DISCUSSION. In British Guiana there has recently occurred a reinfestation of the coastlands with *A. aegypti* (Burton 1963). Following an intensive residual house spraying campaign in 1947–1948 (Giglioli 1948) this vector was eradicated from British Guiana. The effective insecticide of choice at the time was 5 percent DDT in commercial kerosene. Simultaneously *Anopheles darlingi,* the vector of malaria on the coast, was eradicated also. Since *A. aegypti* was one of the three house-frequenting mosquitoes in largest numbers, after *A. darlingi* and *C. fatigans,* eradication was possible (Giglioli 1948a). In any future spraying campaign, dieldrin would be the insecticide of choice. The presence of jungle yellow fever in the interior of British Guiana at present (Burton 1963) points to the necessity for action against this vector.

SUMMARY. Resistance tests against *A. aegypti* larvae and adults were carried out in Georgetown, British Guiana, using W.H.O. resistance testing kits. The larvae were found to be highly susceptible to dieldrin and BHC at 0.1 and 0.5 p.p.m. At 0.5 p.p.m. DDT was only about 80 percent effective. Adults were very susceptible to paper-impregnated malathion emulsion in concentrations of 2.0%, 1.0%, 0.5%, 0.25%, 0.125%, and 0.0625%. In all cases except the last, 100% knockdown occurred in 20 minutes, with complete mortality by 3½ hours. Using 4.0%, 1.6%, and 0.8% dieldrin, most were knocked down after one hour in the holding cage, and all were dead by 5 hours after holding began. Dieldrin is recommended as the insecticide of choice in any anti-*A. aegypti* campaign in British Guiana in the future.

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SUSCEPTIBILITY OF TWO DDT-RESISTANT *AEDES AEGYPTI* STRAINS TO DDT AND DEUTERO-DDT AS LARVICIDES IN LABORATORY TESTS[1]

R. W. ZWICK[2]

Samples of deutero-DDT[3] furnished this laboratory were used to make ethanolic solutions for testing against two strains of chlorinated hydrocarbon-resistant *Aedes aegypti* (L.). Previous tests had indicated these two *aegypti* strains maintained at the Pan American Sanitary Bureau's Kingston, Jamaica, laboratory to possess high tolerances for DDT and also cyclodiene (dieldrin, BHC) compounds using the standard WHO 24-hour exposure.

The Lionel Town, Jamaica, strain reported on herein had been collected in the field in October, 1962, from an area

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[3] 2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane-2d.

sprayed for several years intradomiciliarly under the malaria eradication program which had recently (1961) concluded. This strain had been maintained for three generations in the laboratory and used for bioassay of candidate larvicides (Zwick, in press).

The Carriacou (Grenadine Islands), British West Indies, strain had been collected from eggs in the field in February, 1963, and proved to be extremely resistant to DDT and dieldrin in several prior tests of the F_1 and F_2 progeny. Carriacou Island had experienced perifocal and intradomiciliary DDT applications from the early 1950's through 1958 under the Island's *aegypti* eradication program.

Both strains were reared in enamel trays in darkness at ambient temperatures. Eggs hatching during one to two hours immersion in boiled tap water were fed Purina rabbit chow and Brewer's yeast each day until used for testing. Under the conditions prevailing at the laboratory in Kingston, Jamaica, *aegypti* reared as above started to pupate during the fifth day of larval life or from the ninety-sixth hour after eclosion from the egg. The Lionel Town F_2 and F_3 generation larvae were tested to DDT and deutero-DDT each 24 hours commencing as the larvae became one day old in order to follow the increase in resistance through larval development as demonstrated by Parker (1957). The Carriacou, B.W.I., F_2 generation larvae were tested at 96 hours in their fourth instar.

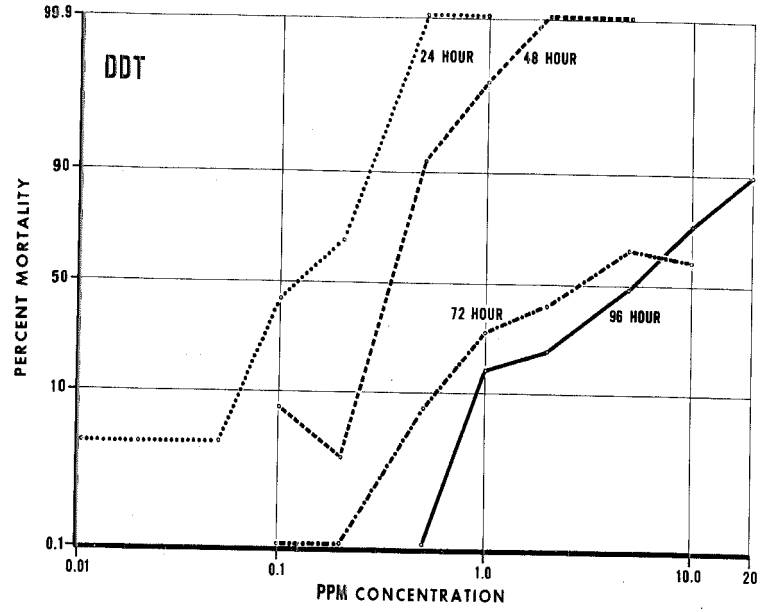
Figure 1 demonstrates the increased resistance of the Lionel Town larvae through the ninety-sixth hour of larval development using total mortalities of all replicates at a concentration in the two series of tests conducted on different dates. Results of the tests using Carriacou, B.W.I., fourth instar larvae on several different dates are shown in Figure 2. Table 1 presents the LC values in tabular form for Lionel Town F_2 and F_3 larvae as read directly from the regression lines formed by connecting the points obtained in plotting mortalities against concentrations of DDT and deutero-DDT (logarithmic scale) employed in these series of susceptibility tests.

The increase in resistance to both insecticides with increasing age of the larvae tested previously noted by Parker (1957) is demonstrated by Lionel Town strain F_2 and F_3 larvae. Both generations tested of the Lionel Town, Jamaica, strain were comparable in their susceptibilities to both DDT and deutero-DDT in these tests. Four-day-old larvae of the Lionel Town F_2 and F_3 strain showed an increase in resistance over one-day-old larvae, of approximately 40-fold to DDT and over 20-fold to deutero-DDT at the LC_{50} level. At

TABLE 1.—LC_{50} and LC_{100} values of DDT and deutero-DDT of one through four day old Lionel Town, Jamaica, F_2 and F_3 *A. aegypti* larvae in laboratory tests.

Generation	Age in Hours	Instar	PPM Insecticide			
			DDT		Deutero-DDT	
			LC_{50}	LC_{100}	LC_{50}	LC_{100}
F_2	24	1,2	0.125	0.5	0.040	0.05
F_3	24	1,2	0.102	0.5	0.029	0.05
F_2	48	2,3	0.35	2.0	0.105	0.20
F_3	48	2,3	0.31	1.0	0.110	0.20
F_2	72	3,4	3.0	>10.0	0.18	1.0
F_3	72	3,4	5.2	>10.0	0.19	1.0
F_2	96	4[1]	5.4	>20.0	0.58	>1.0
F_3	96	4[2]	4.4	>20.0	0.72	>1.0

[1] Control pupation: 61%.
[2] Control pupation: 51%.



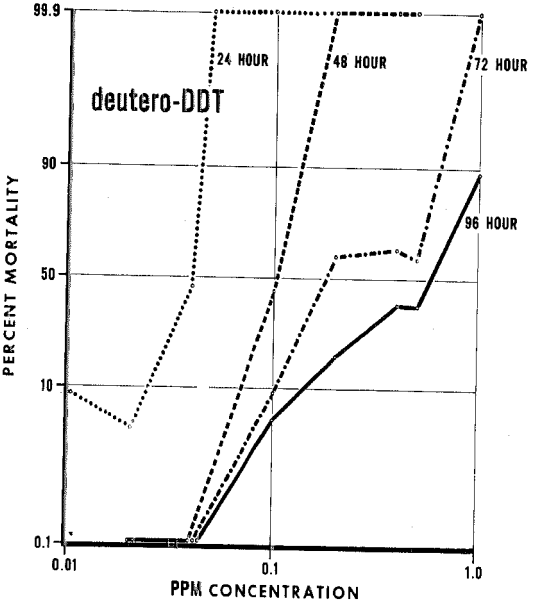


FIG. 1.—Dosage mortality regression lines of *Aedes aegypti* larvae (F_2 of the Lionel Town, Jamaica, strain) aged 24 to 96 hours, obtained in tests of larval susceptibility to DDT and to deutero-DDT, using the WHO technique for testing the suscepibiliy of mosquito larvae.

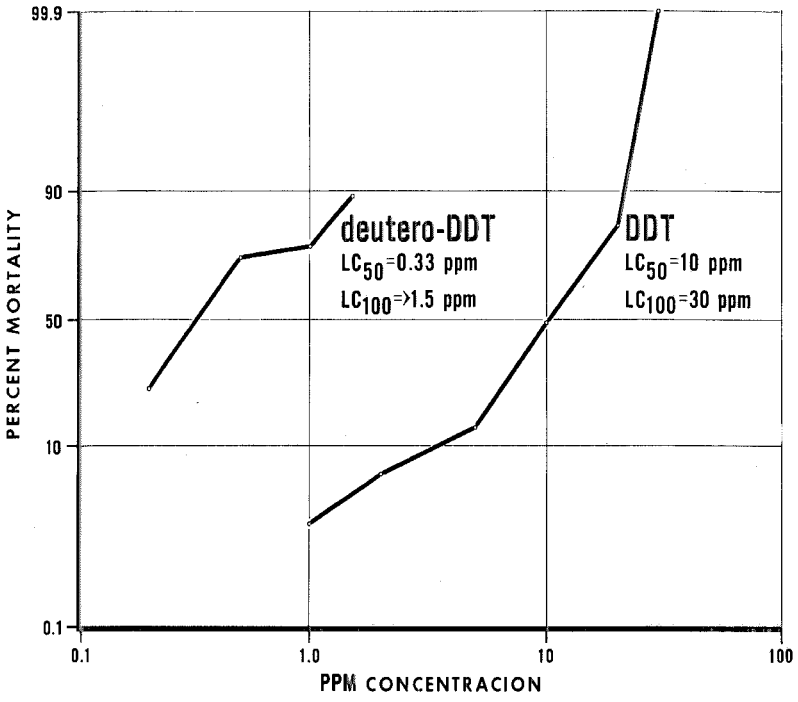


FIG. 2.—Dosage mortality regression lines of F_2 *A. aegypti* larvae from Carriacou Island, B. W. I., obtained in tests of larval susceptibility to DDT and deutero-DDT, using the WHO technique.

the LC_{100} levels, the larvae demonstrated an even higher increase in resistance from one through four days. Control pupation observed in the 96-hour fourth-instar tests however, may have contributed in part to the increased resistance. The Carriacou Island, B.W.I., F_2 strain, tested only as 96-hour fourth instar larvae, were found to be more resistant to both insecticides than the Lionel Town strain with the exception of deutero-DDT at the LC_{50} level.

These resistant Caribbean strains demonstrate a higher tolerance to deutero-DDT than several other known DDT-resistant *A. aegypti* tested by Pillai *et al.* (1963). As these strains were only two or three generations removed from the wild state, their higher tolerance to deutero-DDT may be a result of their shorter history as laboratory populations. Further laboratory and preliminary field testing of DDT-resistant Caribbean *A. aegypti* populations as larvae and adults to deutero-DDT in the *aegypti* eradication program would appear warranted in view of the substantially lowered LC values of deutero-DDT as compared with DDT.

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EVALUATION OF *AEDES AEGYPTI* LARVICIDES IN VARIOUS BREEDING CONTAINERS [1]

R. W. ZWICK [2]

INTRODUCTION. Increasingly widespread resistance of *Aedes aegypti* (L.) to insecticides formerly effective in the Caribbean area has necessitated development of bioassay methods suitable for evaluating newer compounds against larvae under field conditions. The method described in this paper was developed in order to evaluate further compounds considered promising alternatives under the World Health Organization's screening program. The methods used and provision for observations on gradual degradation or loss in toxicity to *aegypti* larvae in the several types of common breeding habitat under field conditions may prove effective in other geographical areas or against other species.

DDT and dieldrin, used in this evaluation, are insecticides to which most Jamaican populations of *aegypti* tested recently have been found to be resistant (Zwick, 1962–63), and were included as standards to which the other three compounds were compared. Fenthion [3] has been tested (Kellett and Gilkes, 1961) and utilized under some situations against insects of public health importance. Malathion [4] is employed against a variety of household and agricultural pests and carbaryl [5] is currently used principally as an agricultural insecticide but has been evaluated by Schoof *et al.* (1962) against adult mosquito species.

MATERIALS AND METHODS. The five compounds selected for testing were in the form of water dispersible powders and were procured from commercial sources. The percentages actual active ingredient of each insecticide were as follows:

DDT—50%
dieldrin—50%
fenthion—40%
malathion—25%
carbaryl—80%

The insecticides were suspended in a minimal amount of water and added to tap water to give a concentration of 10 p.p.m. of the technical compound in all 35 test containers.

Containers utilized, one set of seven per insecticide, included easily procurable types commonly encountered as breeding foci by PASB *aegypti* eradication field personnel in the Caribbean area. These consisted of the following container types with the amounts [6] of tap water added to each:

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[3] o,o-dimethyl o-[4-(methylthio)-*m*-tolyl] phosphorothioate.

[4] S-[1,2-bis (ethoxycarbonyl) ethyl] o,o-dimethyl phosphorodithioate.

[5] (Sevin) 1-napthyl methylcarbamate.

[6] United States gallons employed throughout.