A MOBILE TRAP FOR STUDYING THE BEHAVIOR OF FLYING BLOODSUCKING INSECTS

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In studying populations of flying bloodsucking insects, there is often a need to determine a number of behavioral characteristics. Conventional light traps are rather limited in usefulness, since they attract large numbers of unwanted species of insects. Light traps also require a power source, and therefore cannot be used readily in remote areas.

The trap herein described was developed for maximum versatility within a single unit. It serves as a practical research tool for studying activity periods, with the potential use of several different attractants. Usually a single attractant is tested at any one time, but the nature of the construction permits comparing attraction to an animal host with light or moving visual pattern. The attractants and interval collection principle have been described by others; this trap simply incorporates these methods into a single unit. The arrangement shown can be modified further at the discretion of the investigator.

Although this device was developed for sampling mosquitoes, it also captured ceratopogonids and simuliids. Of course, the light trap portion is attractive to a great variety of insects, and the substitution of various types of odor attractants should collect insects of many different kinds. For example, the use of fruit fly attractants in the animal host portion should permit an analysis of activity periods in these insects.

The following desirable characteristics were incorporated: (1) Mobility through being mounted on a trailer and having a source of electricity. (2) A variety of attractants, i.e. light, moving visual pattern, and a choice of host animals. (3) Interval collections into separate chambers permitting the determination of activity periods. (4) The use of trap cage chambers rather than killing jars, yielding a substantial proportion of live catches for virus determination or other studies requiring living insects. (5) A rotating turntable feature which permits an analysis of the comparative attractiveness of various hosts.

DESCRIPTION. The base of the unit is a two-wheeled trailer (Fig. 1, 3). The essential feature of timed interval operation is a rotating turret, in this instance obtained from a surplus bomber training turret (Fig. 3a). Trap chambers can be attached to the rotating turret for timed interval trapping (Fig. 1), or modified stable traps can be hung by brackets to test animal host preference on a turntable basis (Fig. 3).

The rotating visual pattern (Figs. 1, 3, b) largely follows the design described by Haufe and Burgess (1960). It is rotated by a motor and reduction gear turning a pulley, attached in back of the control panel and therefore not visible in the accompanying illustrations. The actuated pulley connects to a pulley at the base of the rotating striped column by means of a belt, causing the drum to rotate. The speed of the striped column can be varied by changing the size of the pulley connected to the reduction gear. A space at the top of the rotating column permits entrance of insects attracted to that region by the moving visual pattern, and an internal fan pulls them down through a screen funnel where they are ejected into a trap chamber.

The attractant for light trapping is an ordinary 60 watt incandescent bulb. It is mounted within the top of the visual pattern column, and can be made more readily visible by removal of a six-inch upper portion of the striped pattern. Hardware cloth of one-half-inch mesh, lying just

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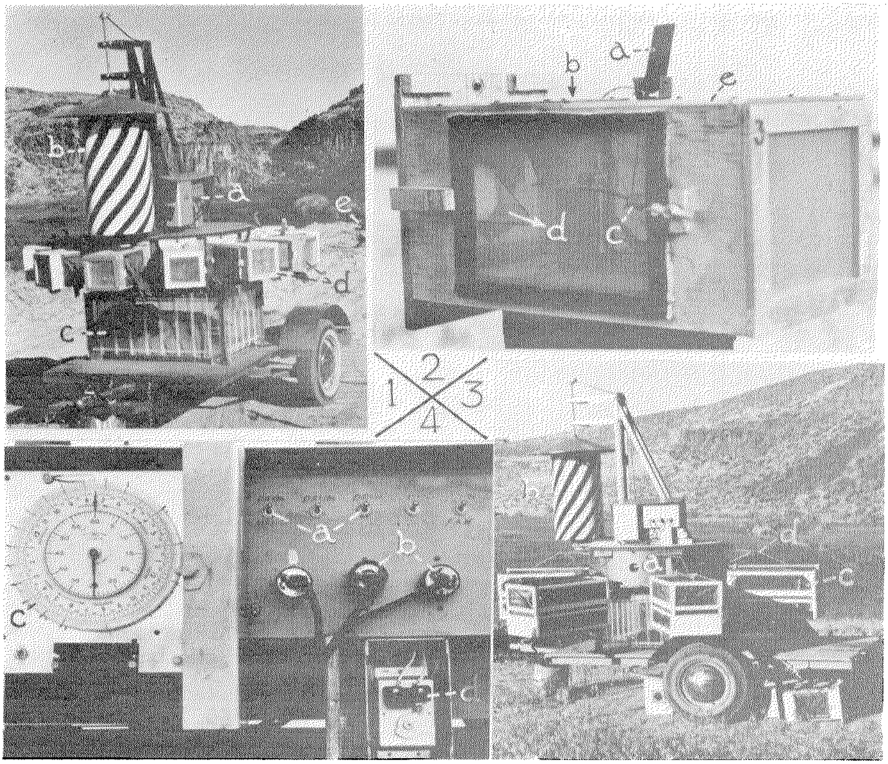

Fig. 1.—General view of trap with timed-interval chambers attached. a. Control panel. b. Striped cylinder providing moving visual pattern. c. Chamber serving as base and containing host animals. d. Timed interval trap chambers. e. Generator for supplying electrical power.

Fig. 2.—Detail of timed-interval trap chamber (9 x 9 x 18″). a. Lever with string attached to weighted closure arm. b. Point of entrance into metal cone in top of chamber. c. Weighted closure arm. d. Screen cone through which insects attracted to animal host are blown. e. Clear plastic top of chamber, admitting maximum light.

Fig. 3.—General view of trap with modified stable-type traps for studying host preference. a. One of twelve holes in turret, on which timed-interval traps are based and through which insects attracted to animal host are blown when trap is in operation as in Fig. 1. b. Striped cylinder providing moving visual pattern. c. Modified stable-type trap with entrance baffle on sides. d. Bracket supporting modified stable-type trap.

Fig. 4.—Detail of control panel. a. Switches for controlling various trapping methods. b. Plug connectors to motors and lights. c. Program timer for controlling interval trapping. d. Intermittent event timer which operates blower at top of animal host chamber.

beneath this removable section, prevents moths and other large insects from being trapped. In principle this operates much like the New Jersey type of mosquito trap, but it empties into a chamber instead of a killing jar. It is also possible to test the combined attractiveness of rotating column and light.

Animal attraction for timed interval evaluation operates on the principles of the trap described by Lumsden (1958). The main chamber containing an animal host is constructed with an angle iron frame, and is sturdy enough to support the heavy upper portion of the trap. Its sides consist of plexiglass panels with one-centimeter spacings. In tests thus far, the host animals are centered in the main chamber within a cage, and this is covered with mosquito netting to prevent mosquitoes from actually feeding. The top of the entrance chamber is solid except for a circular opening containing a powerful fan. The fan sucks air through this chamber and blows it into a screen funnel which empties against the inner face of the rotating main drum. This screen funnel is directed to the side of the drum opposite the location of the moving visual pattern and light trap, and when properly aligned it channels insects through a hole in the drum (Fig. 3a) and into a trap chamber (Fig. 2d). An intermittent event timer (Fig. 4d) is set in these studies to turn the fan alternately on for two minutes and off for four minutes.

Twelve trap chambers (Fig. 1d, 2) receive the insects trapped by attraction to moving visual pattern, light, or animal host. The insects captured while attempting to bite an animal host enter a trap chamber by a screen cone (Fig. 2d). Insects trapped at light or by visual pattern enter the top of a trap chamber through a sheet metal funnel (Fig. 2b). A simple screen cone is unsatisfactory because it plugs up with the enormous numbers of chironomids which are often trapped when light is used as an attractant. When not in the trapping position, the bottom of the metal funnel is forcibly closed by a hinged, counterweighted lid (Fig. 2c). When in the trapping position the counterweight arm is lifted by a string attached to a lever on top of the cage (Fig. 2a). The lever is held in the open position by a removable arm from the main trap frame. During a trapping period insects are prevented from escaping by the entering stream of air from the fan within the rotating column. A cloth sleeve permits the aspiration of trapped insects. The plexiglass top of each trap chamber permits entrance of light for better visibility during aspiration of insects. A lug on the revolving drum strikes a cutoff microswitch on the frame and stops each chamber in the correct position. The next chamber is brought into position when the timer (Fig. 4c) actuates the motor which turns the revolving drum.

The turntable method of determining host selection (Dow, 1959) is also incorporated. To achieve this, the trap chambers are removed and six brackets (Fig. 3d) are bolted to the turret. Small, modified stable traps with entrance baffles are hung on the brackets (Fig. 3c). The trapped insects can be aspirated through a cloth sleeve on the outside end. A circuit to bypass the microswitch which stops the turret at the next trap chamber permits constant rotation. The motor and reduction gear rotate the turret once every four minutes.

Electricity is required to operate the various features of this trap. A surplus Army Signal Corps generator supplies this when it is otherwise unavailable (Fig. 1e). The generator can be bolted to the back of the trailer bed when moving, but it is set at least fifty feet away during operation so as not to influence attractiveness unduly. A timer is mounted on the generator to ground it out at a predetermined time, thus eliminating the necessity for an operator to be at hand the moment a run is completed.

A number of switches are incorporated to operate the trap, and these are centered on a control panel (Fig. 4). A Zenith program timer (model P5–24 Precision Equipment Company, 4403 Ravenswood Avenue, Chicago 40, Illinois) has been most useful because a twenty-four hour cycle can be programmed with divisions down to five-minute intervals. The control panel holds a main cutoff switch, and separate switches are required to operate the turret, to bypass the turret cutoff microswitch, to turn the revolving visual column, to turn on the light, and to operate the cyclic fan connected to the animal host chamber.

Discussion. This trap has been under development for two years, and has been operated for two summers in the Columbia Wildlife Refuge, U. S. Fish and Wildlife Service, near Othello, Washington. It has thus been possible to study the behavior of mosquitoes in remote areas of the refuge where electricity is not available.

Attraction to light and/or moving visual pattern can be compared with the attractiveness of animal hosts. Since both attractants are in rather close proximity, it cannot be stated that they do not influence each other. However, a comparison of tables 1 and 2 indicates that animal host attraction may be more constant than that of light, and may circumvent the cyclic effectiveness of light traps which coincides with the cyclic competition of moonlight referred to by Pratt (1948) and Provost (1959). This trap is being used for further studies on the behavior of mosquitoes, particularly *Culex tarsalis*.

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TABLE 1.—Comparison of light versus animal host for trapping mosquitoes

Othello, Washington 12–13 July 60 (Full Moon 8 July)

Time	*C. tarsalis* 3 chickens ♀	♂	light ♀	♂	*A. freeborni* 3 chickens ♀	♂	light ♀	♂
18.00	0	0	2	0	0	0	0	0
20.00	32	0	4	0	44	0	4	0
22.00	14	0	4	2	15	0	0	0
24.00	12	0	4	0	20	0	6	0
2.00	13	0	4	0	81	0	6	0
4.00	1	0	0	0	14	0	0	0
Total	72	0	18	2	174	0	16	0

TABLE 2.—Comparison of light versus animal host for trapping mosquitoes

Othello, Washington 25–26 July 60 (New Moon 23 July)

Time	*C. tarsalis* 3 chickens ♀	♂	light ♀	♂	*A. freeborni* 3 chickens ♀	♂	light ♀	♂
19.00	2	0	1	0	2	0	0	0
20.00	62	4	74	135	9	0	3	1
22.00	41	4	36	58	2	2	0	2
24.00	37	2	28	56	7	1	1	3
2.00	44	3	21	41	3	3	7	5
4.00	2	0	1	0	1	0	2	0
Total	188	13	161	290	24	6	13	11

developed some of the modifications of the trap chambers. Mr. Paul Steel, manager of the Columbia Wildlife Refuge, U.S.F.W.S., has been most gracious in aiding studies on biting insects within the refuge.

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MOSQUITO CONTROL IN OLIVE VATS [1]

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During the 1960 season a "citizens' committee" to survey the evergrowing problem of *Hippelates* eye gnats and mosquitoes in the Hemet—San Jacinto Valley of Southern California was established. Funds for the survey came from the Board of Supervisors of Riverside County and voluntary contributions by the citizens and organizations of the Hemet—San Jacinto Valley.

The committee requested the State Department of Public Health and the Department of Entomology, University of California at Riverside, to supervise a short-term study to determine the nature and scope of the eye gnat and the mosquito problem in that valley.

During the course of this survey a variety of niches and sources that supported mosquito larval populations were detected. Among them, uncovered olive vats operated by a local packing firm were found to breed large numbers of *Culex p. quinquefasciatus* and, to a lesser degree, *C. peus*. The vats were anywhere from 3 to 8 feet deep and 7 to 15 feet in diameter. There are about 200 vats in this one packing installation and all of them (except those emptied for repair) are kept filled with water from May to October, a period during which they are not used for processing and packing the olives. Since the vats are located in the center of the city of Hemet, and support a fair population of mosquito larvae, they are a constant source of mosquito annoyance.

The olive vats provided an ideal semi-field condition where the effectiveness of granular insecticides in deep bodies of water could be studied. Emulsifiable concentrate formulations were also studied and some were found to be effective at lower concentrations than are necessary to kill susceptible larvae of *C. p. quinquefasciatus* in the laboratory. A plausible explanation for this phenomenon is offered.

METHODS AND MATERIALS

Vats 42 inches deep and 92 inches across were the only ones (Fig. 1) used in these experiments. The pH of the water in the vats was 6; the temperature of the water ranged from 68° to 78° F. during the day

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