OP) and (SP) with N/100 $CaCl_2 \cdot 2H_2O$ = 6.6 and (OP) with distilled H_2O = 6.8. With the calculated regression lines it is possible to determine with high significance the pH values by the three other methods from only one known pH value.—W. Stanek, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ont.

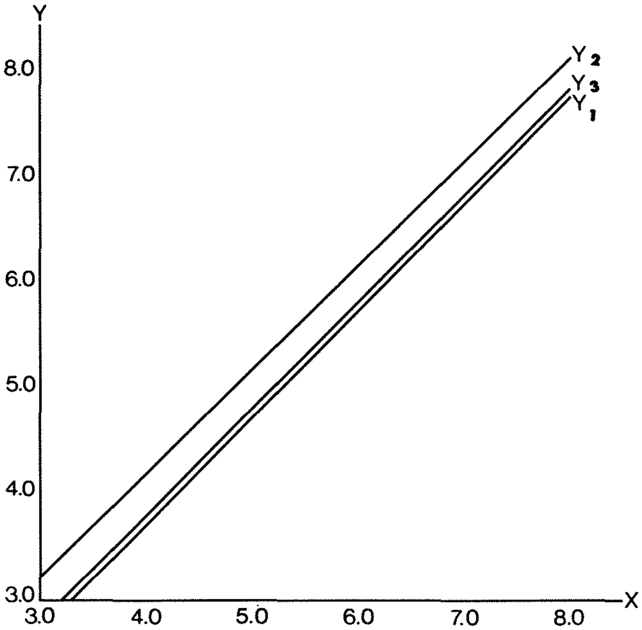


Figure 1. Regression lines of pH values in oven-dry peat, N/100 $CaCl_2 \cdot 2H_2O$ (Y_1); hand-squeezed peat, N/100 $CaCl_2 \cdot 2H_2O$ (Y_3); and field-moist peat, (Y_2) on pH values in oven-dry peat + distilled H_2O (X). The lines cover only the population from pH 3.0 to 8.0.

TABLE 1
Results of inear regression analyses

Method	Variable	Mean	Intercept A	Regr. Coeff. B	Corr. Coeff. R	SE_e	Max.	Min.
OP + distilled H_2O	X_1	5.220	—	—	—	—	7.35	3.41
OP + N/100 $CaCl_2 \cdot 2H_2O$	Y_1	4.965	—0.40383	1.02850	0.98801	0.16254	7.14	3.00
FP	Y_2	5.421	0.25481	0.98971	0.98889	0.15047	7.40	3.52
SP + N/100 $CaCl_2 \cdot 2H_2O$	Y_3	5.016	—0.30540	1.01946	0.98300	0.19260	7.27	3.05

(*Continued from back cover*)

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