Trees were baited by placing small plastic caps of frontalin (>99.2% purity) at or near breast height. Axe-cuts were made near the caps to supply the host-tree volatiles. Frontalin was tested for attractiveness, using a sleeve olfactometer (Gara, Vité and Cramer, Contrib. Boyce Thompson Inst. 23: 55-66, 1965) and polyethylene covered cages on which barrier traps were mounted, as in our earlier cross-attraction tests. For comparisons of beetle response, spruce billets with attacking females were used as sources of attraction. Many trees were baited by hanging such billets against them 3 to 5 feet above ground.

At Elko, olfactometer tests during early beetle flights showed that frontalin, released from vials in combination with alpha-pinene, beta-pinene or 3 carene, attracted spruce beetles. For example, on June 5 and 6 during 4.6 hours of testing, 61, 40 and 37 beetles per hour were attracted to these combinations, respectively, as compared with 22 per hour responding to an uninfested billet. However, during later flights, June 18 to 21, more beetles responded to a billet with 15 attacking females than to the frontalin and alpha-pinene combination (71 and 18, respectively, during 3.7 hours of testing). The cage-trap units showed that although beetles were attracted to frontalin with alpha-pinene, females in billets were more attractive (Table 1).

TABLE 1
Flight-trap catches at cages in three[1] replications of five different sources of attraction

Attractants	Dates June 1970	*Dendroctonus rufipennis* No. of males	No. of females	Per cent males	Per cent total catch for period
Spruce billet	6-9	169	133	56	66
+ 40 females	20-23	1143	352	76	77
Spruce billet	6-9	25	28	47	12
+ frontalin	20-23	55	90	38	8
Alpha-pinene	6-9	23	38	38	13
+ frontalin	20-23	45	96	32	7
Frontalin	6-9	13	8	62	5
only	20-23	31	24	56	3
Spruce billet	6-9	12	8	60	4
only	20-23	45	54	46	5

[1] Only two functioning June 6-9.

When attacks were noticed on standing trees near sites of frontalin release, four uninfested trees were each baited with two caps of frontalin and axe-cuts. These trees were attacked the same day. The brood survived and eventually killed the trees. Four days later the caps were transferred to four other trees, over 600 feet away. These trees were also attacked, during at later and less intense flight; however, their beetle broods failed and the trees survived that season. After beetle flight had ceased, all trees within 50 feet and several within 300 feet from each frontalin source were exeamined. The results were as follows:

	within 30 ft	30—50 ft	50—300 ft
No. trees examined	48	36	47
No. trees attacked	28	1	0

Baited and surrounding trees ranged from 6.0 to 33.0 inches, with an average of 13.6 inches dbh.

The sex ratio of beetle samples at Elko is of interest. The percentage of males was 41.4 in 955 beetles hibernating the previous autumn, 34.3 in 233 beetles taken by sticky wire traps on frontalin-baited trees, and 31.8 in 585 beetles caught by barrier traps on a felled tree, but males predominated in flight trap samples at billets with females and at frontalin only (see Table 1). The sex ratio differences apparently reflect differences in male and female activity or response to different kinds of attraction.

At Naver, olfactometer tests were negative with frontalin combined with various monoterpenes found in spruce, during small early-season beetle flights. However, billet-cage tests, replicated in three locations, indicated that frontalin with alpha-pinene was somewhat attractive. For example, numbers taken June 14 to 21 were: 80—frontalin with alpha-pinene; 417—billet with 40 females; 101—frontalin with billet, and 17—frontalin alone.

A series of trees in 18 locations were baited with billets to which 10 or 15 female beetles were added. The beetles were placed in small holes punched in the bark, and covered with screen wire. Of the 58 baited trees (9 to 23 inches, avg 16.6 inches dbh), 31 were attacked. Most of the billets on these trees had four or more successful attacks by the added females. Most unattacked trees had fewer than four successful attacks by screened females on the bait billet. No trees next to the billet-baited ones were attacked.

On July 17, 10 trees (12—30 inches avg 18.0 inches dbh) in three areas five or more miles apart, were each baited with five caps of frontalin and axe-cuts. Although only a small flying population, mainly reemerged parent adults, was to be expected late in the season, all 10 trees were attacked as well as several others adjacent to the baited trees.

Densities of induced attacks were low at Naver and no attacked trees were killed. Most attacks failed, apparently due to resin flow. Some long egg galleries were noted, but most had no larvae. Attacks were concentrated more at the base of trees baited with billets than when frontalin was used (Table 2). Here, as at Elkio, all attacks seen on standing trees in the test areas were associated with billet- or frontalin-baiting.

TABLE 2
Vertical attack distribution on baited trees—Naver

Height above ground—ft	Billet-female bait[1] No. attacks	Per cent	Frontalin bait[2] No. attacks	Per cent
0 - 1	202	57	56	25
1 - 2	68	19	22	10
2 - 3	38	11	30	13
3 - 4	32	9	33	15
4 - 5	15	4	24	11
5 - 6	1	0.5	21	9
over 6	0	0	37	17
Total	356		223	

[1] 31 trees attacked.
[2] 10 trees attacked.

We conclude that frontalin triggers the process of mass attack by the spruce beetle and that, as with several other *Dendroctonus* species (e.g., McCambridge, Ann. Ent. Soc. Amer. 60: 920-928, 1967), baiting with billets and female beetles acts in a similar way. The low attractiveness of frontalin with alpha-pinene indicates that there are other chemical cues, as yet unknown, involved in secondary attraction of the spruce beetle. However, the consistency with which trees baited with frontalin were attacked, in stands where no attacks on unbaited standing trees were found, suggests that frontalin is a component of spruce beetle secondary attraction. Investigations into the potential uses of frontalin for study, survey and control of the spruce beetle are planned.

The tests were carried out, as part of a cooperative study of secondary attraction in the spruce beetle, with J. P. Vité and G. B. Pitman, Boyce Thomson Institute for Plant Research, Inc. We thank that organization and the Southern Forest Research Institute, Houston, Texas, for supplying the frontalin and D. W. Taylor and T. G. Gray for assistance. E. D. A. Dyer and J. A. Chapman, Forest Research Laboratory, Victoria, B.C.

Field Test of Ethanol as a Scolytid Attractant.—Ethanol, produced in softwood logs, serves as a primary attractant for *Gnathotrichus sulcatus* Lec. (Cade, Hrutfiord and Gara, J. Econ. Entomol. 63: 1014-1015, 1970) and in laboratory tests, for *Trypodendron lineatum* (Olivier) (Moeck, Can. Entomol. 102: 985-995, 1970). A field test with ethanol (Moeck, *loc. cit.*) in 1969 was unsatisfactory due to a small beetle population in the test area, which necessitated repetition in a more highly populated area.

On 29 Apr. 1970, 40 pan-type glass-barrier traps (Dyer and Chapman, Can. Entomol. 97: 42-57, 1965) (Fig. 1a) were placed on the ground in groups of four at three locations in stands of 60–70-year-old Douglas-fir near Mesachie Lake and Caycuse, B.C. In each group, traps were situated at the corners of a 6-foot square, with the glass panes of adjacent traps oriented at right angles to each other, to reduce directional effects. The test solution (750 ml of 10% ethanol) was placed in each of two adjacent traps of each group, and 750 ml of water (control) was placed in each of the other two traps. The solutions were replaced three times until the conclusion of the test on 19 May.

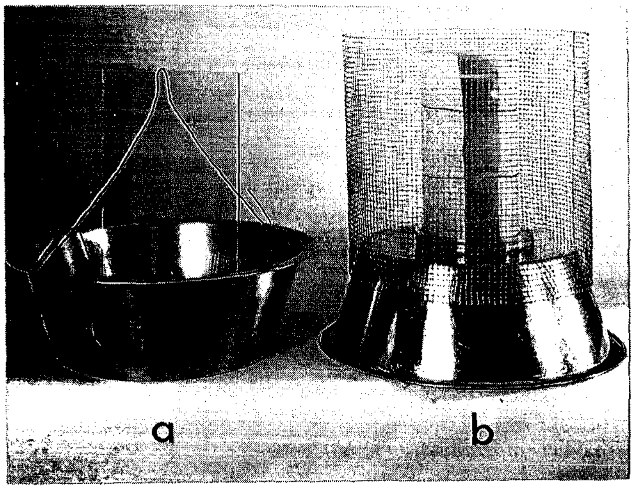

FIGURE 1. Flight traps: a) glass barrier type; b) sticky screen type.

A new flight trap was also used. It consisted of an inverted 64 oz large-mouth jar supported by a ¼-inch mesh wire collar ⅜ inches above the bottom of a petri dish (Fig. 1b). Two paper towels (high wet strength, fast flow rate) wrapped around the jar served as a wick. The jar was surrounded by a ¼-inch mesh wire cylinder dipped in melted 'Stikem Special' (Michel and Pelton Co., Oakland, Calif.). These nondirectional traps operated unattended for a week or more, depending on rate of evaporation as affected by weather. Trapped insects were washed off the wire screen with benzene. Six pairs of these traps were placed at the same locations as the barrier traps between May 12 and 22, one pair-member containing 10% ethanol, the other water. They appeared to be much more effective than the pan-type traps.

The numbers of insects caught in the traps are listed in Table 1. *Trypodendron*, *G. sulcatus*, *Anisandrus* and *Xyleborus* were clearly attracted by ethanol, as was *Rhizophagus dimidiatus*. Analysis of the data for *Trypodendron* (Table 2), with the Wilkoxon matched-pairs signed-ranks test (Siegel, Nonparametric Statistics, McGraw-Hill Co., 1956), indicated significant differences between control and test trap catches for males and females at P=0.025 and 0.005 levels, respectively. Fewer *Trypodendron* were caught than expected, judging by the large number of beetles flying in the area. Several explanations are possible: a) ethanol *per se* may be a weak attractant; b) the ethanol concentration used may not have been the optimum for this insect; c) other chemical or visual factors may play a role in primary attraction; d) only a fraction of the population may be responsive to ethanol, the remainder using the secondary attractant as the main cue, or e) the behavior of the local population may have been dominated by stronger natural attractant sources in the vicinity.

TABLE 1
Field test of ethanol as an attractant

Insect		No. of insects: water (26 traps)	No. of insects: 10% ethanol (26 traps)
Trypodendron lineatum (Olivier)	♂	6	22
	♀	17	55
Gnathotrichus sulcatus Lec.	♂	7	282
	♀	9	58
Anisandrus pyri Peck.	♀	142	3457
Xyleborus saxeseni Ratz.		6	102
Other Scolytidae		50	70
Rhizophagus dimidiatus Mann.		12	126
Cerambycidae		0	12
Other Coleoptera		1202	2251

TABLE 2
Numbers of *T. lineatum* caught in control and test traps

Group No.	Trap Type	water ♂	water ♀	10% ethanol ♂	10% ethanol ♀
1	Glass barrier	0	1	0	1
2	"	0	0	1	1
3	"	0	0	0	4
4	"	0	0	1	2
5	"	0	0	3	13
6	"	1	7	4	13
7	"	1	2	1	4
8	"	1	1	0	1
9	"	1	0	0	1
10	"	0	0	2	1
11	Sticky screen	0	0	1	0
12	"	0	0	1	1
13	"	1	0	1	1
14	"	0	0	1	1
15	"	0	0	0	0
16	"	1	6	6	11
Totals		6	17	22	55

The large number of *Anisandrus* females captured (males are flightless) was unexpected. This ambrosia beetle attacks a variety of hardwoods, and at times is a pest in fruit orchards (Mathers, Can. Entomol. 72: 189-190, 1940; Jack, B.C. Dept. Agr. Rep., 1965). Trapping with ethanol may be useful in the study or control of this insect.

The attraction of *Rhizophagus* by ethanol is interesting. Although the biology of the western North American species is virtually unknown, Escherich (Die Forstinsekten Mitteleuropas Vol. II, 1923) states that adults and larvae of various *Rhizophagus* species prey on the brood of bark and ambrosia beetles. If *R. dimidiatus* is predaceous on Scolytidae, attraction by ethanol (i.e., log odor) would help in locating prey. Henry Moeck, Forest Research Laboratory, Victoria, B.C.

Mortality of Monochamus Larvae in Slash Fires.—The use of prescribed fire as a management tool is increasing and it is of value to know the effect of these fires on wood borer populations in slash. In 1969, experimental fires in slash of lodgepole pine [*Pinus contorta* Dougl. var. *latifolia* Engelm.] at the Kananaskis Experimental Forest, Alberta, (Quintilio, Intern. Rep. A-30. May 1970) provided an opportunity to study the effect of fire on the survival of larvae of the genus *Monochamus*. The experimental plots varied in total fuel loading from 30 to 50 tons per acre, slash was 4 inches and over in diameter, and plots were burned under various hazard ratings. Adjacent 1-acre plots had been cut in the spring of 1968 and were burned in the summer of 1969.

Monochamus adults laid eggs into the logs in 1968, and by 1969 all larvae had tunnelled into the wood. After each plot had been burned, the author chose logs for sampling by walking in straight lines through the plot and sampling the first 10 infested logs. Logs within 10 ft of plot boundaries were not sampled to avoid any edge effects. A sample consisted of one larval entrance hole or more on each log. These were cut open and the larvae were recorded as alive or dead. Larvae previously killed by diseases, as evidenced by their dark brown coloration and shrivelled body, were not included. These were separated from fire-killed larvae which were yellow-brown and brittle.

All *Monochamus* larvae were killed by extreme- and high-rated slash fires; moderate-rated slash fires killed most of the larvae, and low-rated slash fires killed only a few larvae (Table 1).

TABLE 1
Mortality of *Monochamus* larvae in slash fires

Hazard rating of slash fire	Avg fire intensity (BTU/sec per 2 feet)	Slash consumption (>4 inches) (%)	No. of logs sampled	No. of larvae: Live	No. of larvae: Dead	No. of larvae: Total	Larval mortality (%)
Low	358	10	20	25	5	30	16.7
Moderate	1,708	31	20	3	20	23	86.9
High	5,791	42	30	0	39	39	100.0
Extreme	12,544	60	30	0	38	38	100.0
Total	—	—	100	28	102	130	—

The data from logs in the plots with low and moderate hazard ratings were grouped according to several heights of logs above ground and analysed for borer mortality. No clear relation was indicated except for reduced mortality of borers in logs at ground level.—B.M. Dahl, Forest Research Laboratory, Edmonton, Alta.