J. Chem. Ecol., 1978, Vol. 4, No. 1, pp. 1–7

A NONDESTRUCTIVE TRAP FOR *Dendroctonus frontalis* ZIMMERMAN (COLEOPTERA: SCOLYTIDAE)

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(Received February 21, 1977; revised May 12, 1977)

Abstract—The bucket trap is a lightweight device for capturing southern pine beetles in flight and retaining them either alive or dead for later examination. It is not messy like the sticky trap and not cumbersome like conventional live traps. Placing the bucket against a vertical silhouette increases the number of beetles caught. Few nontarget insects are captured except for the clerid *Thanasimus dubius*. When the trap was baited with Frontalure, about 99% of the beetles trapped were male. When infested pine bolts were used as bait, roughly equal numbers of males and females were captured.

Key Words—southern pine beetle, *Dendroctonus frontalis*, bucket trap, Frontalure, *Thanasimus dubius*.

INTRODUCTION

Southern pine beetles (*Dendroctonus frontalis* Zimmerman) in flight are normally captured with live traps, such as rotating nets and sleeve funnels, or with sticky traps (Gara, 1967; Gara et al. 1965). Live traps, however, are large, bulky, and require power sources. Sticky traps, though lightweight, portable, and suitable for synthetic pheromone baits, catch many nontarget organisms as well as debris; moreover, beetles become so mired in the sticky material that they are of little use for chemical investigations and other studies (Moser, 1976).

This paper describes an improved bucket trap that is as lightweight, portable, and easy to bait as the sticky trap but catches few if any nontarget insects. It can retain trapped beetles either alive or dead, and it has none of the messy features of sticky traps.

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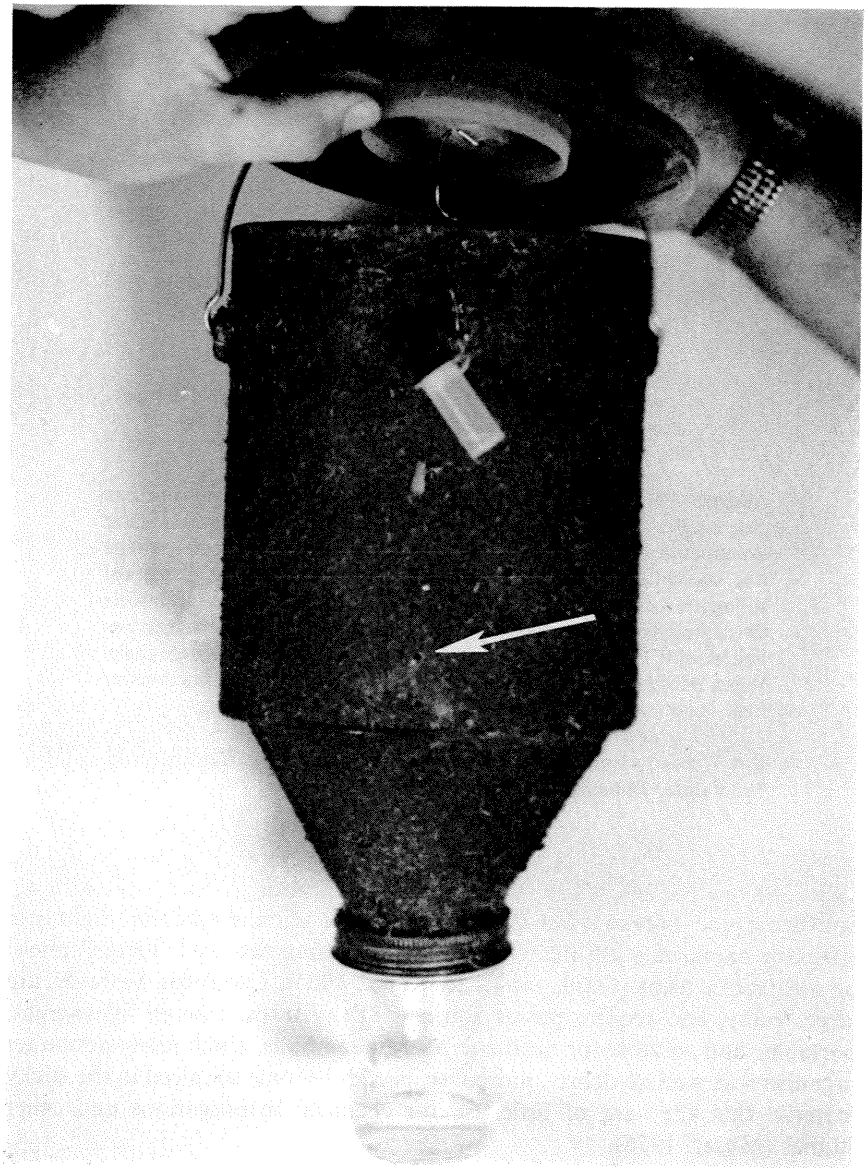

FIG. 1. The bucket trap with Frontalure-containing vial exposed. Beetles enter through the holes (arrow) and drop into jar which contains water.

METHODS AND MATERIALS

Trap Construction

The trap consists of a 1-gal (3.79-liter) paint bucket with top and bottom removed (Fig. 1). A 16-cm (top diameter) metal funnel was soldered to the lower end; a mason jar rim was soldered to the narrow end of the funnel, and a 0.5 pt (0.24-liter) glass jar was connected to the rim. The top of the can was covered by a plastic lid; a 2.5-ml polyethylene snap-cap vial containing 20 drops (0.3 ml) of the attractant Frontalure,[3] a mixture of 1 part frontalin to 2 parts α-pinene (Vité, 1970) was suspended by a stiff wire from the center of the lid. Seventy-two entry holes (2-mm diam) were punched in the can in eight equidistant vertical rows. To minimize rain entering the holes, the upper rim of each was bent out with a punch to form hoodlike shields. One advantage of the trap is that it provides for a walking response in addition to the flying response. To provide a walking surface for the beetles, the can was first painted with water-soluble white glue and then rolled in sawdust; after drying, the can was sprayed with a light coat of red enamel, a color that appears to be highly attractive to flying adults (Nash, 1970). Insects entering the holes fell down the funnel into the glass jar. To collect living specimens, it was necessary to place tissue paper in the jar because the beetles would otherwise concentrate at the bottom and chew off each other's legs and antennae. If dead beetles were desired, water was placed in the jar instead of paper.

Field Placement of Traps

To test the bucket traps, an infestation was artificially started in fall 1973 by baiting several trees with Frontalure in a *Pinus taeda* L. stand in Rapides Parish, Louisiana. The spot was maintained and directed by continuous baiting of new trees just ahead of the line of newly infested trees, which generally advances in only one direction away from the initial attractant source (Gara and Coster, 1968). This line is commonly referred to as a "front" because of its analogy to weather systems. After 10 mo., the spot encompassed about 1 ha and consisted of approximately 250 trees, about one-third of which contained live beetles. Traps were set out November 4, 1974, and tested through November 1, 1975, being inspected twice weekly. Our traps were about 20 m ahead of the front among uninfested trees along a line facing the spot's south end. Traps were placed about 9 m apart and were moved forward as the front advanced. The number of traps varied from 5 to 12 because only those with sustained large catches were retained.

[3] Mention of trade names is solely to identify materials used and does not imply endorsement by the U.S. Department of Agriculture.

FIG. 2. Field placement of bucket trap.

Traps were initially hung with strings from tree branches, but very few beetles were captured until a vertical silhouette was added. Subsequently, buckets were suspended about 4 m high from pulleys against $1 \times 30 \times 400$-cm plywood boards (Fig. 2). These "artificial trees" had the added advantage of being highly mobile.

When a high percentage of the captured beetles turned out to be males, it was necessary to determine if trap design or bait was responsible. Therefore, two bolts of *Pinus taeda* naturally infested with both sexes of southern pine beetles were screened and placed inside each of two bucket traps. In addition, three bucket traps baited with Frontalure and coated with Stickem Special® were set out.

Because large numbers of flying adults have been caught on sticky traps in or near infestations (Reeve, 1975), three pairs of bucket traps were tested to see whether the beetles would enter unbaited bucket traps. Each pair consisted of one trap baited with Frontalure and a twin without Frontalure in the plastic vial. The three pairs were placed in a line along the front of a spot from 6 to 15 m ahead of the infested trees. Individual traps within pairs were separated by about 5 m, and pairs were separated by about 10 m. A total of eight collections were made twice weekly from April 26 through May 20, 1977. After the beetles from each pair of traps were collected, a coin was flipped. If the toss was "heads," positions of the baited and unbaited buckets were switched so that the relative positions of buckets within pairs remained at random.

RESULTS AND DISCUSSION

During a trapping period of 12 mo., a total of 9637 southern pine beetles were caught. Collections improved after the buckets were suspended against plywood boards, apparently because many scolytids (including *D. frontalis*) orient in flight to vertical objects (Henson, 1962; Gara et al., 1965; Rudinsky, 1966; Shepard, 1966; Billings et al., 1976). Traps consistently collecting the most beetles were located in open areas, which provided the beetle with aerial pathways, whereas traps in obstructed areas were inefficient.

Of 1512 beetles examined for sex determination, the majority (98.7%) were males, as determined by clearing the beetles in lactophenol and examining the genitalia. Our data support Hughes' (1976) observation that fewer females than males are attracted to point sources of frontalin. Perhaps the bucket trap simulates a newly initiated female gallery, which, like the trap, attracts only males.

Tests with infested bolts indicated that the bait and not the trap's design was responsible for the high percentage of males captured. One of the buckets containing infested bolts trapped 14 males and 13 females; the other trapped 12 males and 8 females. The traps baited with Frontalure and coated with Stickem Special® captured 242 males, of which 104 were found inside the collecting jar and 138 were stuck to the outside of the can. No females were collected.

Tests with baited vs. unbaited traps likewise showed that the trap's design did not attract beetles. A total of 155 males and 2 females were trapped in the baited buckets during the 4-wk period; no beetles were found in the unbaited buckets. Totals for each collecting date varied from 2 to 41 beetles.

This trap design may be of limited usefulness for attracting other bark beetle species. Small-scale tests with *Dendroctonus brevicomis* (Lec.) in Madera County, California, and with *Scolytus multistriatus* (Marsham) at Delaware, Ohio, showed that bucket traps baited with pheromones that attracted hundreds of beetles to nearby conventional traps caught only one or two beetles each.

In addition to the southern pine beetle, specimens of the following insect species were captured: *Corticeus glaber* LeConte, *Ganascus ventricosus* (LeConte), *Hylastes porculus* Erichson, *Ips avulsus* (Eichhoff), *I. calligraphus* (Germar), *I. grandicollis* (Eichhoff), *Lyctocoris elongatus* (Reuter), *Osmita colon* (L.), *Platydema flavipes* (F.), and *Thanasimus dubius* (F.). Only one or two specimens of each were found, with the exception of *T. dubius*, of which 258 were collected. This species as well as other clerids are known for their attraction to bark beetle pheromones (Wood et al., 1968; Vité and Williamson, 1970; Rudinsky et al., 1971; Whittaker and Feeny, 1971; Pitman, 1973). All except *G. ventricosus*, *H. porculus*, and *O. colon* were previously listed as southern pine beetle associates (Overgaard, 1968; Moser et al., 1971). The euglenid *G. ventricosus* is associated with scolytid-infested trees, where they oviposit in decaying wood (F. G. Werner, University of Arizona, personal correspondence). Adults of the scolytid *H. porculus* are attracted to freshly cut lumber, and breed in stumps and roots of dying pines (Baker, 1972). Furniss and Schmitz (1971) found four related species of *Hylastes* attracted to frontalin and other tree volatiles. W. A. Connel, of the University of Delaware (personal communication), regards the capture of nitidulid *O. colon* as accidental, although this pest of stored products is often attracted to volatiles emanating from decomposing vegetation or fermentation.

Addenda to Proof. Dr. G.D. Amman reports that in August, 1977, at Ogden, Utah, bucket traps baited with linalool, the *Ips pini* (Say) attractant, failed to attract any beetles. Bucket traps containing screened bolts naturally infested with *Ips pini* attracted flying adults of both *Ips pini* and *Pithophthorus* sp.

Acknowledgments—We thank Dr. J. W. Peacock, Northeastern Forest Experiment Station, Forest Service—USDA, Delaware, Ohio, for evaluating our bucket traps against the elm bark beetle; Dr. L. Edson, Department of Entomology, Texas A & M University, for assistance in trap design and placement; and E. I. du Pont de Nemours, and Co. (Inc.), Wilmington, Delaware, for supplying plastic overlids for the buckets.

REFERENCES

BAKER, W.L. 1972. Eastern forest insects. *USDA For. Serv. Misc. Pub.* 1175, 642 pp.

BILLINGS, R.F., GARA, R.I., and HRUTFIORD, B.F. 1976. Influence of ponderosa pine

resin volatiles on the response of *Dendroctonus ponderosae* to synthetic trans-Verbenol. *Environ. Entomol.* 5:171–179.

FURNISS, M.M., and SCHMITZ, R.F. 1971. Comparative attraction of Douglas-fir beetles to frontalin and tree volatiles. *USDA For. Serv. Res. Pap. INT*-96, 16 pp. Int. *For. and Range Exp. Stn., Ogden, Utah.*

GARA, R.I. 1967. A field olfactometer for studying the response of the southern pine beetle to attractants. *Environ. Entomol.* 60:1180–1181.

GARA, R.I. and COSTER, J.E. 1968. Studies on the attack behavior of the southern pine beetle. III. Sequence of tree infestation within stands. *Contrib. Boyce Thompson Inst.* 24:77–86.

GARA, R.I., VITÉ, J.P. and CRAMER, H.H. 1965. Manipulation of *Dendroctonus frontalis* by use of a population aggregating pheromone. *Contrib. Boyce Thompson Inst.* 23: 55–66.

HENSON, W.R. 1962. Laboratory studies on the adult behavior of *Conophthorus coniperda* (Coleoptera: Scolytidae). III. Flight. *Ann. Entomol. Soc. Am.* 55:524–530.

HUGHES, P.R. 1976. Response of female southern pine beetles to the aggregation pheromone frontalin. *Z. Angew. Entomol.* 80:280–284.

MOSER, J.C. 1976. Surveying mites (Acarina) phoretic on the southern pine beetle (Coleoptera: Scolytidae) with sticky traps. *Can. Entomol.* 108:809–813.

MOSER, J.C., THATCHER, R.C. and PICKARD, L.S. 1971. Relative abundance of southern pine beetle associates in east Texas. *Ann. Entomol. Soc. Am.* 64:72–77.

NASH, C.R. 1970. The use of a synthetic attractant as a survey instrument for the southern pine beetle, *Dendroctonus frontalis* Zimmerman. Unpublished M.S. thesis. Texas A & M University. 55 pp.

OVERGAARD, N.A. 1968. Insects associated with the southern pine beetle in Texas, Louisiana and Mississippi. *J. Econ. Entomol.* 61:1197–1201.

PITMAN, G.B. 1973. Further observations of Douglure in a *Dendroctonus pseudotsugae* management system. *Environ. Entomol.* 2:109–112.

REEVE, R.J. 1975. Temporal and spatial distribution of flying *Dendroctonus frontalis* Zimmerman (Coleoptera: Scolytidae) and the predator *Thanasimus dubius* F. (Coleoptera: Cleridae) in and near small infestations. Unpublished M.S. Thesis. Stephen F. Austin State University. 72 pp.

RUDINSKY, J.A. 1966. Host selection and invasion by the Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopkins, in coastal Douglas-fir forests. *Can. Entomol.* 98:98–111.

RUDINSKY, J.A., NOVAK, V., and SVIHRA, P. 1971. Attraction of the bark beetle *Ips typographus* L. to terpenes and a male-produced pheromone. *Z. Angew. Entomol.* 67: 179–188.

SHEPARD, R.F. 1966. Factors influencing the orientation and rates of activity of *Dendroctonus ponderosae* Hopkins (Coleoptera: Scolytidae). *Can. Entomol.* 98:507–518.

VITÉ, J.P. 1970. Pest management systems using synthetic pheromones. *Contrib. Boyce Thompson Inst.* 24:343–350.

VITÉ, J.P. and WILLIAMSON, D.L. 1970. *Thanasimus dubius:* Prey perception. *J. Insect Physiol.* 16:233–239.

WHITTAKER, R.H., and FEENY, P.P. 1971. Allelochemics: Chemical interactions between species. *Science* 171:757–770.

WOOD, D.L., BROWNE, L.E., BEDARD, W.D., TILDEN, P.E., SILVERSTEIN, R.M., and RODIN, J.O. 1968. Response of *Ips confusus* to synthetic sex pheromones in nature. *Science* 159:1373–1374.