A TRAP FOR USE IN EVALUATIONS OF INSECTICIDES AS HOUSEHOLD SCREEN TREATMENTS AGAINST *CULICOIDES* SPP. BITING MIDGES[1,2]

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ABSTRACT. A trap that uses CO_2 as an attractant was designed to evaluate the residual effectiveness of candidate insecticides on window screening as protectants against biting midge invasions into houses or screened-in patio areas. The described technique has the advantage over an older technique by reducing handling of midges, and consequently reducing time and labor.

Insects of the genus *Culicoides* (Diptera:Ceratopogonidae) are referred to not only by the official common name of biting midge but also by such pseudonyms as punkies, no-see-ums, gnats, sand flies, and by the marine recruits at Parris Island, South Carolina, as flying teeth. Tolerance to the annoying and often painful bites of the females varies greatly, but Linley and Davies (1971) carefully speculated that the tolerance level for most people was ca. 5 bites/hr. In areas near coastal salt marshes and mangrove swamps, biting rates of several thousand per hr have been recorded during periods of peak activity. Female biting midges attracted by lights, potential hosts, or both can, because of their small size (1–1.5 mm), easily pass through household window screens and prevent enjoyment of screened-in areas. The seriousness of the situation is compounded by the lack of adequate area control techniques against either adults or immatures. Personal protection for outdoor activities can be achieved for as long as 5 hr with repellents (Schreck et al. 1979), but the use of repellents within one's house or screened-in patio is not an acceptable practice. One acceptable alternative has been to treat household screens with a residual insecticide.

Jamnback (1961) described a method for evaluating residual insecticides on window screens. Biting midges were collected by aspirator and inserted into the dark end of a paper-carton test chamber through a small, temporary opening. Attracted by light at the other end of the test chamber, they passed through a treated disk of window screen and accumulated at the lighted end of the chamber.

Since biting midges are small and fragile, we thought that a technique which would eliminate the aspiration and insertion of the midges into the test chamber would be advantageous. We report here a trap we developed that uses the attractancy of CO_2 (Nelson 1965) and light to induce natural populations of biting midges to pass, without human handling, through a treated screen and into a collecting/holding cage.

METHODS AND MATERIALS

The trap consisted of a 30.5 cm box (H x D x W) constructed of 13-mm plywood; one side, was left open. On the open side, a 13-mm-wide strip of plywood moulding was recessed 13-mm from and along all the edges. The box was painted white on the outside and black on the inside with exterior flat finish paint. A support frame

[1] This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation for use by the U.S. Department of Agriculture nor does it imply registration under FIFRA as amended. Mention of a commerical or proprietary product does not constitute an endorsement of this product by the USDA.

[2] The research reported in this manuscript was conducted in part with contract funds transferred from the Office of Naval Research, Department of the Navy.

for the screen (14 x 18 mesh) was constructed from 19-mm aluminum channel to fit the open side of the trap. The screen was held in place with plastic tubing (Fig. 1 and 2). On the side opposite the opening, a 7-cm-diam hole was cut near one of the corners. Four screw-in brass cup hooks were placed around the hole at equal intervals for attachment of the collection cup. Facing the opening and with the box oriented so that the opening for the collection cup was in the upper right corner, we fastened a 19.1-mm threaded galvanized floor flange in the center of the bottom side of the box. This held the threaded end of a 19.1-cm pipe that was used to support the trap.

We fabricated the collection cup from a 14-cm deep, 9.4-cm-diam screw top plastic container (#50, Crown Hill Industries, Inc., Urbana, Ohio), by replacing a 6.4-cm-diam section of the cup bottom with 32 x 32-mesh saran screen. We modified the lid by replacing the center 6.4-cm diam section with a 7.8-cm, 59-ml funnel with the stem removed. The funnel was attached to the inside of the lid with epoxy cement (Fig. 3). The collection cage, with the funnel end over the hole in the box, was held securely in place by 2 rubber bands over the 4 cup hooks.

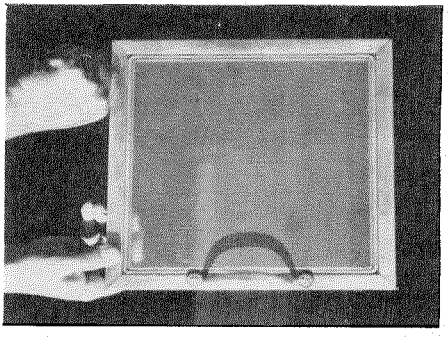

Fig. 2.—Test screen and frame.

The screens and their aluminum frames were treated by dipping in

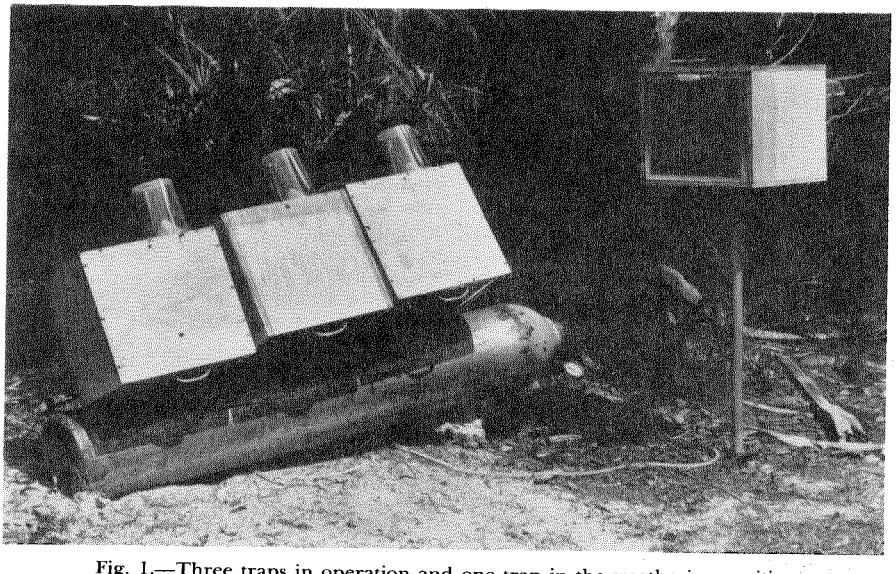

Fig. 1.—Three traps in operation and one trap in the weathering position.

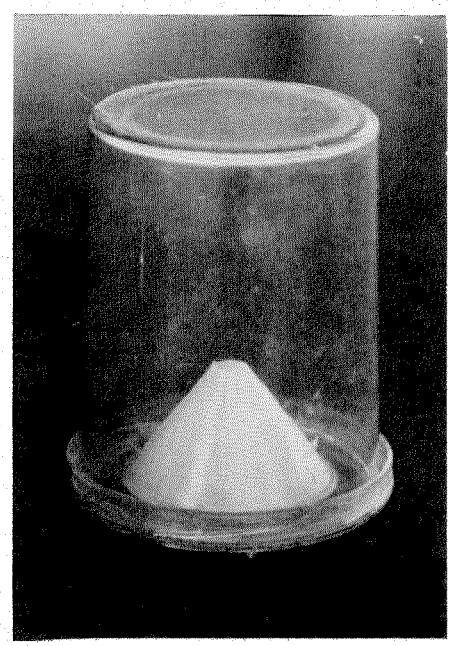

Fig. 3.—Collecting and holding cage.

acetone solutions containing 1, 3, 6, or 8% (W/V) active ingredient of technical malathion. Controls were dipped into acetone only. All screens were allowed to dry for at least a day before testing.

In initial tests, the boxes were supported ca. 0.9-m above ground level with the 19.1-mm-diam support pipe placed over a 0.6-m length of 13-mm-diam grounding rod that had been driven into the ground. In this orientation, the screen was vertical and the collection cage was horizontal with respect to the ground. CO_2 was introduced from a 22.7 kg compressed gas tank through a small hole in the top located in front of the collection cage. The flow rate, ca. 100 ml/min., was controlled with a single-stage regulator and metered with a Gilmont® compact flowmeter.

Numbers of collected midges were consistently low in this orientation compared to bite counts, so the orientation of the trap was changed so that the screen was in a nearby horizontal position ca. 20–30 cm above ground level and the collection cage was almost perpendicular to the ground. In this orientation, the numbers of midges collected increased dramatically, especially when the CO_2 was released at ground level below the screens.

In these tests, the midges were usually collected for ca. 10- min. intervals in late afternoon and early evening during periods of peak biting midge activity. After collection and initial mortality counts were made, the cages were transferred to styrofoam ice chests that contained several layers of damp paper towels or cotton to maintain high humidity. On top of each cage we placed a cotton pad containing 10% sugar-water solution. We conducted 3–5 replicate collections per test. Alternatively, if large numbers of replicates were conducted, the biting midges were briefly immobilized with CO_2 and placed into gauze-covered ½ pint cartons before they were transferred to the ice chests. We counted moribund or dead midges 0.5, 1, 2, 3, 4, and 24 hr after collection. Numbers collected per test varied according to native population levels.

After completion of the desired numbers of replicates, the traps were left with screens in the vertical position for aging and weathering. Effectiveness of each insecticide was further tested at various intervals posttreatment, depending on the availability of biting midges.

RESULTS AND DISCUSSION

The results of a study with malathion-treated screens against *Culicoides mississippiensis* Hoffman using this technique are presented in Table 1. The data show that malathion has a slow action as a toxicant. At 0.5 hr after exposure, mortality was highest (53%) on the screen treated with the 8% solution after a 1-week aging period. However, after 1 week of aging, the screens treated with 1%, 6%, and 8% malathion solutions

Table 1. The effectiveness of malathion against *Culicoides mississippiensis* Hoffman that passed through treated window screen (means of 3–5 replicates) at Yankeetown, Fl., 1979.

Conc.	Week post-treatment	Percentages mortality at indicated number after exposure[a] 0.5	1	2	3	4	24	Mean number exposed/rep.
1%	1	19	35	43	52	54	95	64
	3	13	17	27	32	42	88	195
3%	2	7	24	42	50	60	85	41
	3	19	30	44	57	67	97	190
6%	1	49	72	78	80	84	95	27
	3	33	48	62	74	77	99	137
	7	6	7	2	2	2	4	41
8%	1	53	72	81	84	92	95	16
	3	29	48	67	72	77	98	81
	7	10	11	8	8	8	10	31

[a] Control mortality ranged from 0 to 6% in these tests.

caused 95% mortality 24 hr after exposure. Mortality after 24 hr remained high (88–99%) after 3 weeks of weathering for all concentrations. However, all the treatments failed after 7 weeks. Control mortalities in these studies ranged from 0 to 6%.

Our results with malathion agree with those reported by Jamnback (1963) and Dukes and Axtell (1976) with the divided test chamber. However, the technique described here is more efficient than theirs because it eliminates the handling of the biting midges as well as the time and labor involved in that step.

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JOB OPPORTUNITY

Dr. Richard H. Baker is seeking an insect ecologist to participate in laboratory and field studies in Pakistan. Details about the position may be obtained from Dr. Baker at: International Health Program, Univ. of Maryland School of Medicine, 10 S. Pine St., Baltimore, MD 21201.