RESISTANCE OF *CULEX QUINQUEFASCIATUS* TO CHLORINATED HYDROCARBONS ON OKINAWA

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It is known that long and intensive use of chlorinated hydrocarbon insecticides may cause the development of resistant strains of insects. Okinawa, a relatively small island where these insecticides have been used for several years, is a place where such resistance would be expected to develop. DDT was first used on the island during World War II, when it was widely dispersed by airplanes and ground control groups. Extensive application of this insecticide was continued by various organizations after the war. In July, 1947, a permanent insect control program was established on military installations and in an area one mile wide around the perimeter of these units. This program, with necessary changes and improvements, is still in effect. DDT is used as a residual house spray for adult mosquitoes and continues to be the primary insecticide used in larval control. The Government of the Ryukyu Islands undertakes mosquito control measures in all areas not protected by the military program. This agency used DDT from 1947 through 1952, and both DDT and chlordane from 1953 until the present.

The first evidence of resistance sufficient to affect mosquito control on Okinawa was observed by field workers in 1954. Preliminary laboratory tests conducted early in 1955 suggested that the larvae of *Culex quinquefasciatus* had become resistant to DDT and chlordane. The experiments cited below were made during the winter of 1955–1956 to ascertain the degree of resistance of *Culex quinquefasciatus* to

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these insecticides and to dieldrin, lindane and malathion.

METHODS. Late third and early fourth instar larvae were collected for testing from ditches, streams and temporary pools at Awase and Naha in southern Okinawa. The larvae were then held over-night to allow injured specimens, or those that might have had recent exposure to insecticides, to die before testing. Ten larvae were placed in each of three petri dishes, making a total of thirty larvae for each concentration of insecticide. Ten additional larvae were placed in a petri dish with distilled water and used as a control for each concentration. The larvae were held in the insecticide for forty-eight hours, at which time those individuals which had pupated were discarded and all dead and moribund larvae were counted.

The figures shown in Table 1 are averages of three to five replicates. The Reed-Muench method was used to obtain the LD 50s shown in Table 2.

No non-resistant strains were available for comparison, but according to other reported resistance (see references), this species is extremely resistant to DDT and chlordane. There is also considerable resistance to the other chlorinated hydrocarbon insecticides tested.

TABLE 2.—LD 50 estimates of the five insecticides tested against *Culex quinquefasciatus*.

Insecticide	No. of Tests	LD 50 Range in p.p.m.		Geometric LD 50 Mean
DDT	3	.2	.8	.6
Chlordane	3	.9	1.7	1.2
Dieldrin	5	.08	.5	.2
Lindane	3	.08	.5	.2
Malathion	4	.003	.03	.01

SUMMARY. Inability to control *Culex quinquefasciatus* larvae on Okinawa with DDT and chlordane prompted initiation of a series of tests with these insecticides as well as dieldrin, lindane and malathion. Results of these tests indicate that this mosquito is extremely resistant to the chlorinated hydrocarbon insecticides and that it has little or no resistance to malathion.

TABLE 1.—Toxicity of five insecticides to larvae of *Culex quinquefasciatus*.

	Percent Mortality in 48 Hours				
P.P.M.	DDT	Chlordane	Dieldrin	Lindane	Malathion
2.0	96.6	66.4	100	100	100
1.0	59.9	33.7	94.5	97.7	100
.5	48.3	8.8	72.0	83.2	100
.1	0.0	4.4	25.4	26.7	100
.05	0.0	4.4	6.98	8.8	100
.025	....	....	....	....	64.12
.01	....	....	....	....	53.85
.005	....	....	....	....	51.0
.0025	....	....	....	....	35.5
.001	....	....	....	....	0.0

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