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NUMBERS OF *DENDROCTONUS RUFIPENNIS* (KIRBY) AND *THANASIMUS UNDATULUS* SAY AT PHEROMONE-BAITED POISONED AND UNPOISONED TREES

by

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ABSTRACT

Four times as many spruce beetles, *Dendroctonus rufipennis* (Kirby), were killed at spruce trees (*Picea engelmannii* Parry, *Picea glauca* (Moench) Voss) baited with frontalin and sprayed with insecticide than at trees baited but unsprayed. Many clerid predators, *Thanasimus undatulus* Say, were also killed at the baited and sprayed trees. Their numbers were correlated with those of killed spruce beetles. Other correlations show that sprayed and unsprayed trees were exposed to the same attacking spruce beetle population and that predation on the spruce beetles was occurring.

INTRODUCTION

A synthetic pheromone, frontalin (Kinzer *et al.*, 1969) causes aggregation in both sexes of spruce beetle (*Dendroctonus rufipennis* (Kirby)) and a clerid predator (*Thanasimus undatulus* Say), when released from polyethylene capsules on living spruce trees (*Picea glauca* (Moench) Voss, *P. engelmannii* Parry) (Dyer, 1973). Insecticide sprayed onto the lower 3.0 m (10 ft) of tree boles kills all arriving insects, and thus prevents the establishment of galleries by spruce beetles and predation by *T. undatulus* (Dyer, 1973). Without insecticide, some arriving spruce beetles enter the bark of baited trees and attempt to reproduce, even though resistance by the tree may prevent subsequent egg hatching or development of brood. The predators, attracted to baited trees, arrive at about the same time as the first beetles, which gives them an opportunity for predation, which would probably not occur during natural attacks when some spruce beetles would have entered the bark before producing pheromone (Dyer, 1973). The following experiments carried out in 1973 and 1974 were designed to determine any differences in numbers of spruce beetles and predators at baited trees sprayed with insecticide, and the numbers of spruce beetles in baited, unsprayed trees.

METHODS

Near Prince George, B.C., 133 spruce trees, about 20.1 m (66 ft) apart in a line around a stand perimeter in the Naver forest, were baited with 1.0 ml of 1 part frontalin and 2 parts alpha-pinene, in May 1973. Two polyethylene capsules, containing the frontalin-pinene mixture, were placed on each tree on opposite sides at breast height. Every tenth tree was sprayed to drip with insecticide (lindane 0.5% in water) on the basal 3.0 m and was fitted with a wire-screen basket at the base (Dyer, 1973).

Collections from the baskets were made about twice a week, from June 14 to the end of August. In August, bark samples of 20.3 x 25.4 cm (8 x 10 inches) were removed from 25 trees randomly chosen out of the 91 attacked trees. A minimum of four samples was taken from each tree, one from each of the north and south aspects at breast height and at the base. If the attack height was greater than 1.8 m (6 ft) a further two samples were taken from the north and south aspects midway between breast height and attack height. The number of attacks, i.e. entrance holes, was counted for each sample.

In 1974, ten pairs of spruce trees were selected at about 403.3 m (1320 ft) intervals, in the Naver forest near the 1973 experiment.

Each pair had approximately the same dbh (± 5 cm) and the trees were spaced about 20 m apart. Both trees of a pair were baited with frontalinal and alpha-pinene, as was done in the 1973 experiment and one tree from each pair was sprayed with lindane and fitted with a screen basket as described. Screen baskets were also placed on seven of the ten unsprayed trees. Collections were made from all screen baskets about twice per week, from June 4 to August 28. Fragments of spruce beetles, such as pairs of elytra, were collected from baskets on unsprayed trees as evidence of arthropod predation.

At the end of the spruce beetle flight period in August, from five to 14 randomly distributed (20.3 x 25.4 cm) bark samples were removed from the unsprayed trees to obtain an estimate of the mean attack density. The estimated number of beetles was calculated by using the total attacked surface area of each tree, attack

density, and the male to female ratio found in the sprayed-tree collections. Analysis of these data included three correlations: (1) between the number of spruce beetles and the number of *Thanasimus* caught on each date at the sprayed trees; (2) between the number of *Thanasimus* caught at each sprayed tree and the number of predator-killed spruce beetles at the corresponding unsprayed tree, and (3) between the number of spruce beetles caught at each sprayed tree and the estimated numbers under the bark of each corresponding unsprayed tree.

RESULTS AND DISCUSSION

In 1973, the average numbers of spruce beetles and *T. undatulus* killed per sprayed tree were 130.5 and 73.7, respectively. The average number of spruce beetles in the unsprayed trees was 43.5 (Table 1), or one-third the number killed at sprayed trees. At the sprayed trees, the ratio of *T. undatulus* to spruce beetles was 1 to 1.8.

TABLE 1. Numbers of *D. rufipennis* and *T. undatulus* caught at insecticide-sprayed and unsprayed trees baited with frontalinal in 1973.

	No. of trees sampled	Mean no./ tree	Std. error of mean	% ♂ ^{1/}
Dendroctonus caught at sprayed trees	13	130.5	44.68	40.1±0.2
Thanasimus caught at sprayed trees	13	73.7	19.64	41.1±0.2
Estimated no. of Dendroctonus in attacked unsprayed trees	25	43.5	2.38	-

^{1/} 95% confidence belt

In 1974, the average numbers of spruce beetles and *T. undatulus* killed per sprayed tree were 1703.8 and 418.0, respectively. The average number of spruce beetles in the unsprayed trees was 395.7 (Table 2); about one fourth the numbers at sprayed trees. One *T. undatulus* was killed for each four spruce beetles on the sprayed trees, nearly half the ratio found previously. Fragments of spruce beetles were found in the screens on the unsprayed trees (Table 2), indicating that predation was occurring.

In the 1974 study, the following three pairs of variables were linearly related with significant ($P < .01$) correlation coefficients: (1) the number of *D. rufipennis* caught at sprayed trees and the number in unsprayed trees ($r=0.77$); (2) the number of *D. rufipennis* and *T. undatulus* caught at sprayed trees ($r=0.87$); and (3) the number of *T. undatulus* and the number of predator-killed *D. rufipennis* at paired trees ($r=0.88$).

Since the numbers of *D. rufipennis* at spray-

ed and unsprayed trees were significantly correlated, each of a pair of trees was exposed to the same or similar attacking populations. Therefore, some factor other than available population determined the difference in numbers at the sprayed and unsprayed trees. Since, at sprayed trees, the number of *T. undatulus* caught was correlated with the number of *D. rufipennis* caught and, at unsprayed trees, with the number of *D. rufipennis* destroyed, predation was one factor that reduced the number of beetles entering unsprayed trees. However, a precise count of the number of *D. rufipennis* killed by *T. undatulus* is difficult to obtain because some evidence of predation is lost in the bark crevices and spider webs on the tree boles; moreover, other insect predators may have killed attacking beetles. Table 2 shows that each *T. undatulus* would have had to remove about three spruce beetles to account for the reduced number in the unsprayed trees compared to those caught at the sprayed trees.

In 1974, the estimated ratio of predator to

TABLE 2. Numbers of *D. rufipennis* and *T. undatulus* caught at insecticide-sprayed and unsprayed trees baited with frontalinal in 1974.

	No. of trees sampled	Mean no./ tree	Std. error of mean
Dendroctonus caught at sprayed trees	10	1703.8 ^{1/}	274.21
Thanasimus caught at sprayed trees	10	418.0	95.73
Estimated no. of Dendroctonus in attacked unsprayed trees	10	395.7	85.92
Predator-killed Dendroctonus at unsprayed trees	7	15.8 ^{2/}	2.57

^{1/} 44.4% ♂ ± 0.16% (95% confidence belt)

^{2/} Based on parts of *D. rufipennis*, such as pairs of elytra, in screen baskets at tree bases.

prey decreased from that of 1973, which should have resulted in a higher proportion of the arriving spruce beetles entering the trees, if predation were the only factor influencing attack density. However, the proportion was less in 1974 (0.23: 1) than in 1973 (0.33:1), indicating that some mechanism other than predation influenced the number of beetles entering the unsprayed trees. Nijholt (1973), studying another scolytid, *Trypodendron lineatum* (Oliv.), showed that the presence of males masked the secondary attraction of females. Hedlin¹ found that when using an insecticide on logs, the natural secondary attraction of *Trypodendron* females in the logs continued to attract other beetles longer and in

greater numbers to treated rather than to untreated logs, presumably because the males were killed before they could join the females.

An anti-aggregative pheromone MCH (3-methyl-2-cyclohexen-1-one) is produced by spruce beetles after entering the host tree (Kline *et al.*, 1973; Rudinsky *et al.*, 1973). MCH repelled *D. rufipennis* from attractive host logs and felled trees when released nearby. Since it is probable that MCH was produced by the beetles after both sexes had entered the unsprayed trees, later arriving beetles in similar numbers would have been repelled from entering the unsprayed trees while the sprayed trees would have continued to be attractive throughout the flight period.

¹A. F. Hedlin personal communication.

Résumé

Les auteurs rapportent que 4 fois plus de Dendroctones de l'Épinette, *Dendroctonus rufipennis* (Kirby), furent tués sur des Épinettes (*Picea engelmannii* Parry, *Picea glauca* (Moench) Voss) appâtées avec de la frontalinal et arrosées avec un insecticide, que sur des arbres appâtés mais non arrosés. Plusieurs prédateurs Cléridés appartenant à *Thanasimus undatulus* Say, ont également été tués sur des arbres appâtés et arrosés, leurs nombres ont été mis en corrélation avec ceux des Dendroctones. D'autres corrélations ont démontré que les arbres arrosés et non arrosés ont également été exposés aux attaques par la même population de Dendroctones et que la prédation sur les Dendroctones avait lieu.

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