

pounds except UC-8454 and Gardona caused increased ratios of the numbers of mosquitoes in the cage to those in the untreated boxes during the first 7 hours of observation, another indication of an irritating effect produced by contact with the chemicals.

Methoxychlor and Abate were not effective in killing mosquitoes in these tests, and Abate also had little or no effect on the resting behavior of the mosquitoes. Methoxychlor reduced the number of mosquitoes in the treated boxes and increased the number found in the cage.

Of the 28 materials studied, only 2—methoxychlor and Abate—were ineffective in killing adult mosquitoes. However,

three others—DDT, carbaryl, and Gardona—were only moderately effective. The other compounds killed a high percentage of mosquitoes though the mosquitoes were not confined directly on the deposits and could fly to and rest in either an untreated box or the cage. Repellency, irritability or avoidance behavior did not prevent all or high percentages of mosquitoes from obtaining a lethal dose of the highly effective materials.

Literature Cited

- Muirhead-Thompson, R. C. 1960. The significance of irritability, behavioristic avoidance and allied phenomena in malaria eradication. *Bull. Wld. Hlth. Org.* 22:721-734.

PRELIMINARY EVALUATION OF THE EFFECTIVENESS OF MOSQUITO BEATER®¹, A GRANULAR REPELLENT, AGAINST MOSQUITOES AND BLACKFLIES¹

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ABSTRACT. Mosquito Beater® containing naphthalene and polymethylated naphthalenes performed satisfactorily as a repellent against mos-

quitoes and blackflies. In a limited area, the material was effective for a 24-hour period.

In recent years there has been a trend by the suburban homeowner toward increased outdoor activity, such as gardening, outdoor meals and backyard sports. There has also become decreasing tolerance of nuisance insects, particularly biting flies such as mosquitoes (Culicidae), blackflies (Simuliidae) and punkies (Ceratopogonidae).

Many devices and materials are available in hardware, farm and garden, sporting goods and even drug and grocery stores

to better enable the homeowner to protect himself from these pests. Among these is a granular area mosquito repellent marketed by Bonide Chemical Company of Utica, N. Y. under the tradename, Mosquito Beater.² Because there have been a substantial number of inquiries regarding this product, it was tested during the summer of 1972 for its effectiveness in repelling mosquitoes and, to a lesser extent, blackflies, from small treated areas.

MATERIAL TESTED. Mosquito Beater is

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² This paper reflects the results of research only. Use of the trade name Mosquito Beater does not constitute a recommendation or endorsement by the N.Y. State Museum & Science Service.

composed of 30-50 mesh exfoliated vermiculite granules impregnated with polymethylated naphthalenes (16 percent), naphthalenes (4.5 percent), Beta-butoxy beta' thiocyno diethyl ether (1.0 percent), butoxypolypropylene glycol (0.5 percent) and a petroleum distillate (9.0 percent). The product is marketed in 1 pound-10 ounce cellophane bags. The formulator states that since the active ingredients must be released as a vapor, the effectiveness is considerably affected by wind movement and that wet conditions may reduce or destroy its effectiveness. The label states that a 50 x 100 foot area (5000 sq. ft.) can be treated with the bag contents. However, it was found that 10 bags contained an average of 128 volumetric ounces of material (122-130 ounces), which meant that by applying it at the recommended dosage of 1/2 cup (4 ounces) per 100 square feet, only about 3200 square feet could be treated.

METHODS. Four 50-foot square plots in typical suburban yards or public camping or picnic areas were selected for evaluating the material against adult mosquitoes. Each plot bordered a wooded area where mosquitoes were abundant. One test plot (A) was located in Letchworth State Park in midwestern New York and three plots (B-D) were located 1/8-8 miles distant from each other near Schenectady in eastern New York. One of these same plots near Schenectady and another similar one (E) in the same vicinity were selected for evaluating the material against adult black-

flies (*Simulium jenningsi* group) which were abundant and bothersome in the area. Tests were begun on July 7, 14, 21, 26 and August 4 and 11 and observations were made for a minimum of 48 hours after each application.

Three observation stations were selected at each test site: Station I (control) was 25 feet outside of the treated plot in woods; station II was at the edge of the treated plot adjacent to the woods and station III was in the center of the plot. Landing rate counts of mosquitoes were made by the author at each station just prior to application of the test material in early evening and approximately 0.5, 1.0, 1.5, 12, 24, 36 and 48 hours following application. Counts were made by waiting 3 minutes at each station, beginning with station I, counting the mosquitoes landing on the observer during a 1-minute period, then moving quickly to the next station (II then III). At the conclusion of counting at each station mosquitoes remaining on the observer were brushed away by hands or a net before proceeding to the next station. Although mosquitoes might be carried from one station to another by the observer, it was thought that an effective repellent should repel these also. Fifty specimens from each test plot were collected at random from the observer and preserved in alcohol for later identification. The species composition of mosquitoes from each site is shown in Table 1.

The abundance of annoying blackflies

TABLE 1.—Mosquito species composition at four locations in New York during evaluation of Mosquito Beater® granular repellent.

Test plot ¹	Number of mosquitoes collected ²					
	<i>Aedes canadensis</i>	<i>Aedes stimulans</i> gp. ³	<i>Aedes cinereus</i>	<i>Aedes communis</i>	<i>Aedes vexans</i>	<i>Anopheles punctipennis</i>
A	24	20	0	6	0	0
B	18	19	8	5	0	0
C	16	18	8	2	0	6
D	12	19	0	8	8	3

¹ See text for location.

² Composition of samples of 50 specimens collected while biting or annoying man.

³ Includes *Aedes stimulans* and *A. fitchii*.

was estimated by waiting at each observation station for 10 minutes, then making 10 directed sweeps with a standard 16-inch insect net at blackflies flying about the head.

The test material was applied in a manner similar to that suggested by the manufacturer by punching holes in the cellophane bag and scattering the material by shaking. For these tests the material was first measured into paper bags which were perforated with 3 holes using a pencil. By light shaking the manufacturer's recommended dosage of $\frac{1}{2}$ cup per 100 square feet was obtained.

OBSERVATIONS AND RESULTS. The mean landing rates of mosquitoes at three observation stations in four test plots are illustrated in Graph 1. Just prior to application of the test material landing rates were approximately equal at each of the observation stations (station I=34.75, station II=33.25, station III=32.75). The landing rate at station I outside of the treated area remained approximately stable for counts made 0.5, 1.0, 1.5, 12, 24, 36 and 48 hours after treatment (31.25-40.75). At station II located at the edge of the treated area the landing rate progressively decreased to 6.00, 3.73 then 1.50 at half-hour intervals following application. The count remained low at 3.50 for 24 hours then increased to 11.75 and 24.00 at the 36 to 48 hour counts respectively. At station III in the center of the treated area the landing rate dropped to 6.00 one-half hour after application, then to approximately 0, where it remained for 24 hours. After 36 and 48 hours the rate increased to 8.50 and 19.75 respectively.

It was observed while making counts at the edge of the treated areas, especially on still evenings, that mosquitoes would fly toward the observer from the untreated areas as if to attack, then suddenly stop in mid-air and fly vertically upward very rapidly. Apparently the mosquitoes encountered a barrier of vapors from the repellent and rose in an attempt to escape.

The mean annoyance rates of blackflies (*Simulium jenningsi* gp.) at three observa-

tion stations in two test plots are illustrated in graph 2. The counts just prior to application of the test material were approximately equal to all observation stations (13.5-16.0). During the 1.5 hours immediately following treatment the number of blackflies dropped to 0 at stations II and III, but remained high (11.0-22.0) at station I outside of the treated area. Blackflies were less abundant when counts were made at 8 a.m., 12 and 36 hours after treatment (6.0-6.5 for station I and 0-1.5 for stations II and III).

When counts were made in the evening 24 hours after treatment blackflies were still considerably more abundant at station I outside of the treated area (21.5) than at stations II and III (6.0 and 6.5 respectively). By 48 hours after treatment blackfly abundance had returned to approximately the pre-treatment levels at all 3 stations (13.5-21.5).

CONCLUSIONS. The results of these tests indicate that Mosquito Beater granular repellent applied as directed at the rate of approximately 22 pounds per acre (approximately 4.5 pounds per acre of naphthalene and polymethylated naphthalenes) is effective in driving nuisance mosquitoes from a limited area (2500 square feet) and preventing re-entry beginning $\frac{1}{2}$ to 1 hour after application. The material was highly effective for up to 24 hours, after which mosquito re-population progressively increased. The repellent action was most effective at the center of the treated area, but was also appreciably effective throughout the area.

The results of two tests indicated that the material is also effective in repelling blackflies (*Simulium jenningsi* gp.) from a similar limited area. In a treated area the blackfly population was reduced essentially to zero for at least an evening (1½ hours) after application and was still moderately effective 24 hours later, after which the population returned to approximately the pre-treatment level. The repellent action of the material was almost as effective at the edges of the treated area as it was in the center.