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CONTROL OF *AEDES TAENIORHYNCHUS* WIED. ON GRAND CAYMAN, WITH ULV BIORESMETHRIN

J. P. BROOKE,[1] M. E. C. GIGLIOLI[2] AND J. INVEST[3]

ABSTRACT. Three hundred fifty hectares of mangrove swamp which allow extensive breeding of *Aedes taeniorhynchus* Wied., were treated by ground ULV drift spraying from a converted TIFA (Model 1503) machine. Rates of 3 g., and 1.5 g., of 5-benzyl-3-furylmethyl (+) *trans* chrysanthemate (bioresmethrin) were applied per hectare.

CDC light traps were used to determine levels of reduction. 3 g/ha and 1.5 g/ha gave 88%–92% reduction in numbers of adult mosquitoes when 50 ml/ha of solution were used.

Introduction. Ultra low volume (ULV) dispersion of malathion aerosols to control adult mosquitoes has been established for some years. Resistance to organophosphate and chlorinated insecticides and fear of environmental contamination have naturally encouraged a search for safer yet more effective materials, especially those which can be applied by ULV.

Recently at the Rothamsted Experimental Station in the United Kingdom, numbers of pyrethroids have been synthesised. Of these, the most active at present commercially available is 5-benzyl-3-furylmethyl (+) *trans* chrysanthemate (bioresmethrin. NRDC 107), first described by Elliott *et al.* (1967). Hadaway *et al.* (1970) showed this compound to have the greatest activity of several synthetic pyrethroids against *Anopheles stephensi* Liston. and *Aedes aegypti* L. using a topical application technique. Brooke and Evans (1971) showed it to be approximately 8 times as

[1] Wellcome Foundation Ltd., Berkhamsted, U.K.

[2] Mosquito Research Control Unit, Grand Cayman, B.W.I.

[3] Wellcome Research Laboratories, Berkhamsted, U.K.

effective as unsynergised pyrethrins when used in a space spray against free flying female *A. aegypti*. Bioresmethrin is not synergised for kill by piperonyl butoxide against *A. aegypti*. Lee and Giglioli (unpublished) showed that 3 g/ha of bioresmethrin in 708 ml of dieseline when used as an airspray with a mass median diameter of 83 μ, gave 95%–99% reduction in numbers of adult *Aedes taeniorhynchus* Wied., in mangrove swamps on Grand Cayman. The degree of reduction was measured by the use of light traps.

The experiments described in this paper were designed to determine the minimum amounts of bioresmethrin and carrier which would provide a satisfactory measure of control of adult *A. taeniorhynchus* using a mobile, truck mounted, ULV cold aerosol machine.

TRIAL SITE. Grand Cayman Island was selected as a trial location, because of the very large numbers of *A. taeniorhynchus* which emerge shortly after the mangrove swamps become flooded. The aquatic interval for *A. taeniorhynchus* falls usually between 5 and 7 days and the larval distribution is almost totally limited to the mangrove where water is brackish. Various estimates of the adult dispersal of this species have been given. Zetek (1915) traced stained females 1.8 km. in Panama while in Florida, King, *et al.* (1942) and Provost (1960) recorded flights of 48 km. and 32 km. respectively. Grand Cayman is approximately 27 km. x 13 km. Migrations of up to 80 km. from Grand Cayman have been verified by Giglioli, thus the entire island is within the flight range of the species. It was desirable, therefore, to select a locality, where the prevailing winds might not bring fresh mosquitoes during the assessment period following spraying.

In June 1972 when these trials began, the prevailing wind was S.E., and so an area of mangrove swamp at South Sound, about 350 hectares in extent was selected. This site (see Figure 1) at that time was provided with an onshore S.E. wind so that mosquitoes were unlikely to enter the swamp from outside sources, while the wind remained in that quarter. Roads alongside the drainage dykes provided access to the swamp (see Plate 1 and Figure 2).

CHEMICAL DATA. A concentrate containing 15% bioresmethrin and 15% piperonyl butoxide w/v was used and diluted with dieseline to make a 3% w/v or 6% w/v bioresmethrin solution.

PHYSICAL DATA. A TIFA [4] model 1503

[4] Todd Combustion Ltd., Tifa Division, Swanley, England.

FIG. 1.—Grand Cayman Island.

PLATE 1.—Drainage dykes with central access road.

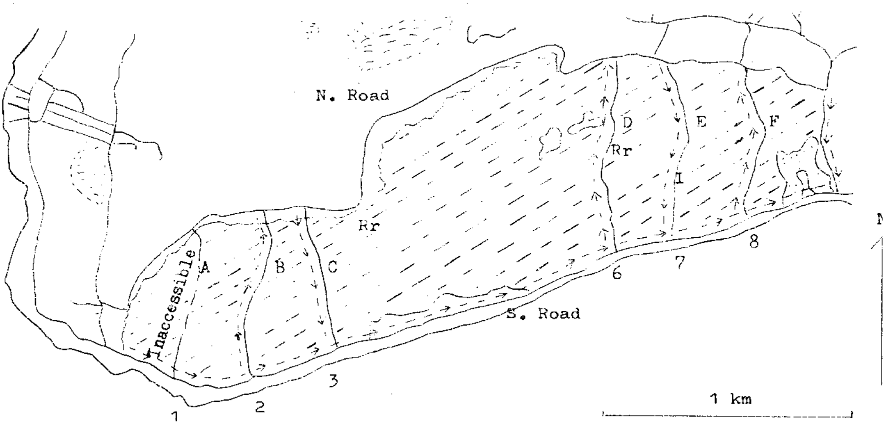

FIG. 2.—Mangrove swamp showing direction of travel during spraying operations, access roads and trap sites.

was adapted to give a cold ULV aerosol by removing the heating section and retaining the existing blower. The insecticide was pressure-fed from a 5 litre tank through a flow meter to the nozzle. The standard TIFA thermal fogging head which has a gap between the inner and outer components of 0.272 cm. was replaced by one with a gap of 0.0381 cm. Figure 3 shows the output of the machine at an air temperature of 34° C using dieseline. A solution of 6% w/v bioresmethrin in dieseline gives a similar output.

Particle size collections were carried out

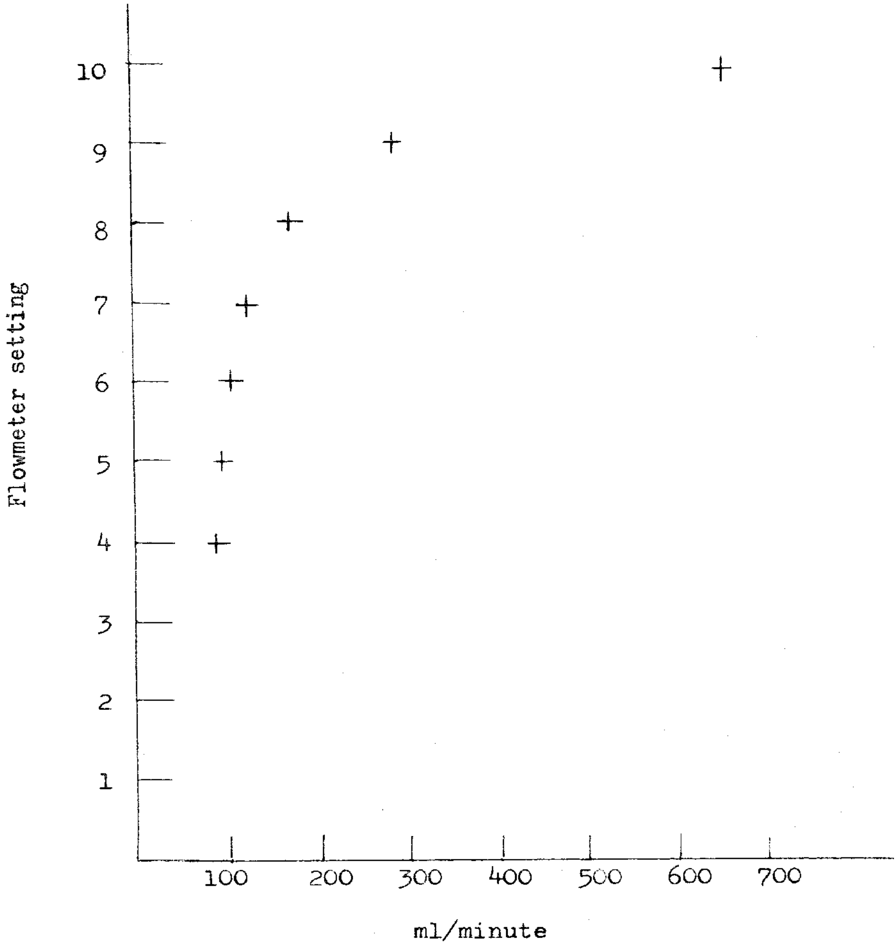

FIG. 3.—Discharge rates of converted TIFA machine using 6% w/v bioresmethrin in dieseline.

using magnesium oxide coated slides, fixed at a 45° angle, the treated surface facing upwards, 1.5 m. from the ground at 50 m. and 100 m. downwind from the nozzle of the TIFA. Four slides were prepared for each distance and 200 particles measured using a Portion G2 graticule.

Experimental. The experimental area was used as one unit of 350 ha. CDC light traps were set up on the access roads as shown in Figure 2, and emptied at 8 a.m. each morning. The traps were switched on at dusk by photoelectric cells. *A. taeniorhynchus* comprised between 80% and 95% of the catch and so other species were discarded. Heavy rains caused large numbers of eggs to hatch, the peak emergence of the adult mosquitoes taking place on or about the 18th June. Two treatments were carried out on the 19th and 22nd June.

The route followed by the TIFA which was mounted on a Mini Moke (see Plate 2) is shown in Figure 2. The Moke was driven at 16 km/h, the fogging head pointing 30° upwards and at a 45° angle to the path of travel, spraying with the wind. Calibration was achieved by recording travel time at 16 km/h for the route, dividing this into the total volume required and setting output accordingly.

The application rates used are shown in Table 1. Spraying began at approximately 20 minutes after sunset, i.e. about 19.20 hr when mosquito activity was at a peak. The volume applied per hectare was calculated according to the total area, on the assumption that the prevailing wind would carry the aerosol through the mangrove, which was up to 10 m. in height and dense.

The center section of the swamp was not provided with access roads. To check penetration of the particles through this mangrove, Rotorods coated with magnesium oxide were installed 1.5 m. and 4 m. from the ground at the two sites marked Rr on Figure 2. Dieseline containing 1% w/v Rhodamine B was discharged at 100 ml/min from the TIFA, travelling at 14

Plate 2.—ULV Tifa machine mounted on Mini Moke.

TABLE 1.—Application rates and catch reduction.

Experiment	g ai/ha	Bioresmethrin % conc. w/v in aerosol	Volume used	Volume/ ha	ml discharged minute	Air T ° 19.20h	Wind-speed and direction	% catch reduction
(a)	3	6%	17.5 l	50 ml	240	28° C	8.2 kph S.E.	92.0
(b)	1.5	3%	17.5 l	50 ml	240	31° C	2.4 kph S.E.	88.6

kph in a northerly direction along dyke 7 shortly after sunset, spraying with the S.E. wind (6.4 kph). The Rotorods were left in place for three hours and then examined beneath ultra violet light. Numbers of fluorescing particles in the range 10μ–25μ were found on all the rods, indicating that penetration through the mangrove for at least one kilometre had taken place. No quantitative measurements were taken. It was assumed, therefore, that with a S.E. wind of 6.4 kph, the whole swamp could be covered by drift using the spray route shown in Figure 2.

RESULTS. *Particle size analysis.* The mass median diameter, peak particle size and maximum and minimum diameters are shown in Table 2. The mass median diameters are high and it is likely that particles below 15 microns would not impinge freely upon the plates using the rather unsatisfactory magnesium oxide method. The optimum for the adult mosquito, probably falls between 5μ–15μ. One would expect an MMD falling within this range to give an improvement on the results reported here.

Biological results. Table 3 shows the individual trap catches per night of operation and should be studied with Table 1. Great variation occurs between trapping stations, and clearly the positioning of traps in the light of local experience is of paramount importance. These catches were transformed to geometric means using Williams' mean (Bidlingmayer 1969). The rise and fall of *A. taeniorhynchus* density adjusted by Williams' mean during the experiments is shown in Figure 4. It was accepted for the purposes of these experiments that mosquitoes captured in light traps following spraying were those which had survived. Nevertheless with little knowledge of local mosquito migration, it was impossible to say whether or not these were newly emerged adults or perhaps migrants which had entered the area after spraying. Since aerial spraying was taking place outside this area, it is probable that these were newly emerged adults rather than migrants.

Experiment (a), 3 g. bioresmethrin/50 ml. dieseline/ha. Because of a blockage in the insecticide feed to the nozzle of the TIFA, two passes were made over 1¾ hours, i.e. each at 1½ g. bioresmethrin/25 ml. dieseline/ha, although it was intended to deliver twice this quantity in one pass. On the 1st run very large numbers of flying mosquitoes were encountered. On the 2nd, few were seen, indicating perhaps a rapid knockdown after the 1st pass. *A. taeniorhynchus* was reduced by 92% when the trap catch was compared with that of the previous night.

Experiment (b), 1.5 g bioresmethrin/50

TABLE 2.—Particle size analysis using a solution of 6% bioresmethrin w/v in dieseline discharged downwind at 100 ml/min.

Distance of plate from nozzle	MMD	Peak diameter	Min. diameter	Max. diameter
50 meters	40μ	33μ	5.8μ	66μ
100 meters	30.5μ	23μ–33μ	5.8μ	66μ

ml dieseline/ha. Although the wind speed had fallen to 2.4 kph this apparently provided sufficient drift to give 88.6% reduction in the catch of *A. taeniorhynchus.*

DISCUSSION. Clearly, only extremely small quantities of bioresmethrin are needed to control *A. taeniorhynchus* and 1.5 g in 50 ml dieseline/ha provided a

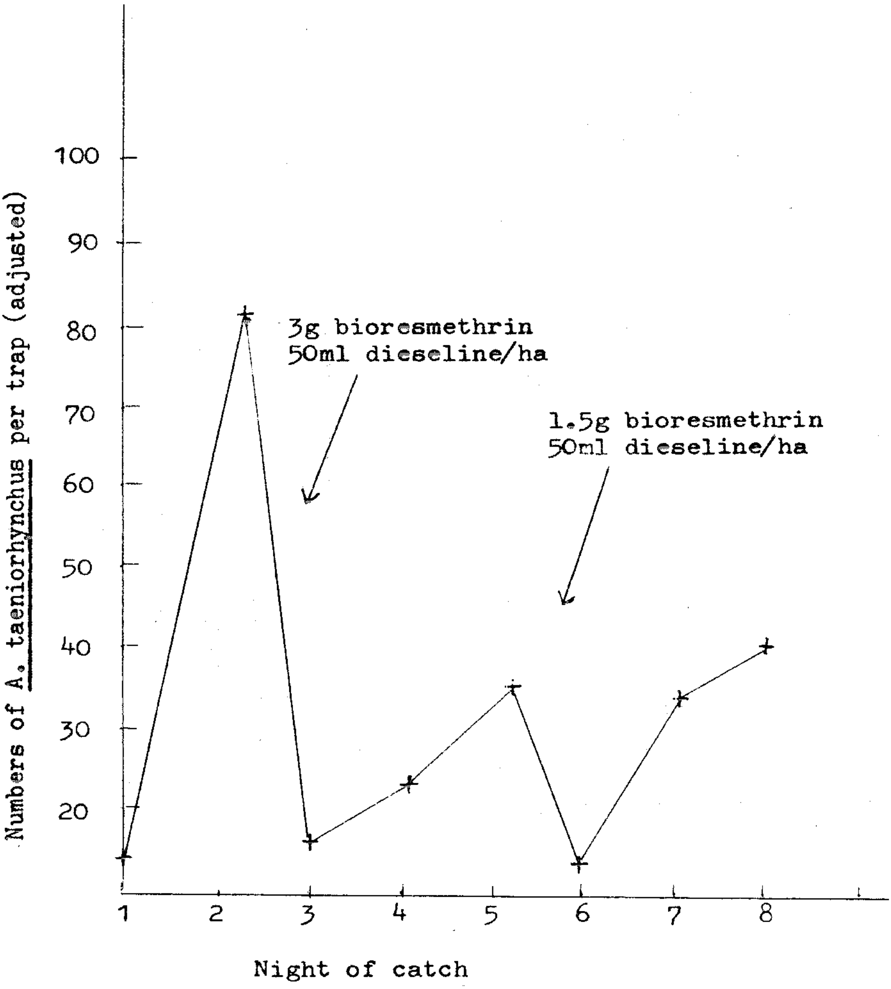

FIG. 4.—Result of ULV applications upon mosquito density.

TABLE 3.—Nightly catches (unadjusted) per trap.

Trap position	Trap night 1	2	3	4	5	6	7	8
				A. taeniorhynchus				
A	56	253	11	20	13	0	1	0
B	6	49	0	0	36	2	9	15
C	0	18	1	3	13	3	19	34
D	1	14	3	5	2	0	5	5
E	13	130	27	138	101	17	95	214
F	0	128	25	19	18	0	8	5
I	Not set			133	278	31	222	201

marked degree of reduction (88.6%) of the adult mosquito population. It would be useful to be able to determine the height to which the drifting swath of droplets will rise. It is interesting to record that using an arbitrary depth of 10 meters, i.e. 100,000 cubic meters per hectare, then a dose of 1.5 g provides a concentration of 0.015 mg of bioresmethrin per cubic meter. This is about six times the LC_{50} determined by Brooke and Evans (1971) for free flying female *Aedes aegypti*, using a Peet Grady Chamber. Nevertheless, it should be taken into account that in the ULV technique, the insecticide dose is not evenly distributed throughout the area to be treated, but is presented as a drifting curtain of highly concentrated particles. Thus at any one time, the concentration per m^3 may be many times the overall calculated concentration.

Further field work is needed, dispersing less than 50 ml solution per hectare, in an aerosol with an MMD of perhaps 12μ.

Since completing these studies one of the authors (JPB) has had access to purpose built ULV equipment particularly the LECO HD ULV cold aerosol generator for ground operations and the Micronair AU 3000 for use on aircraft. These machines are eminently suitable for ULV applications.

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