TABLE I

Numbers of *Calosoma frigidum* on lower 2 m of plantation white spruce trees, Sault Ste. Marie, 16 June, 1977

Category of tree (lower 2 m)	No. of trees	No. of trees on which indicated no. of beetles were found							Total no. of beetles	Avg. no. per lower 2 m section
		0	1	2	3	4	5	6		
a) No foliage	10	7	3	0	0	0	0	0	3	0.3
b) Peripheral foliage	5	3	1	0	0	1	0	0	5	1.0
c) Fully foliated to ground	35	15	9	4	4	1	1	1	44	1.26
Total	50	25	13	4	4	2	1	1	52	1.04

least one each. More beetles were on the foliage than on dead, bare branches, and they were distributed with fair uniformity over the foliage to the tops of the trees. Consequently, a spruce 15 m high might have had as many as 40 beetles on it. Beetles were seen crawling over current foliage and eating budworm larvae. They also seized and ate larvae placed in front of them, but we did not attempt to quantify consumption. No quantitative estimates of beetle populations were made in plantation A, but 25 beetles were counted up to a height of 1.5 m on the branches of one 7 m high white spruce, and this suggests that populations in A were at least as high as those in B.

On 22 June both plantations were visited so that beetles could be collected for further study. However, a 45 min search of the litter and dead stumps, and under loose bark, failed to locate any beetles or the remains of beetles.

We have no quantitative data on the impact of these beetles on budworm populations, but their size, numbers, and manner of searching the current foliage suggest that they may have played an important role in reducing budworm populations in these two populations near Searchmont. Where they came from and where they went is not known.—C.J. Sanders and K. van Frankenhuyzen, Great Lakes Forest Research Centre, Sault Ste. Marie, Ont.

Pine Oil Delays Attack of Ambrosia Beetles on Piled Log Sections.—Field tests show that pine oil applied to single Douglas-fir log sections has a repellent effect that delays and reduces the attack by ambrosia beetles (Nijholt, Can. Entomol., in press). Pine oil is a mixture of naturally occurring secondary and tertiary terpene alcohols refined from by-products of the pulp and paper industry. Its repellent effect is such that complete coverage of the log surface may not be necessary. To test this theory, an experiment on piled logs was conducted in the spring of 1978 in a second-growth forest near Caycuse, B.C. Twelve sections (75 cm long) were cut from four fall-felled Douglas-fir trees and were covered with a plastic sheet. On 10 May, the log sections were randomly arranged in two piles placed 5 m apart; the outer bark surfaces and ends of one pile were sprayed to the drip point with undiluted pine oil (sample provided by Northwest Petrochemical Corporation, Anacortes, Wash. 98221, under the commercial name "Norpine 65"), and a garden-type pressure sprayer (Hudson Manuf. Co. Model #6622) was used. The second pile was left untreated.

The sides of the piles, made up of log sections numbered 1,2, and 4 (Fig. 1), were facing eastward toward the adjacent experimental area, where flight activity and attacks had been noted in the previous 2-wk period.

The untreated pile was attacked on the day after exposure and was severely infested during the main flight activity around 20 May. The treated pile showed no attacks until 2 June, 23 days later, when five dust piles were noted. Three days later this number increased to 40. Most of the initial attacks occurred in places where two bark surfaces met (A in Fig. 1). This was attributable to the thigmotropic behavior of the beetles. Nevertheless, a 3-wk delay in attack was achieved with the pine oil treatment.

The experiment was terminated after 42 days, on 21 June, and the bark was stripped from all log sections. The surface of each section was divided into eight longitudonal segments. The entrance holes made by *Trypodendron lineatum* and *Gnathotrichus* spp. were counted in each segment. Treatments reduced the attack damage from 24.3 to 3.3 holes

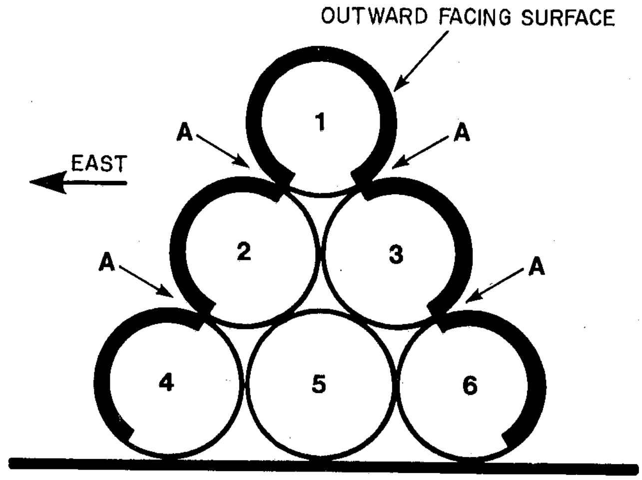

Figure 1. Diagram of position of log sections in pile, indicating outward and inward facing surfaces.

TABLE I

Numbers of attack holes made by *Trypodendron lineatum* and *Gnathotrichus* spp. on piled sections of Douglas-fir 42 days after treatment with pine oil

		Treated			Untreated		
		Tryp.	Gnath.	(Tot.)	Tryp.	Gnath.	(Tot.)
Log section no.	1	31	16	47	154	13	167
	2	10	21	31	149	5	154
	3	0	4	4	133	13	146
	4	2	29	31	201	12	213
	5	0	1	1	114	3	117
	6	3	13	16	149	9	158
TOTALS		46	84	130	900	55	955

TABLE 2

Number of attack holes made by *Trypodendron lineatum* and *Gnathotrichus* spp. on outward- and inward-directed surfaces of piles Douglas-fir log sections 42 days after treatment with pine oil

	Treated		Untreated	
	Outward	Inward	Outward	Inward
Number of holes made by:				
Trypodendron	38	8	545	355
Gnathotrichus	76	8	30	25
TOTALS	114	16	575	380

per 0.1 m^2. Virtually all holes in the log sections of the untreated pile were made by *Trypodendron* (Table 1). Logs from the treated pile had 88% of the holes located on outward facing surfaces (Fig. 1); 60% of the holes were so located on comparable segments of the untreated pile (Table 2). Interpretation and comparison of results were complicated because, when the treated log sections no longer repelled the beetles, they were exposed to populations that were numerically and proportionally different from those present when the untreated logs were attacked. Log sections no. 5 (Fig. 1) were completely covered by other logs; the one in the treated pile received the least amount of spray

yet appeared to have been the most successfully protected (Table 1).

Experiments are planned to further improve and test the effectiveness of this type of treatment and to combine the use of these repellents with pheromone-based strategies to achieve protection from ambrosia beetle damage, as well as a reduction in local beetle populations.—W.W. Nijholt, Pacific Forest Research Centre, Victoria, B.C.

Chemical Control Trials on the Box Elder Twig Borer in Alberta.—The box elder twig borer, *Proteoteras willingana* (Kft.) is a common pest of the box elder, *Acer negundo* L., in shelterbelt plantings in the Prairie Provinces. In severe infestations many dormant buds and new shoots are destroyed and the destruction causes stunting and disfigurement of trees and seedlings. This note reports on the results of eight chemical insecticides applied as soil drenches in 1973 and 1974 and as foliar sprays in 1975, 1976, and 1978 to control this insect in three locations in Alberta.

The development of *P. willingana* in Alberta is about 2 wk later than that reported for Indian Head, Sask., by Peterson (Can. Entomol. 90:639-646, 1958). In Alberta, female moths usually lay a single egg near the midvein on the underside of the leaf in mid-July. After hatching from late July to mid-August, the first- and second-instar larvae, appearing from early to late August, skeletonize the mesophyll of the leaves. When the larvae reach the third instar, between mid-August and early September, they migrate down the leaf petiole to the twig and bore into a leaf bud. The fourth instar and an occasional fifth, appearing from June to mid-September, spin hibernacula in the fall and then overwinter. In the spring they become active and leave the hibernacula to resume feeding in the buds. In early June the fifth-instar larvae bore downward into the current shoots, the extensive feeding and tunnelling causing the tips to swell and form spindle-shaped galls. These galls usually become desiccated and die. Mature seventh-instar larvae leave the galls in early July, drop to the ground, and pupate in the duff and leaf mold. Adults emerge in late July, and egg-laying begins a few days later.

Insecticides used for the soil-drench trials were placed at the base of the tree in early May before insect activity began and were drenched with water to enhance translocation of the chemicals. Dimethoate, aldicarb, carbofuran, diazinon, oxydemeton-methyl, mexacarbate, and phorate were applied in 1973 and 1974 at Erskine, Stettler, and Bashaw at the rate of 4.5 g active ingredient/cm basal diameter for granular concentrates and 5.6 mL a.i./cm for emulsifiable concentrates. All plots consisted of 10 trees each, including the control plots. Percentage insect control was determined by applying Abbott's formula (J. Econ. Entomol. 18:265-267, 1925) to counts of living and dead larvae on eight 45 cm branches taken from each tree in the treatment and control plots approximately 8 wk after treatment.

TABLE 1
Results of chemical control field tests on the box elder twig borer, *Proteoteras willingana* (Kft.), 1973-76 and 1978

Material	Type	Location	Living (L) and dead (D) larvae and percentage control (%)														
			1973			1974			1975			1976			1978		
			L	D	%	L	D	%	L	D	%	L	D	%	L	D	%
Dimethoate	SD[1]	Erskine	0	3	100	2	5	66	—	—	—	—	—	—	—	—	—
Dimethoate	H[2]	"	—	—	—	—	—	—	—	—	—	10	29	73	3	13	76
Aldicarb	SD	"	22	18	45	—	—	—	—	—	—	—	—	—	—	—	—
Carbofuran	SD	"	19	9	32	—	—	—	—	—	—	—	—	—	—	—	—
Carbofuran	SD	"	—	—	—	18	3	1	—	—	—	—	—	—	—	—	—
Carbofuran	SD	Stettler	74	25	18	—	—	—	—	—	—	—	—	—	—	—	—
Diazinon	SD	Erskine	10	4	29	—	—	—	—	—	—	—	—	—	—	—	—
Diazinon	H	"	—	—	—	—	—	—	15	8	33	—	—	—	2	7	70
Oxydemeton-methyl	SD	Stettler	27	8	16	—	—	—	—	—	—	—	—	—	—	—	—
Mexacarbate	SD	Bashaw	22	8	27	—	—	—	—	—	—	—	—	—	—	—	—
Phorate	SD	"	39	5	11	—	—	—	—	—	—	—	—	—	—	—	—
Malathion	H	Erskine	—	—	—	—	—	—	—	—	—	5	20	79	—	—	—
Control plot		"	22	0	100*	6	1	86*	29	1	97*	64	3	96*	64	3	96*
Control plot		Stettler	33	3	92*	—	—	—	—	—	—	—	—	—	—	—	—
Control plot		Bashaw	2	0	100*	—	—	—	—	—	—	—	—	—	—	—	—

[1]SD = soil drench.
[2]H = hydraulic spray.
*Percentage living larvae in control plot.

Foliar sprays were applied with a hydraulic sprayer unit in early August 1975, 1976, and 1978. Plots consisted of two replicates of 0.04 ha each in a randomized block design in a box elder, or Manitoba maple, shelterbelt at Erskine. Spray solutions were applied at a pressure of 60 kg/cm² and a rate of 114 L per plot at 0.5 mL a.i./L with a spreader sticker (Atplus 526) added at the rate of 0.25 mL/L. Percentage insect control was determined 24 h later by the previously described method. Results of all field tests are shown in Table 1.

Soil drenches did not perform well, except in one test with dimethoate that gave excellent borer control. Low soil moisture may have been a contributing factor. Foliar-spray results were good except for the 1975 test with diazinon, possibly because of rain showers that came shortly after application. No phytotoxicity was recorded on box elder from either soil or foliar application of the chemicals tested. Foliar sprays in Alberta should be applied in late July or early August for 2-3 consecutive years for maximum control. Dimethoate and diazinon are now registered for foliar application on box elder to control the box elder twig borer.—J.A. Drouin and D.S. Kusch, Northern Forest Research Centre, Edmonton, Alta.