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.

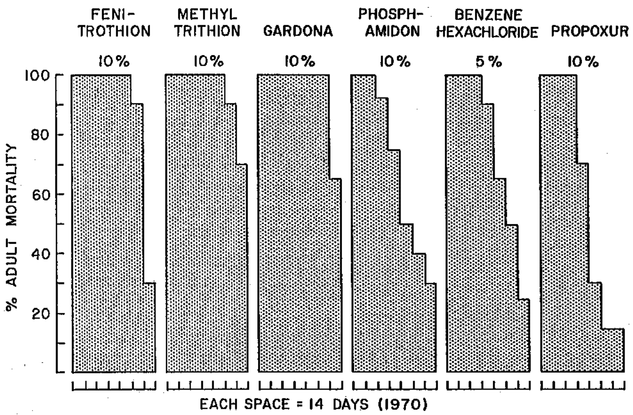

Figure 1. Residual toxicity of various insecticides over 14 weeks, showing percent mortality of weevils within 48 hr of introduction on to pre-sprayed trees.

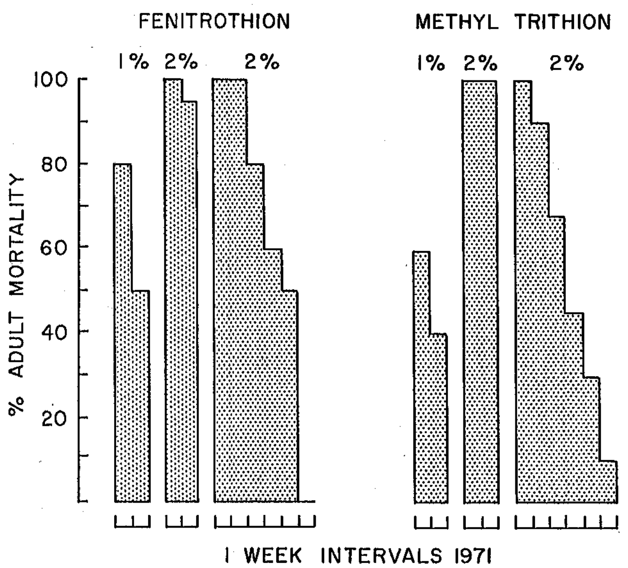

Figure 2. Percent mortality of weevils 48 hr after introduction at different periods of time following insecticide application.

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 elevation 2700-3000 ft (825-918m).