

SUSCEPTIBILITY OF *Aedes Aegypti* (L.) FROM FLORIDA AND TEXAS TO DDT, DIELDRIN AND MALATHION¹

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Since the establishment (1963) of a program for the eradication of *Aedes aegypti* (L.) from the continental United States, Puerto Rico, and the Virgin Islands by the Communicable Disease Center, baseline data on susceptibility to DDT, dieldrin, and malathion have been required for the various areas. The Pan American Sanitary Bureau originally found *A. aegypti* in the Caribbean area to be DDT susceptible; but in subsequent years this species in several areas was found to be definitely DDT resistant and often dieldrin resistant (Kerr *et al.*, 1964). In later studies larvae and adults of 17 strains of *A. aegypti* from Puerto Rico (with one exception) and the Virgin Islands showed lesser susceptibility to DDT and dieldrin than did a susceptible CD strain (Flynn *et al.*, 1964). Strains from St. Thomas and St. Croix were highly resistant to DDT and dieldrin. Both larvae and adults of all strains were susceptible to malathion. Resistance of *A. aegypti* to DDT, dieldrin, or other chlorinated hydrocarbons has been reported in Puerto Rico and Florida (Evans *et al.*, 1960; Fox *et al.*, 1960; Fox, 1961; Porter *et al.*, 1961). The following report gives the results of tests to determine baseline susceptibility levels to DDT, dieldrin, and malathion of larvae and adults of *A. aegypti* from seven locations in Florida and eight in Texas.

METHODS. During June through December 1964, larvae collected from the various locations in Florida and Texas by personnel of the *Aedes aegypti* Eradication Branch were used to establish temporary colonies at the different locations. Eggs from these colonies were shipped to Savan-

nah, Georgia, to provide larvae and adults for test purposes.

Susceptibility to DDT, dieldrin, and malathion was measured by the standard procedures established by the World Health Organization (Anon., 1960). Each test was replicated three or four times at each concentration of insecticide used. Twenty-five larvae or female adults were exposed in each replication. Specimens of a susceptible strain (CD) were included as a check in each test together with untreated checks of each field strain. The Florida strains were from Bradenton, Ft. Lauderdale, Key West, Miami, St. Petersburg, Tampa, and West Palm Beach; the Texas strains from Austin, Dallas, Ft. Worth, Houston, Laredo, Marshall, San Antonio, and Waco.

RESULTS. Response to DDT. Data on the larvae from the seven localities in Florida (Table 1) indicate apparent resistance to DDT when compared to the susceptible CD strain at the 0.02- and 0.1-p.p.m. level. However, at the 0.5-p.p.m. dosage, 98- to 100-percent mortality of all strains was obtained; consequently, the significance of those lowered responses is questionable. In the adult tests against DDT (Table 1), there was a marked lack of response to DDT in all seven Florida strains. At the 4-percent level the field strains had kills of 14 percent or less, whereas an 80-percent kill of the susceptible strain was obtained.

The Texas strains gave responses to DDT that were similar to those of the susceptible (CD) strain except for the larvae from Laredo (Table 1). Although the Laredo strain showed low kills at 0.02 and 0.1 p.p.m., 0.5 p.p.m. produced 100-percent mortality. Adults of two of the eight strains (San Antonio and Waco) tested against DDT gave low kills (30 and 53 percent), but the remainder were equal to or more susceptible to DDT than the CD

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TABLE 1.—Comparative susceptibility to DDT of 15 strains of *Aedes aegypti* (L.) from Florida and Texas.

Strain	No. of tests	Percent mortality				
		Larvae (p.p.m.)			Adults (%)	
		0.02	0.1	0.5	2.0	4.0
Florida						
Bradenton	1	0	35	100	1	3
Ft. Lauderdale	3	1	42	99	<1	6
Key West	2	2	34	100	<1	11
Miami	1	1	60	100	1	0
St. Petersburg	3	12	79	99	2	14
Tampa	4	11	73	98	<1	9
West Palm Beach	1	15	63	100	0	4
Susceptible (CD)	15	63	97	100	40	80
Texas						
Austin	3	92	99	100	10	79
Dallas	1	75	100	100	86	100
Ft. Worth	2	75	100	100	17	95
Houston	2	97	100	100	12	84
Laredo	1	31	65	100	75	100
Marshall	2	78	100	100	15	85
San Antonio	7	42	92	100	7	30
Waco	2	95	100	100	6	53
Susceptible (CD)	16	71	93	100	16	80

TABLE 2.—Comparative susceptibility to dieldrin of 15 strains of *Aedes aegypti* (L.) from Florida and Texas.

Strain	No. of tests	Percent mortality						
		Larvae (p.p.m.)			Adults (%)			
		0.02	0.1	0.5	0.4	0.8	1.6	4.0
Florida								
Bradenton	1	0	35	100	38	99	100	100
Ft. Lauderdale	3	1	42	99	11	74	88	77
Key West	2	2	34	100	13	98	100	100
Miami	1	1	60	100	4	37	37	47
St. Petersburg	3	12	79	99	12	95	100	100
Tampa	4	11	73	98	24	89	100	100
West Palm Beach	1	15	63	100	5	95	98	97
Susceptible (CD)	15	63	97	100	37	95	99+	100
Texas								
Austin	3	93	93	98	18	93	92	90
Dallas	1	96	100	100	12	97	99	100
Ft. Worth	2	78	100	100	27	97	100	100
Houston	2	94	100	..	20	84	93	95
Laredo	1	64	91	100	18	85	94	92
Marshall	2	69	76	91	11	44	67	75
San Antonio	7	23	43	73	12	17	19	18
Waco	2	93	96	100	53	98	94	92
Susceptible (CD)	16	99	99+	100	26	98	100	100

strain. Since seven tests were made with the adults from San Antonio, the low kill indicates a definite resistance.

Response to Dieldrin. As with DDT, the Florida strains (Table 2) exhibited lowered susceptibilities to dieldrin at the 0.1-p.p.m. dosage, but at 0.5 p.p.m. these strains responded similarly to the susceptible CD strain. Resistance was apparent in the adult specimens from Miami and to a much lesser extent in those from Ft. Lauderdale. These strains showed little increase in kills when adults were exposed to paper containing 0.8, 1.6, and 4.0 percent DDT; however, the other five strains gave essentially the same results as the CD strains.

Data for the Texas strains (Table 2) indicate larval resistance to dieldrin in the Marshall and San Antonio strains at the 0.5 p.p.m., a dosage at which 91- and 73-percent mortalities were obtained, respectively. With the adults the Marshall and San Antonio strains again showed resistance to dieldrin. In addition, the absence of complete kill of the Austin, Houston, Laredo, and Waco strains exposed to 4-

percent dieldrin papers indicated that a small proportion of these strains also was resistant to dieldrin.

Response to Malathion. Data on the strains from Florida and Texas (Table 3) showed the larvae and adults of all strains to be susceptible to malathion. However, at 0.1 p.p.m. the larvae from several localities showed a lesser response to malathion than was true for the CD strain, and at 0.8 percent the same occurred with the adults, particularly with the adults from Miami and St. Petersburg, Florida. However, an increase in concentration resulted in sharp rise in kill, and at the higher levels all strains gave responses similar to the CD strains.

DISCUSSION. Data for the Florida projects indicate a resistance of the adults to residues of DDT in the seven localities as well as a lowered response of the larvae to both DDT and dieldrin. Except for the sample from Ft. Lauderdale and Miami, the adults were susceptible to dieldrin. The essentially complete mortalities coupled with the sharp increase in kill with increasing dosages of malathion indicated

TABLE 3.—Comparative susceptibility to malathion of 15 strains of *Aedes aegypti* (L.) from Florida and Texas.

Strain	No. of tests	Percent mortality					
		Larvae p.p.m.			Adults (%)		
		0.02	0.1	0.5	0.8	1.6	3.2
Florida							
Bradenton	1	0	7	100	66	98	100
Ft. Lauderdale	3	11	15	98	50	97	100
Key West	2	16	29	96	39	100	100
Miami	1	0	0	87	23	99	100
St. Petersburg	3	21	35	96	22	93	100
Tampa	4	9	20	91	53	100	100
West Palm Beach	1	65	92	100	85	100	100
Susceptible (CD)	15	38	75	100	68	98	100
Texas							
Austin	3	53	69	100	91	100	100
Dallas	1	41	91	100	97	100	100
Ft. Worth	2	<1	82	100	43	97	100
Houston	2	<1	66	100	75	100	100
Laredo	1	0	16	100	96	97	100
Marshall	2	0	48	100	100	100	100
San Antonio	7	12	44	98	54	100	100
Waco	2	0	95	100	63	96	100
Susceptible (CD)	16	21	74	99+	69	95	100

A. aegypti to be susceptible to this insecticide.

Data for the Texas projects indicated less resistance to DDT in *A. aegypti* larvae and adults than was true for the Florida strains. Against dieldrin, the strains from San Antonio displayed the highest level of resistance of all strains tested. All Texas strains were susceptible to malathion.

Tests for physiological resistance are designed to measure the response of the insects to an insecticide and to enable the worker to detect any changes that may occur in this response either in time or in regard to standard susceptible strains. Such tests measure changes in response to a fixed dosage and exposure time but cannot be considered an indicator as to whether or not the compound is effective under field conditions. This fact is obvious from the larval data for all three chemicals whereby it is shown that at certain concentrations (e.g., 0.1 p.p.m.) there is a difference in kill between the field and CD strains, yet in most instances the next higher concentration produces essentially complete mortalities of all strains. Since in the field the amount of applied residue exceeds that on the test paper, and time of exposure may well exceed that of the evaluation techniques (1 hr. for adults, 24 hr. for larvae), a strain may exhibit a change in response to a chemical and yet be susceptible to control efforts in the fields. Obviously, the response of insects may decline to such an extent that field control is influenced. In St. Thomas, Virgin Islands, where the strain displayed 12-percent larval kill at 2.5 p.p.m. of DDT and 2-percent kill on 4-percent DDT paper, field dosages of 50 p.p.m. of DDT were found to be ineffective.

The data reported show that in areas of Florida and Texas (San Antonio and Waco) the species has a lowered response, and in some instances resistance to DDT. Under continued selection with field treat-

ments of DDT the response of these populations can be expected to decline further until eventually field usage of this toxicant will be impractical. The current data must be considered as an alert to operational personnel at these projects to maintain critical observations on the effectiveness of the field application and to conduct periodic tests on the response of the mosquito population to the chemical in use.

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