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SURVIVAL OF SELF-MARKED MOUNTAIN PINE BEETLES EMERGED FORM LOGS DUSTED WITH FLUORESCENT POWDER

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Abstract

Mountain pine beetles, *Dendroctonus ponderosae* Hopk. (Coleoptera: Scolytidae), were allowed to emerge in the laboratory from naturally infested lodgepole pine bolts, which had been heavily dusted with dry fluorescent (Day-Glo) powder. Emergent beetles were collected daily and stored at 5°C. Mortality was assessed daily for 21 days, after which the insects were killed. All dead beetles were examined under UV light for the presence and degree of marking. The survival of marked beetles was compared to that of unmarked beetles from control bolts. Analysis of variance showed no difference in mortality rate due to the treatment.

Résumé

On a épandu abondamment une poudre fluorescente sàche (Day-Glo) sur des billes de pin tordu infestés naturellement par des dendroctones du pin ponderosa (*Dendroctonus ponderosae* Hopk.) Coleoptera: Scolytidae). On a recueilli chaque jour les ensectes émergents et on les a placés dans une enceinte réfrigérée à 5°C. On a contrôlé la mortalité chaque jour pendant 21 jours, puis on a tué les insectes. On a examiné tous les insectes morts sous un éclairage UV pour connaître le degré de marquage. On a comparé la survie des insectes marqués à celle d'insectes non marqués ayant émergé des billes témoins. D'après l'analyse de la variance, le tratiement n'a eu aucun effet sur le taux de mortalité.

INTRODUCTION

An ongoing series of field experiments to study the dispersal behavior of mountain pine beetles (mpb), *Dendroctonus ponderosae* Hopk., was begun in 1982 near Riske Creek, in the Cariboo Forest Region of B.C. These experiments required the development of techniques suitable for field-marking large numbers of emergent mpb used in release-recapture experiments.

Fluorescent powders have been used extensively as markers on insects and are usually non-toxic, readily available and inexpensive (Gangwere *et al* 1964; Gara 1967; Moffitt and Albano 1972; Schmitz 1980). Powders have been applied to insects using vacuum chambers (Dunn and Michalas 1963; Moffitt and Albano 1972; Linton *et al* 1987), or the insects have been allowed to dust themselves on release platforms (Gara 1976; Schmitz 1980). An alternative method for applying the powder was sought which did not involve handling the insects. The method proposed and used in 1984 and 1985 (Linton *et al* 1987) was to apply a heavy coating of fluorescent powder to the lower boles of infested lodgepole pine trees, *Pinus contorta* Dougl. var *latifolia* Englm. when the brood adults were ready to emerge and begin their dispersal flight. It was thought that the beetles would become coated with the dust while they moved around on the bark surface prior to taking flight. This experiment was carried out to determine whether or not emergent mpb would pick up enough fluorescent powder to become reliably marked, and how the survival of the self- marked beetles compared to unmarked beetles.

METHODS AND MATERIALS

Six infested lodgepole pine bolts (24-30 cm in diameter and 15-22 cm in length) were collected in fall, 1982 near Riske Creek. The bolts were transported to outdoor storage in Victoria and waxed on both ends to prevent desiccation. In January, 1983, the bolts were brought into the laboratory. The insects were in the late larval stages and in winter dormancy. The bolts were kept at 20 ± 2 °C until most of the brood had developed to the adult stage and were ready to emerge. Three of the bolts were selected randomly for treatment, the remainder were controls. Treatment consisted fo uniformly coating the entire bark surface of each bolt with fluorescent powder (Day-Glo Corp., Cleveland, Ohio 44103, #A-21 Corona Magenta) by blowing the dust from an aspirator made from a 250-ml vacuum flask connected to the lab air supply at 100 kPa. Approximately 50g of powder were applied to each bolt. All six bolts were then placed separately in darkened cages with light traps for emergents, and were held at room temperature. Emergent mpb were collected from the light traps daily and placed in vials in a refrigerator (5°C). Each day's collection was examined for mortality every day for 21 days, which was considered adequate for the purpose of the experiment, as under natural conditions flight, attack and brood establishment are normally completed within 3 weeks of emergence. At the end of the 21 day experimental period, the remaining live beetles were killed.

After death, each beetle from the treated bolts was examined for the presence and degree of marking using the naked eye or a dissecting microscope (16X) in a darkened room with short-wave ultra violet (UV) lamp (Pin-Ray Quartz Lamp, Ultra Violet Porducts Inc., San Gabriel, Calif. 91778) held 5-10 cm from the insects. (It is necessary to protect the eyes with effective filter goggles when using these lamps.) The degree of marking on each insect was classified into one of the following categories: none, light, medium, or heavy. Heavily marked insects were easily seen by the naked eye in normal daylight or using the UV lamp. Medium marking was visible only with the UV, but magnification was not always necessary. color was easily seen on most of the insects' dorsal or ventral surfaces using the microscope. Light marking was not visible to the naked eye, and only seen with difficulty using the microscope; often only a few grains of powder were present, usually on the ventral surfaces concentrated in sutures and declivities. Beetles from dusted bolts having no visible marking were classified as having "none." Emergents from the unmarked bolts formed the control group.

Mortality was analysed by ANOVA in a split-plot design with two treatments (dusted vs undusted) and three time durations (1-7 days, 8-14 days, 15-21 days). Differences in mortality among groups of beetles with different degrees of self-marking, and variation in the relative proportions of beetles with different degrees of self-marking among the replicates were examined by χ^2 analysis.

RESULTS AND DISCUSSION

On average, of the 765 and 683 beetles that emerged from treated and control bolts, respectively, 0.7% and 1%, 2.5% and 1.3%, 5.5% and 5.7% died within the 1st, 2nd, and 3rd week after emergence. Of the beetles that emerged from the treated bolts, 758 (99.1%) were marked. Of the marked beetles, 43 (5.6%) were heavily marked, 204 (26.7%) were medium, and 511 (66.8%) were light. The relative proportions of beetles in the four marking degree categories were not significantly different among the three replicates (bolts) ($\chi^2$6df=10.43, p=0.11). Analysis of variance indicated that the mortality of emerged beetles increased significantly with time, but there was no significant difference between the controls and treatments, or in the interaction of treatment x time (Table 1).

In mortality among beetles that emerged from treated bolts, there was no interaction between storage duration and degree or marking ($\chi^2_{6df}=4.41$, $p=0.63$); mortality, however, did increase with the degree of marking ($\chi^2 2_{df}=116.37$, $p<0.001$). Average mortality in the light, medium and heavy marking classes was 2.7%, 15.7% and 51.2%. As average mortality was not statistically significant between treatment and control (Table 1), the finding above appears to indicate that beetles of reduced viability may have spent more time on the treated bark than did more active beetles and thus become more heavily marked, or were less able to cleanse themselves of the powder. We have observed that beetles which do not readily fly, tend to spend considerably more time on the bark following emergence than beetles which are good fliers. Furthermore, we have found in several experiments using marked and unmarked beetles, that there are usually between 1 and 8% which will not fly (Linton *et al.* 1987, and unpublished data). The apparent association between the degree of self-marking and viability requires further investigation.

These results indicate that there was no statistically significant difference in survival in the laboratory between self-marked or control beetles for the first three weeks after emergence.

Table 1. Analysis of variance of percent mortality by treatment and storage interval following emergence of mountain pine beetles from bolts of lodgepole pine dusted with fluorescent powder and from undusted bolts.

Source	df	Sum squares	Mean squares	F-value[a]
Replication (bolts)	2	9.1892	4.5936	<1 n.s.
Treatments (dusted vs undusted)(D)	1	1.7422	1.7422	<1 n.s.
Error I	2	40.6834	20.3417	
Major plots	5	51.6148		
Time intervals (T)	2	282.5391	141.2695	35.08**
DxT	2	18.2290	9.1145	2.26 n.s.
Error II	8	32.2184	4.0273	
Total	17	384.6013		

a. Percentages were transformed to arcsine sqrt x prior to analysis. n.s. = not significant; ** = significant at p<0.01.

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ASSESSMENT OF TWO PINE OIL TREATMENTS TO PROTECT STANDS OF LODGEPOLE PINE FROM ATTACK BY THE MOUNTAIN PINE BEETLE

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Abstract

Pine oil (Norpine-65) was evaluated as an infestation deterrent for the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, in a high hazard forest of lodgepole pine, *Pinus contorta* var. *latifolia* Engelmann. Two experimental treatments were tested, each in four, 9 ha, square blocks (replicates): 1) spraying trees in a grid at 50 m centres with 1.8 L of pine oil/tree, and 2) creating a "barrier" consisting of a double line of pine oil-sprayed trees, 25 m apart, 25 m within the block boundary. There were significantly-reduced ratios of newly-infested (green) trees to the previous year's infested (red) trees in both treatments compared to control blocks. However, neither treatment prevented beetles from attacking semiochemical-baited trees 75 m inside the block boundaries, and neither treatment is recommended for operational use. At maximum costs/ha of $22.04 and $43.39 (Can.) for grid and barrier treatments, respectively, the operational use of a repellent, or an insecticide would approach cost effectiveness if it reduced new infestations of *D. ponderosae* by 1 or 2 trees/ha, respectively.

INTRODUCTION

Pine oil is a commercially-available by-product of the pulp and paper industry. When sprayed on the boles of trees or on logs, it has repeatedly been shown completely or partially to deter attack by scolytid beetles (Nijholt 1980; Nijholt and McMullen 1980; Nijholt *et al.* 1981; Richmond 1985; McMullan and Safranyik 1985; Berisford *et al.* 1986; O'Donnell *et al.* 1986; Werner et al. 1986). Nijholt et al. (1981) reported that attack by the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, was deterred up to 10 m from pine oil-treated lodgepole pines, *Pinus contorta* var. *latifolia* Engelmann. This result suggested that pine oil might have potential in protecting large blocks of forest from attack by the beetles. However, McMullen and Safranyik (1985) did not induce such protection by affixing pine oil-impregnated fibre boards on trees or distributing them on the forest floor.[1]

Our objective was to test pine oil on an operational basis to determine if it could be used to protect high hazard stands from attack by the mountain pine beetle. Several criteria had to be met in such a program: 1) the stands had to have minimal infestations; 2) there had to be sufficient mountain pine beetle infestation in the adjacent forest to threaten each treated block; 3) the pine oil treatment had to be simple enough for regular forestry crews to carry out; 4) the pattern of treated trees had to be set up so that large blocks could be treated in a reasonably short time; and 5) the treatments had to be cost-effective.

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