ARTICLES

INSECTICIDE STUDIES AT THE MOSQUITO RESEARCH AND CONTROL UNIT, GRAND CAYMAN, B.W.I.

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I. SUSPENSIBILITY AND LONGEVITY OF SOME COMMERCIALLY AVAILABLE FORMULATIONS

The mosquitoes on the Cayman Islands are found in breeding sites varying from fresh water (pools and rain flooded pastures) through a range of degrees of brackishness and pollution to the seawater flooded mangrove swamps. The main communities on the island are protected from mosquitoes by a fogging program while a long-term physical control scheme is being completed. Limited protection from mosquitoes which result from localized rain showers can be given by application of a larvicide (Armstrong, 1970), but many outlying communities and isolated houses could not be given protection by fogging or larviciding and efforts were made to provide some sort of protection for these people. From 1950 to 1956 DDT wettable powder was applied to the walls of houses on Grand Cayman; this, in conjunction with a campaign to screen all water containers and cisterns resulted in the eradication of *Aedes aegypti* from the island (Giglioli personal communications, 1967). As a result of this history of a successful residual treatment the Mosquito Research and Control Unit embarked on a program of external wall treatment in areas where fogging would not be practicable. The external walls of all houses and outbuildings, as well as under the raised houses and within carports and shelters were treated with malathion wettable powder obtained as a 25 percent formulation. Spraying was carried out using a 200-gallon Hudson sprayer fitted with two spray lances each on a 200 foot length of hose. The formulated insecticide was applied to give a nominal dosage of 200 mgms of active ingredient per square foot.

The treatment converted the inhabited localities into baited traps. The mosquitoes (primarily *A. taeniorhynchus*) were attracted to the houses, or sought shelter in outbuildings and under the houses and were exposed to the insecticide. As originally planned the program was to be a field experiment to compare the effectiveness of Sevin and malathion wettable powders. Unfortunately the Sevin did not arrive on the island until after the mosquito season and thus all houses were treated with malathion. Bioassay tests were attempted in the field, but as a result of high control mortalities data of significance were not obtained. Interviews with the residents within the treated area led us to believe that this technique was successful in providing some relief in the immediate vicinty of the houses. The sequence of events resulting in this relief was presumably as follows: the female mosquito was attracted to the house during the evening or morning peak of activity; if it was not killed during this first period of contact with the treated surface at dawn it moved to a protected site (the carport, under the house, or some secluded spot) and was again exposed to insecticide in these areas with a further mortality. Thus on the subsequent night the mosquitoes attracted to the house would be new mosquitoes and not a build-up with the previous night's mosquitoes. In the interviews the residents stated that the lack of mosquitoes was most noticeable in the morning and many reported that carports were free of mosquitoes at this

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time which serves to support the hypothesis of the mode of control.

During the course of the spray program locally available water was used in preparing the spray mixtures. In many of these outlying areas, fresh water was scarce and the well water varied in the degree of brackishness. To provide fresh water for home consumption it was customary to collect rain water from the house roofs and store it in cisterns. The householders were not too willing to have this limited supply of water used to mix insecticides so the brackish well water was used. It was noticed that the malathion wettable powder did not remain in suspension and a check of the suspensibility of wettable powder in water of varying salinity and pH was made. Bransby-Williams (1967) has discussed the problems of selection of a larvicide for use in clear and polluted water for the control of *C. pipiens fatigans*, and showed the necessity of preliminary screening to test insecticidal activity before an insecticide is chosen. This problem of suspensibility was also of concern in the larvicide program and the study was extended to include larvicidal formulations. At the time of the field application of the residual insecticide, laboratory studies were also started to investigate the longevity of residual formulations. In Table 1 are listed the commercially available formulations and their accepted common names. Other compounds in which the commercial name is the same as the common name are shown in the tables.

Suspensibility Studies. The suspensibility tests were carried out in distilled water, well water, cistern water, and sea water. The salinity of each type of water was determined using the method described in the WHO Guide for Malariologists (Sinton and Kehar, 1930), and the pH was recorded. The formulations were mixed to give the equivalent of 200 mgms of active ingredient in 50 mls of water. A 50 ml graduated cylinder was filled to about the 30 ml mark and to it was added the required amount of wettable powder or emulsifiable concentrate. This was mixed and water was then added to bring the volume to 50 mls. Each cylinder was then inverted 10 times and left to stand. Observations were made at 5, 15, 30 minutes and 1, 2, 3 and 4 hours after the final mixing. The time at which first precipitation, separation, or settling of the mixture or emulsion was observed and was recorded. The results are shown in Table 2.

The results show that, with the exception of Baygon w.p., Baytex w.p. and Sevin w.p., no wettable powder stayed in suspension in any of the water types longer than 15 minutes. Of the compounds that did stay in suspension longer than 15 minutes, none stayed in suspen-

Table 1.—The accepted common names of commercial formulations used in insecticidal studies.

Commercial Name	Common Name or Composition
Abate ®	O,O,O′,O′-tetramethyl O,O′-thiodi-p-phenylene phosphorothioate
Accothion ®	O,O, dimethyl O-(4-nitro-m-tolyl) phosphorothioate
Akton ®	O-(2-chloro-1- (2,5-dichlorophenyl) vinyl) O,O-diethyl phosphorothioate
Basudin	diazinon
Baygon ®	propoxur
Baytex ®	fenthion
Birlane ®	chlorfenvinphos
Cidial ®	ethyl mercaptophenylacetate O,O-dimethyl phosphorodithoate
Dibrom ®	naled
Dursban ®	O,O-diethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothioate
Marlate ®	methoxychlor
Rhothane ®	TDE
Sevin ®	carbaryl
Vapona ®	dichlorvos

TABLE 2.—The time of first precipitation, settling, or separation of commercially available insecticide formulations in four types of water.

	Water type			
	Distilled Sal. 0 † pH 7.9	Cistern Sal. 0.1. pH 8.7	Well Sal. 1.25 pH 7.4	Sea Sal. 25.0 pH 7.6
Wettable powders				
Basudin 40% *	5 min.	5 min.	5 min.	5 min.
Baygon 50%	2 hrs.	2 hrs.	15 min.	5 min.
Baytex 40%	5 min.	30 min.	30 min.	5 min.
Birlane 25%	5 min.	15 min.	5 min.	15 min.
Cidial 40%	5 min.	5 min.	5 min.	5 min.
DDT 50%	5 min.	5 min.	5 min.	5 min.
Malathion 25%	5 min.	5 min.	5 min.	5 min.
Marlate 50%	5 min.	5 min.	5 min.	5 min.
Rhothane 50%	5 min.	5 min.	5 min.	5 min.
Sevin 50%	15 min.	3 hrs.	15 min.	5 min.
Emulsifiable concentrates				
Abate 50%	5 min.	30 min.	2 hrs.	5 min.
Accothion 50%	2 hrs.	2 hrs.	4 hrs.	5 min.
Akton 40%	5 min.	15 min.	5 min.	30 min.
Basudin 20%	30 min.	30 min.	5 min.	5 min.
Basudin 60%	4 hrs.	4 hrs.	4 hrs.	4 hrs.
Baygon 20%	4 hrs.	3 hrs.	3 hrs.	5 min.
Baytex 50%	2 hrs.	2 hrs.	2 hrs.	2 hrs.
Cidial 50%	4 hrs.	4 hrs.	15 min.	30 min.
Dibrom 58%	2 hrs.	2 hrs.	4 hrs.	15 min.
Dursban 40%	4 hrs.	4 hrs.	15 min.	5 min.
Malathion 50%	2 hrs.	4 hrs.	4 hrs.	4 hrs.
Marlate 93%	2 hrs.	1 hr.	1 hr.	5 min.
Vapona 48%	4 hrs.	2 hrs.	2 hrs.	2 hrs.

† Salinity expressed in grams per litre.
* Commercial name with percentage active ingredient. See Table 1 for descriptions.

sion in sea water for the minimum 5 minute period. The best compounds were Baygon w.p. (2 hrs. in cistern water) and Sevin w.p. (3 hrs. in cistern water). Birlane w.p. remained in suspension in cistern and sea water for 15 minutes.

The emulsifiable concentrates showed better mixing qualities than the wettable powders. The compounds with the poorest record were Abate e.c., Akton e.c., and Basudin e.c. 20 percent and of these Abate showed good suspensibility qualities in cistern water and well water. However, the suspensibility of the emulsifiable concentrates must be balanced against their effectiveness as larvicides and this characteristic must be considered in the final choice.

These studies show generally that as the salinity increases the suspensibility decreases and as the pH increases the suspensibility also increases.

The tests were repeated following the same procedure except that Triton X151 was added in progressively increasing amounts to give 1, 2 and 4 percent mixes. With the wettable powders the addition of up to 4 percent of Triton X151 did not improve the suspensibility. The addition of Triton X151 to the emulsifiable concentrates in an amount equal to the amount of concentrate added, resulted in all emulsions remaining in suspension for 4 hours.

This investigation shows that, with the shortage of fresh water on Grand Cayman, a formulation which will remain in suspension in brackish water should be used. If a powered sprayer, with a mechanical agitator is used the lack of suspensibility is not too important; however, if a hand sprayer, with no means of agitation is used then the lack of suspensibility is critical. This problem is also of importance when considering larvicides. There is the possibility that an emulsifiable concentrate used as a larvicide will precipitate, or separate in some fashion with the result that the active material will not be available to the larvae.

LONGEVITY OF INSECTICIDE DEPOSITS. Bioassay studies to determine the effectiveness and longevity of insecticide deposits were carried out at the laboratory. For these studies, unpainted and painted cement blocks and wood panels were treated with formulations to give 100 and 200 mgms of active ingredient per square foot. Replicates of each type of surface and treatment were prepared; one set was stored on a sheltered verandah, (to represent the protected eave on the lee side of a house or within a carport) and the other set was exposed to full effects of weather (to represent the exposed walls of a house). Immediately after treatment of the surface and when it was dry, a bioassay was set up using 15–20, 3–5 day-old sugar fed *A. taeniorhynchus* females. The insects were exposed for 15 minutes under a WHO bioassay cone; the cone was plugged to prevent the exit of insects as a result of irritation. After the exposure period, the insects were transferred to paper-lined WHO holding tubes and kept in a darkened room for 24 hours. A pad soaked in a 10 percent sugar solution was applied to the screened end of each tube. Control tests were also carried out on untreated surfaces. Mortality counts were taken at the end of the 24-hour period and if the control mortality was greater than 25 percent the complete test series was discarded. With control mortalities less than 25 percent the test mortalities were corrected using Abbott's formula (Finney, 1952).

The duration of the mosquito season was normally 12–16 weeks. It was decided that the main requirement in the choice of an insecticide was that a single application would provide protection for this period, thus the residences would only have to be treated once at the start of the mosquito season. More frequent application, to give protection during the mosquito season, would render the treatment uneconomical. The criterion of effectiveness was therefore set at a 50 percent mortality after a 2-hour exposure to a deposit 16 weeks old. Thus, in the bioassay tests, the aim was to determine the length of life of the insecticide deposit using a mortality of 50 percent after a 2-hour exposure and 24-hour holding period as the limit of effectiveness. Tests were planned so that using first a 15-minute exposure period the mortality was determined; when the mortality decreased to less than 50 percent, the exposure time was doubled to 30 minutes, then to 60 minutes, and finally a 2-hour exposure period. In Table 3 are shown the results of the tests after a 10–16 week aging period.

These partial results indicate that, on a wood surface, malathion was the best insecticide, and on cement the best were DDT, Sevin and Basudin (Diazinon) in that order. At the time of the investigation approximately half of the houses on the island were cement with the others being wood or a wood frame covered with lime plaster. Generally the wood and wood frame houses are being replaced with cement block houses and thus first choice of insecticide is for that which is most effective on cement. With the potential of DDT resistance the choice of insecticides was (1) Sevin, (2) malathion, and (3) Basudin. Baygon, Baytex and Birlane did not meet the requirements and were not considered to be effective.

The variation in mortality, and the apparent inconsistency when comparing the results at 200 and 100 mgms a.i./sq. ft. are the result of too few replicates. The results do show generally that a deposit on a protected surface lasts longer than on an unprotected surface. Of the weathered set of surfaces the deposit on the unpainted surfaces lasted longer than on the painted surfaces. In this case the insecticide was presumably absorbed into the protected unpainted cement or wood (as shown by a lower mortality than for the comparable painted surface) and was

TABLE 3.—The mortality of *A. taeniorhynchus* after a 2-hour exposure to insecticide treated surfaces.

Insecticide (age of deposit in weeks)	Amount of active ingredient (a.i.) of insecticide on the surface															
	100 mgms (a.i.)/sq. ft.								200 mgms (a.i.)/sq. ft.							
	Cement				Board				Cement				Board			
	Weathered		Protected		Weathered		Protected		Weathered		Protected		Weathered		Protected	
	P	U	P	U	P	U	P	U	P	U	P	U	P	U	P	U
Baygon 50% w.p. (16)	0*	0	0	0	—	—	—	—	0	0	0	0	—	—	—	—
Baytex 40% w.p. (16)	7.2	0	0	0	—	—	—	—	0	0	18.8	7.2	—	—	—	—
Birlane 5% w.p. (10)	0	0	0	0	0	0	6.3	20	0	0	0	0	0	6.3	13.4	6.7
Basudin 40% w.p. (10)	0	0	11.8	0	0	0	6.7	0	72	0	87.5	71.5	33	0	12.5	0
DDT 50% w.p. (16)	40	84	44	66	—	—	—	—	67.3	90	90	100	—	—	—	—
Malathion 25% w.p. (16)	0	0	0	0	5.9	29.4	78.5	100	0	7.2	0	0	0	0	91	100
Sevin 50% w.p. (15)	—	—	—	—	—	—	—	—	47.7	—	100	—	—	—	—	—

P—painted surface.
U—unpainted surface.
* Percentage mortality.
— No test.

not washed off by the rain. Any surface deposit would be washed off but as the board or block dried, insecticide from within the surface would migrate to the surface and be available to affect insects.

Conclusions. This study shows the necessity of a screening program before the initiation of a control program. The tests showed that, under conditions peculiar to the island, some otherwise acceptable formulations would not remain in suspension long enough to be effective. Control by the application of a residual insecticide to the external walls of dwellings was found to be useful for the reduction of mosquitoes in the immediate vicinity of houses.

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II. Susceptibility of Mosquitos to Insecticides

The major mosquito pest on Grand Cayman is *Aedes taeniorhynchus*. The control program of the Mosquito Research and Control Unit is a physical control scheme with insecticides being applied to provide temporary relief. In the latter stages of the control program, when the potential and actual breeding areas have been decreased in size and number, insecticides will be used. At present a program is in progress to eradicate, or greatly reduce the *Aedes aegypti* population on Cayman Brac by application of Abate as a larvicide (Giglioli personal communication, 1970). Two of the objectives assigned to the author in setting up the joint program with Canadian International Development Agency and the Mosquito Research and Control Unit were (1), to measure the susceptibility of the island mosquitoes to insecticides, and (2), to search for insecticide resistance.

The results of the susceptibility survey are reported here. A later section reports the findings of the resistance survey. With *A. taeniorhynchus* comprising 80–90 percent of the total mosquito population on Grand Cayman the response of this mosquito to each insecticide was determined. *Culex nigripalpus* larvae also tested were frequently found in large numbers in water-filled containers near houses. The tests with *Aedes aegypti* and *Culex bahamensis* were carried out on Cayman Brac (situated 90 miles N.E. of Grand Cayman) as part of a survey in conjunction with World Health Organization/Pan American Health Organization representatives from Jamaica. This survey was initiated to determine the extent and degree of *A. aegypti* infestation on that island and to measure its susceptibility to insecticides.

The larval and adult susceptibility tests were made according to the standard WHO test procedures. Adult tests were made with treated papers supplied by WHO; the larval tests were made with chemicals supplied in the WHO test kit or solutions prepared from technical compounds or from commercially available formulations. In preliminary work, attempts were made to use insects collected as they were found naturally occurring following a rain or flooding of the land. This was not successful and mosquito larvae were then produced by pumping water to flood selected areas of mangrove or open land. In this way larvae and adults of uniform development were available. Sufficient numbers of larvae were collected to permit four replicates of 25–30 larvae per concentration of insecticide plus four control replicates to be set up. The adult tests were with twenty-five 3–5 day-old sugar-fed females per replicate. Four replicates at each concentration and four control replicates were set up. A minimum of five concentrations were used for each test series. During the test period all insects were kept in the darkened holding room; the ambient temperature in this room was 70–80° F., there was no humidity control but the relative humidity was in the range 60–80 percent. Sucrose soaked pads were applied to the screened end of the adult holding cages. Mortality counts were made at the end of 24 hours and Abbott's formula (Finney, 1952) was applied as necessary for all control mortalities less than 25 percent; if the control mortality was greater than 25 percent the test was discarded. The average control mortality for all larval tests was 5.3 percent (a total of 2120 insects exposed); the average control mortality for all adult tests was 7.0 percent (a total of 257 insects exposed).

In Tables 4 and 5 are shown the LC 50's and LC 90's calculated from the susceptibility tests for each compound. The accepted common names of the insecticides, where different from the commercial names, are listed in Table 1.

The susceptibility tests showed the order of effectiveness of insecticides against the major pest mosquitoes on Grand Cayman and Cayman Brac. The most interesting results are those from the exposure of *A. taeniorhynchus* larvae and adults to dieldrin (See Part III, below). The larval test results, when plotted, showed a decreasing slope at the higher concentrations of dieldrin. The adult test showed the classical resistance curve for a population of insects in which a proportion are resistant to the insecticide (Elliott, 1959). A plot of the Birlane and BHC larval susceptibilities gave dosage-mortality lines parallel to the dieldrin line suggesting that *A. taeniorhynchus* might develop resistance to these two compounds if they were used extensively.

At the time the tests were carried out, insecticides had not been used on Cayman Brac; the *A. aegypti* on Cayman Brac did not exhibit a resistance to DDT. *Culex nigripalpus* were susceptible to DDT with a 95 percent mortality at 0.004 p.p.m. and 100 percent mortality at all higher concentrations.

TABLE 4.—Susceptibility of III & IV instar larvae to insecticides.

(Insecticides)	LC–50 (ppm)	LC–90 (ppm)
Aedes taeniorhynchus		
Abate	0.0005	0.0012
Dursban	0.0006	0.0014
Akton	0.00065	0.0055
Baytex	0.0018	0.0031
Accothion	0.0023	0.0058
Birlane	0.003	0.025
Dieldrin	0.0058	0.045
Vapona	0.007	0.014
Cidial	0.0078	0.016
DDT	0.012	0.04
Methoxychlor	0.035	0.09
BHC	0.065	0.22
Diazinon	0.078	0.17
Dibrom	0.16	0.30
Baygon	0.38	0.9
Aedes aegypti		
Abate	0.0048	0.0078
Fenthion	0.0056	0.009
Dieldrin	0.045	0.50
Malathion	0.06	0.09
DDT	0.12	0.20
Culex bahamensis		
Dieldrin	0.0018	0.005
Culex nigripalpus		
Dieldrin	0.006	0.019
DDT	95% mortality at 0.004 ppm.	

Note: *Aedes taeniorhynchus* and *Culex nigripalpus* from Grand Cayman. *Culex bahamensis* from Cayman Brac.
Aedes aegypti from Cayman Brac—tests carried out in conjunction with World Health Organization.

TABLE 5.—The susceptibility of adult female *A. taeniorhynchus* to DDT, malathion and dieldrin.

Insecticide	LC–50	LC–90
DDT	1.0%	2.3%
Malathion	0.77%	2.3%
Dieldrin	1.0%	(81.0% mortality at 4.0%)

III. DIELDRIN RESISTANCE IN *A. taeniorhynchus*

The island of Grand Cayman, with a total area of 70 square miles possesses almost 50 square miles of permanent mangrove swamps. The principal communities and areas of habitation and the extent of the major mangrove swamps are shown in Figure 1. The Western Peninsula of the island, which has the two main communities (George Town and West Bay) and the majority of the population, has large areas of mangrove swamp close to, and upwind of, these communities.

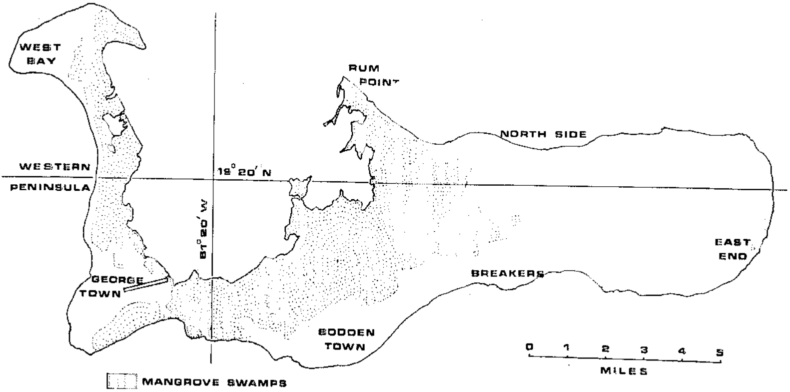

FIG. 1.—Outline map of Grand Cayman showing the principal communities and the extent of the main mangrove swamps.

During the rainy season, or at any time that these swamps are flooded, large numbers of *A. taeniorhynchus* are produced, and with the proximity of the swamps to the towns the mosquitoes present a serious pest problem. It is in these areas that Dr. Giglioli, the Director of the Mosquito Research and Control Unit, initiated the physical control scheme to reduce the area of potential *A. taeniorhynchus* breeding ground.

In 1963, in an attempt to provide more effective and long-lasting relief, dieldrin granules were applied by aircraft to the swamps in the Western Peninsula at a nominal dosage of 0.2 pound of active ingredient per acre. The treatment was started about the end of December, 1962 and was completed in early January, 1963. The period November through to May is normally the dry period of the year with only light, scattered rain showers. The year 1963 was no exception; in the period January to April there was never more than 0.75 inch of rain at any one time, and the total rainfall was only 2.5 inches. Following the onset of the heavy rains in May-June there was apparently normal mosquito development with no noticeable reduction in numbers. From available records and interviews with the residents mosquitoes were evidently as bad as prior to the treatment.

The susceptibility study described above showed that dieldrin-resistant mosquitoes formed a proportion of the population in the area which had been treated with dieldrin only once 4 years before the time of the susceptibility survey. The mosquitoes used in the susceptibility survey were from areas of mangrove swamp which had been artificially flooded by pumping water during the dry season. This technique was useful in that mosquitoes of uniform age could be produced as required, and by running a series of floodings in different areas it was possible to have an almost permanent supply of mosquitoes. There was however, the possibility that mosquitoes produced in this manner might, as a result of environmental differences between normal rain-flooded and artificially flooded pools, be different to the extent that there would be a variation in response to exposure to insecticide.

In this present study larval tests were carried out with mosquitoes produced by artificial flooding (dry season) and with mosquitoes which developed in normal rain-flooded pools (wet season). Attempts were made to use field-collected adults but there was a high mortality (averaging about 50 percent) which was attributed to collection and handling problems associated with trying to collect active hungry insects. To produce adults, fourth instar larvae and pupae were collected from the flooded pools and returned to the laboratory. They were permitted to complete their development in water brought from the breeding site. Pupae were collected in beakers which were filled to within ½ inch of the top and which were then placed in cages. A sucrose-soaked pad was placed on the top of the cage. Once adults started to emerge, several pupal containers were placed in a single new cage and left for 12 hours. At the end of the 12-hour period the pupae were removed to another cage; again for a 12-hour period; in this way it was possible to obtain adults with their age known to within ± 6 hours. These insects were used for the susceptibility tests. Attempts were made to blood-feed the adults, but being autogenous, and also probably as a result of being in cages, virtually none of the females engorged. The test insects were 3–5 day-old sucrose-fed females. Preliminary tests showed no difference in mortality when 3–5 day-old sucrose-fed females were compared with blood-fed mosquitoes of the same age.

Larval tests were carried out according to WHO procedures with dieldrin solutions provided in the test kit. There was no difference in mortalities at the concentrations used when wet-season larvae were compared with dry-season larvae and all the data are grouped and shown in Table 6 as from the Western Peninsula. In an attempt to obtain insects from areas which had not been treated with dieldrin, larvae were collected from a small swamp area in the eastern limits of the island near the community of East End, (Figure 1), which is about 20 miles from the dieldrin-treated area. Although the results are within the limits of mortalities found when larvae from the Western Peninsula were tested, there was a consistently higher mortality at each concentration of dieldrin suggesting a relatively more susceptible strain of insects.

Adult tests were with the sucrose-fed mosquitoes exposed to dieldrin treated papers following WHO procedures. Mosquitoes were exposed in replicates of approximately 25 insects per replicate. After the 1-hour exposure the adults were transferred to clean holding tubes and held in a darkened room for 24 hours. Since the original survey showed no increase in mortality at exposures above 1.6 percent dieldrin, the level of 4.0 percent was used as the discriminating dosage to check for resistance (Davidson, 1956). A collection of larvae and pupae from the swamps at

TABLE 6.—The susceptibility of III and IV instar larvae of *A. taeniorhynchus* to dieldrin.

Source of material	Control	Dieldrin concentration (ppm)					
		0.0008	0.004	0.02	0.1	0.5	2.5
Western Peninsula	3.4(671)*	2.7(469)	31.9(692)	73.0(724)	89.0(652)	99.2(620)	100(582)
East End	3.0(101)	....	51.0(104)	80.0(108)	97.5(113)	100(110)	100(111)

* Percentage mortality with number of insects tested in parens.

TABLE 7.—Summary of the susceptibility of adult *A. taeniorhynchus* to a series of concentrations of dieldrin.

Source of Mosquitoes	Control	Percentage concentration of dieldrin							%R*
		0.05	0.1	0.2	0.4	0.8	1.6	4.0	
	Percentage mortality; numbers of insects tested in parentheses								
Western Peninsula (dry season) (Females)	0(83)	0(86)	0(83)	1.2(82)	8.5(82)	43.8(80)	76.1(84)	81.0(74)	19.0
Western Peninsula (wet season) (Females)	6.5(31)	3.8(26)	3.4(29)	45.5(35)	53.5(28)	69.7(23)	80.6(36)	78.0(453)	22.0
Western Peninsula (Males)	....	....	....	....	....	....	....	97.0(35)	3.0
East End (Females)	0(22)	0(25)	0(24)	0(23)	22.7(22)	58.0(19)	79.0(19)	91.6(72)	8.4
East End (Males)	0(24)	0(24)	36.4(22)	53.9(26)	73.0(26)	....	....	100(21)	0

* %R=percentage resistant to dieldrin.

East End were permitted to develop to adults, and males and females from this collection were exposed to a range of concentrations of dieldrin. With the possibility of a variation in response due to environmental differences in wet season pools and artificially flooded dry season pools, females from the Western Peninsula which had developed under each of these conditions were exposed to the range of dieldrin concentrations. A single collection of males was exposed to 4.0 percent dieldrin. The results of all the adult tests are shown in Table 7.

The adult tests indicated that dieldrin-resistant *A. taeniorhynchus* comprised a large proportion of the population in an area which had been treated with dieldrin only once 4 years before the susceptibility survey was carried out. There was no significant variation in the proportion of the population resistant to dieldrin when the results of the wet season mosquito test were compared with the dry season tests. There was a higher mortality at the lower concentrations of dieldrin with insects produced in the wet season which suggests some difference in the larval environment which showed as a vigour tolerance to dieldrin (Hoskins and Gordon, 1956). No dieldrin resistant males were found in the collection from East End. Dieldrin resistant females were found to be present in the collection from East End. Although this area had never officially been treated with dieldrin there is the possibility that some person with access to the insecticide supply at the time of the aerial application may have treated the limited breeding areas adjacent to East End. The swamp in East End is small and within the community, hence the possibility of this unofficial treatment.

The occurrence of dieldrin resistant mosquitoes on Grand Cayman can probably be attributed to the dieldrin application carried out in 1963. This treatment was done at the start of the dry season and the dieldrin granules lay on the ground exposed to normal weathering conditions and to the damp soil for 4 months before there was any egg hatch. With the mosquitoes being autogenous, and present in large numbers, any survivors from the dieldrin exposure would probably deposit eggs within the dieldrin-treated area. With the large area treated, any surviving mosquitoes would have had to fly a mile or more from the southern boundaries of the treated area to oviposit on insecticide-free ground; hence the chances of dieldrin resistance would be enhanced.

These tests confirm the necessity of carrying out a detailed insecticide screening and resistance survey before any large-scale application of insecticide is planned.

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