FIELD TECHNIQUES FOR REARING AND MARKING MOUNTAIN PINE BEETLE FOR USE IN DISPERSAL STUDIES

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Abstract

Mountain pine beetles, *Dendroctonus ponderosae*, were marked with fluorescent (Day-Glo) powders in vacuum chambers and on powder-covered brood trees in the field for use in release-recapture studies of dispersal behavior. A large wall tent was used as a field insectary to accelerate late stages of development of large numbers of beetles in naturally infested bolts of lodgepole pine. Up to 28% of the marked beetles which flew were recovered from lethal trap trees. Beetles self-marked on powdered brood trees were captured in barrier traps in predicted proportions.

Résumé

Des dendroctones du pin ponderosa ont été marqués à l'aide de poudres fluorescentes (Day-Glo) dans des chambres à dépression ainsi que sur des arbres foyers couverts de poudre sur le terrain pour des études par libération-recapture du comportement de dispersion. Une grande tente canadienne a été employée comme insectarium sur le terrain pour accélérer les derniers stades de développement des grands nombres de dendroctones se trouvant dans des billons de pins tordus infestés naturellement. Jusqu'à 28% des dendroctones marqués qui s'étaient envolés ont été retrouvés dans des arbres pièges létaux. Les dendroctones qui s'étaient marqués eux-mêmes sur les arbres foyers couverts de poudre ont été capturés dans des pièges dans les proportions prévues.

Introduction

A series of release-recapture field experiments to study the dispersal of mountain pine beetles, *Dendroctonus ponderosae* Hopk., (mpb) required development of techniques for rearing, marking, releasing, and subsequently recapturing large numbers of these insects. The experiments were carried out from 1982 to 1985 in the Cariboo Forest Region of B.C. near Riske Creek.

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). Techniques have been described for applying powders to large numbers of moths or flies quickly and reliably using a vacuum dusting chamber (Dunn and Mechalas 1963; Moffitt and Albano 1972). We used similar chambers made from 6-mm-thick plexiglass (Fig. 1) to dust up to 250 adult mpb placed on the bottom of the chamber at one time using 0.5 g of dust.

In the absence of a permanent insectary, mpb were partially force-reared in a large wall tent which incorporated a specially constructed door consisting of a large window above a cold trap for capturing live beetles soon after emergence. Storage, handling, and release and recapture methods used in 1982 and 1983 are described. Also presented is a new and simple method of marking beetles (tested in 1983 and used in experiments in 1984 and 1985) by applying fluorescent powder to brood trees before emergence. The powders are shown to have no apparent effect on dispersal behavior or longevity of mpb up to the time of release and they persist through pre-flight handling, dispersal flight, and handling subsequent to recapture. Full results of the dispersal experiments will be reported elsewhere.

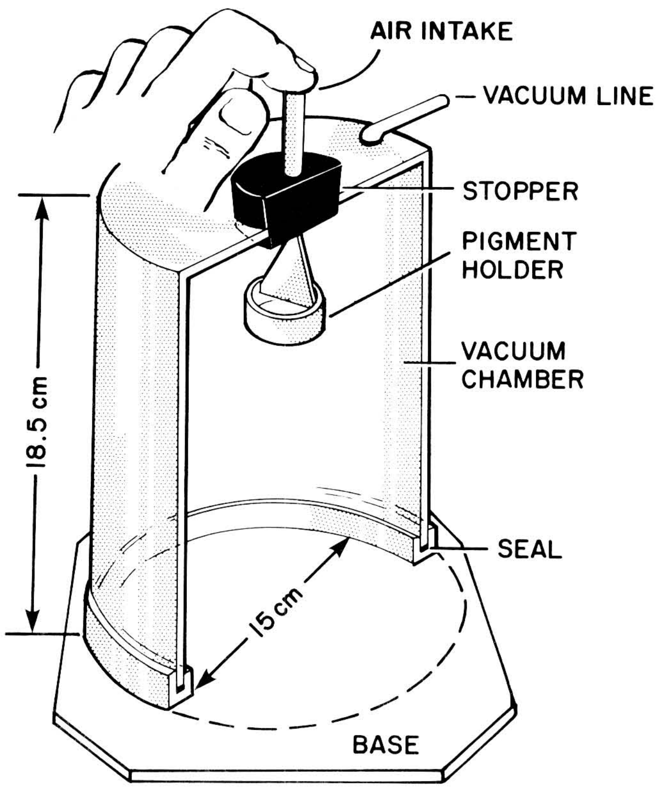

FIG. 1. Vacuum dusting chamber (Dunn & Mechalas 1963: Moffitt & Albano 1973).

Rearing

In early June, 1982 and 1983, 15-20 infested lodgepole pine, *Pinus contorta* var. *latifolia* Dougl., were felled, and the lower 2-7 m were sawn into 1 m lengths. All logs were examined for density of live mpb brood, and the most heavily infested logs (93 in 1982, 90 in 1983) were piled between heavy posts driven into the ground within a 3 m x 4 m area which had been cleared of debris and vegetation. The log pile was made up to fit within a 3 m x 4 m x 2 m canvas wall tent having 1-m-high walls, leaving at least 25 cm of clearance on all sides. The tent was erected over the log pile and was covered by an opaque plastic tarpaulin fly suspended about 25 cm above the roof.

The tent was left closed on all but the hottest days, when end flaps were opened to prevent possible lethally high temperatures. A 3000-btu catalytic propane heater (Coleman model # 9446-510) was used during cool weather and at night. A thermograph in the tent recorded temperatures (Fig. 2).

Brood development in the logs was monitored every few days by removing small areas of bark. In late June tenerals were found and a sloped clear plastic window with a rectangular sheet metal funnel at the bottom was installed on a plywood frame in the west-facing tent door. The funnel fed into a portable 12 V refrigerator (Koolatron mod. 10) which was operated on the "max cold" setting 24 hours a day using an AC adapter and line (110 V) current. The original lid of the refrigerator was removed and replaced with an insulated plywood lid having a 7.5 cm square center hole which fitted tightly around the funnel tube. The temperature inside the refrigerator remained between 1 and 5 °C, which was cool enough to rapidly immobilize the trapped beetles. The metal heat exchanger portion of the bottom of the refrigerator

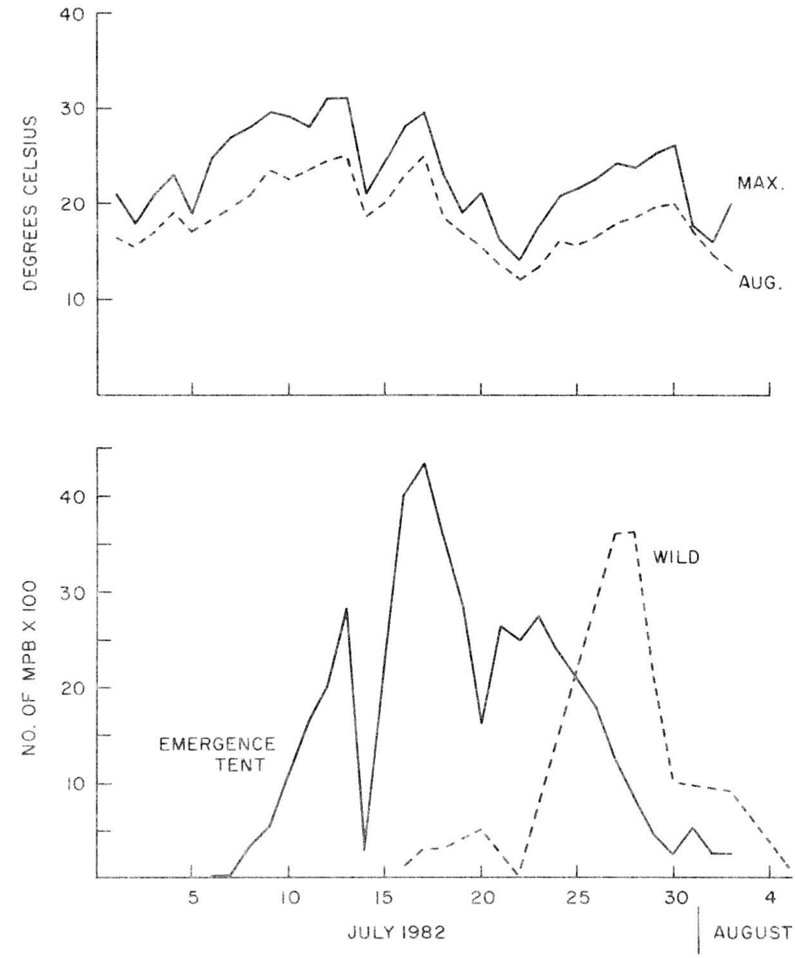

FIG. 2. ABOVE. Solid line = maximum temperatures attained inside the rearing tent. Dotted line = average ambient temperatures. BELOW. Solid line = emergence of mpb from rearing tent. Dotted line = total catches of wild mpb at trap trees. All data recorded Jul-Aug, 1982.

compartment was lined with tightly fitted cardboard to prevent insects from freezing from direct contact; crumpled paper towel was also placed in the bottom to provide climbing surfaces, thus minimizing crowding which results in insects injuring one another. When newly emerged photopositive beetles attempted to fly out of the tent they struck the plastic barrier, and fell into the cold trap. In 1982, 45,415 beetles were collected between July 8 and August 4. In 1983, approximately 25,000 beetles were collected between June 14 and July 24.

The cold trap was cleared of insects daily (more often during peak emergence). Beetles were kept cool until counted by hand into lots of 250 in preparation for vacuum dusting. Beetles having obvious injuries or malformations were discarded.

Vacuum Dusting

To distinguish beetles released on different days or plots, we used four colors: corona magenta, Saturn yellow, arc yellow, and horizon blue (Day-Glo Corp, Cleveland, Ohio). These colors were chosen for ease of separation under UV light. After dusting, the beetles in lots of up to 1000 were stored for periods of up to 10 days in 1 L of fresh lodgepole pine sawdust (from a chainsaw operated with no chain oil) in plastic 4-L ice cream pails in a refrigerator

(4°C). After storage, the fluorescent dust was no longer visible to the naked eye, but was easily recognized under a dissecting microscope (16x) in a darkened room using long-wave UV illumination provided by a fluorescent tube (Sylvania F15T8-BLB) held 5-10 cm from the insects. To prevent loss of night vision due to glare, and to maximize the intensity of light on the microscope stage, it was necessary to shade the fluorescent tube.

Release – Recapture Studies, 1982

On July 15, 1982 at 14:15 Pacific Daylight Time, 2750 each of marked and unmarked mpb were released from two sites in a lodgepole pine forest near Riske Creek, B.C. The peak flight of wild beetles in the area occurred July 26-28. The pails containing beetles were removed from the refrigerator at 08:30 and transported to the release site where they were kept shaded until needed. At the time of release at each site, the beetles and their storage sawdust were spread evenly on the upper surfaces of two release platforms (one for marked beetles, the other for unmarked). A layer of fresh pine excelsior 5-10 cm thick (made by chain-saw ripping a log with an unoiled chain) was sprinkled over the top of the sawdust to provide many locations for takeoffs. The release platforms consisted of three concentric squares of 6-mm plywood, one above the other separated by 1.5-cm spacers. The largest (bottom) square was 120 cm, the smallest (top) 60 cm. The top surface had a rim 7.5 cm high and 1.5 cm wide set back 1 cm from the edge. The rim prevented sawdust from blowing off, and the multiple steps provided many edges for takeoffs. The platforms were supported 1 m above the ground on a pole structure. Insect screen was suspended below the platforms to catch nonflying beetles which fell. Another screen was suspended 1.5 m above the platforms to provide partial shade to prevent overheating.

At each site, four trap lines were established, one in each cardinal direction radiating from the plot center. The traps were approximately 10, 29, 85 and 250 m from the center. The traps consisted of two trees sprayed to a height of 4 m with 2% Sevin (prepared from Sevin SL in water) and basketed at the base with wire screening to trap poisoned beetles. Each tree was baited with (a) 0.5 ml of both transverbenol and mycrene in separate size 00 polyethylene Been capsules (J.B. EM Services Inc., Dorval, Quebec) and (b) four virgin females caged on 600-cm^2 slabs of fresh lodgepole pine. In addition, a 30-cm^2 window trap (Chapman and Kinghorn 1958) was hung 1.5 m high facing the plot center, 45 cm from each tree bole. Traps were checked and cleared every 3 h during the day for several days after a release. Trapped mpb were placed in 70% alcohol in vials and examined in the lab as described above.

On the two sites, 24.3% and 28.0% of the marked beetles that flew were recaptured during the first 3 days after release. Comparable figures for the unmarked beetles were 34.5% and 47.6%. The relatively larger proportion of unmarked beetles trapped possibly indicates that even though most of the wild beetles were not ready to fly, some flight of wild beetles occurred, more on one of the plots, during the trapping period (Fig. 2). Alternatively, differences in the detectability under blacklight or washing in alcohol of different colored fluorescent powders could also explain this result. These factors need further investigation.

During cloudy periods, the beetles tended to drop from the excelsior and conceal themselves in the sawdust on the platform surface. If the platforms were left unattended, the beetles remaining on the platform were subject to predation by birds (species unknown). Dragonflies were observed capturing and eating mpb as they flew from the platforms.

Five and seven percent of the marked released beetles failed to fly on the two plots and the corresponding figures for unmarked beetles were 6% and 7%. On average, 1% of the marked beetles and 2% of the unmarked beetles were dead on the flight platform. Thus, marking did not increase mortality or physical injury over that resulting from normal handling of emerged beetles.

These results indicate that marked and unmarked beetles behaved similarly under our experimental conditions; marking did not have a significant effect on mortality up to release or ability to take flight. More marked beetles than unmarked beetles may have been lost during dispersal flight. The vacuum method is well suited to quick marking of large numbers of beetles. The marking is not lost when the beetles are stored in sawdust but there was some transfer of powder onto unmarked individuals when trapped beetles were collected in alcohol and the vials were agitated. However, this problem does not appear to introduce a serious bias into identification of tagged beetles and can be minimized by reducing the volume of alcohol in the collecting vials.

Self-Dusting

Gara (1967) marked *Dendroctonus frontalis* and Schmitz (1980) marked *Ips pini* in the field by forcing the insects to walk across tables or platforms coated with fluorescent powders.

Laboratory trials had shown us that mpb emerging from logs heavily dusted with fluorescent powders became marked similarly to those treated in vacuum dusters. In the field shortly before mpb emerged, we applied the powders to brood trees using a gasoline-powered backpack sprayer (Holder, Supra-Neu 40) equipped with a dusting adapter (Marino Inc.) instead of the normal spray wand. Approximately 250 g of dust was used to treat a 30-cm-dbh pine to a height of 2.0 m. Care was taken to blow the dust into bark crevices, and to uniformly cover the boles.

Clear plastic barrier traps were used to capture beetles as they dispersed into the surrounding forest. Collections were made daily throughout the flight period and were handled as described above. Sampling of brood trees in plot areas in 1985 revealed a total population of approximately 56,000 mpb expected to emerge from 639 attacked trees in an isolated 5.86-ha stand of lodgepole pine. Based on the same sampling, approximately 4800 mpb were expected to emerge from 47 dusted trees. Based on the above figures, 8.6% of the beetles captured should have been marked. The total trap catch in 1985 was 162 mpb, 15 of which (9.3%) were marked. The extra marked beetles are probably a result of having the dusted trees close to the trap locations, and the percentage of beetles recovered indicates that performance of the marking system was excellent.

Summary

The marking and handling techniques described have proven valuable tools for the study of mountain pine beetle dispersal. The low toxicity, ease of application, and ease of examination using common equipment make fluorescent powders attractive for field use. The mass rearing of mpb in a tent provided up to 50,000 mpb with a total loss from handling or other factors of only 7% up to the time of release. Marking beetles with fluorescent dust using either technique did not apparently alter their dispersal behavior or increase mortality prior to flight.

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