

STUDIES OF MOSQUITO RESISTANCE TO INSECTICIDES AT SOME NAVAL ACTIVITIES¹

LT. JOSEPH G. McWILLIAMS, MSC, USNR

AND

B. L. MUNN, HMC, USN

U. S. Navy Disease Vector Control Center, U. S. Naval Air Station, Jacksonville 12, Florida
U. S. Naval Station, San Juan, Puerto Rico

GENERAL INFORMATION. Two members of the U. S. Navy Disease Vector Control Center arrived at the U. S. Naval Station, San Juan, Puerto Rico, on 6 September 1955 for the purpose of conducting studies on reported resistance to DDT of the southern house mosquito, *Culex quinquefasciatus*. This study was requested by the Commandant, Tenth Naval District.

The resistance tests conducted by members of this Center were purposely limited to mosquito larvae. Because of the limited time and facilities no attempt was made to approach the problem through study of adult populations. It is pointed out, however, that the finding of true physiological (genetical) resistance in immature stages ordinarily implies, *per se*, resistance in the adult population since this character or factor or the capacity therefor is passed through succeeding generations.

TESTING TECHNIQUE. The technique used for the determination of insecticide resistance in mosquito larvae in this investigation was the technique established by the U. S. Department of Agriculture, Agricultural Research Service, Entomology Research Branch, Orlando, Florida.

FINDINGS. Table i gives the results of tests conducted on larvae collected in the San Juan, Puerto Rico, area.

The tests are to be considered as preliminary in nature; nevertheless the results are highly indicative of true resistance in the populations tested. In several of the

tests the 48-hour mortality was very high in the control group. Where possible, these tests were repeated. Several tests could not be repeated for one of two reasons: either an insufficient number of larvae were available from the same location, or time did not permit returning to outlying areas to collect additional larvae.

The results of these tests strongly indicate the presence of resistance to DDT in the *C. quinquefasciatus* populations tested.

One test made with dieldrin indicates the *C. quinquefasciatus* strain tested may also be resistant to this insecticide. This is entirely possible in view of the fact that larvae have been repeatedly and extensively exposed to this material as the Insular Health Department was using dieldrin as a larvicide in the mosquito control program throughout the San Juan area.

It was recommended that the Navy's civilian entomologist conduct additional confirmatory larval tests on *Culex quinquefasciatus* using the same insecticides and techniques.

CONCLUSIONS. These tests establish strong positive presumptive evidence of the presence of DDT resistance in most *C. quinquefasciatus* larval populations encountered. This resistance is probably passed on to the adult stage and so to succeeding generations. Field observations by personnel of the mosquito control program of the Puerto Rico Insular Health Department and the U. S. Public Health Service have led them to believe that *C. quinquefasciatus* adults have been resistant to DDT for several years. The 1951-1952 annual report of the Insular Health Department stated that *C. quinquefasciatus* was resistant to DDT. To our knowl-

¹The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

TABLE 1.—Toxicity of acetone suspensions of some chlorinated hydrocarbon insecticides to fourth instar mosquito larvae.

Location	Total Replicates	Concentrations PPM	Corrected Percent 48-hr. Mortality	USDA Standard Non-resistant Strain	USDA Standard Resistant Strain
U. S. Naval Station,* San Juan, Puerto Rico	2	0.05	25.8	—	—
		0.025	17.9	86-100	—
		0.01	11.1	62-100	—
San Patricio* (Housing) Puerto Rico	2	0.1	48.2	—	—
		0.05	53.8	—	—
		0.025	48.2	86-100	—
		0.01	58.5	62-100	—
Martin Pena* U. S. Navy Radio Factory	1	0.1	12.0	—	—
		0.05	12.0	—	—
		0.025	16.0	86-100	—
		0.01	16.0	62-100	—
Santurce* Puerto Rico	3	0.1	56.4	—	—
		0.05	41.6	—	—
		0.025	36.5	86-100	—
		0.01	17.9	62-100	—
Key West and environs**	7	0.1	42.0	—	66-100
		0.05	18.0	82-100	39-84
		0.025	30.0	68-100	68-100
		0.01	30.0	51-100	0-60
Key West and environs***	3	0.025	7.0	88-100	48-100
		0.01	28.0	84-100	44-87
		0.005	34.0	36-100	16-66
Key West and environs****	4	0.025	36.0	98-100	80-100
		0.01	15.0	82-100	36-100
		0.005	15.0	56-100	16-96

* Tests with DDT against *Culex quinquefasciatus* fourth instar larvae.

** Tests with DDT against salt marsh *Aedes* spp. fourth instar larvae.

*** Tests with lindane against salt marsh *Aedes* spp. fourth instar larvae.

**** Tests with dieldrin against salt marsh *Aedes* spp. fourth instar larvae.

edge this statement was not substantiated by laboratory or field data.

U. S. NAVAL BASE, KEY WEST, FLORIDA

GENERAL INFORMATION. A field party consisting of a medical entomologist and one environmental sanitation technician from this Center arrived at the U. S. Naval Base, Key West, Florida on 26 September 1956 for the purpose of investigating resistance in salt-marsh mosquitoes, *Aedes* spp., to the chlorinated hydrocarbon insecticides which had been used for control operations in that area over a period of several years.

The manager of the Monroe County Mosquito Abatement District was contacted and the resistance problem was discussed with him. No studies of this nature had been attempted by that organization. Preliminary information on the effect of certain insecticides applied as aerosols on adult salt-marsh mosquitoes of the Key West area has been reported by Warner.¹ Resistance has previously been

¹ Warner, W. M. 1956. A preliminary report on the chemical control of the salt-marsh *Aedes* with thermal aerosol apparatus on the Florida Keys. Rpt. of the 27th Ann. Mtg. Fla. Anti-Mosq. Assoc. pp. 126-39.

reported in salt-marsh mosquitoes from certain localities in Florida.²

The resistance tests conducted by personnel of this Center were purposely limited to mosquito larvae. Because of the limited time and facilities no attempt was made to approach the problem through study of adult populations.

TESTING TECHNIQUE. The testing technique used was the same as previously described. Field collected, fourth instar *Aedes* salt-marsh mosquito larvae were used throughout. No effort was made to identify and differentiate between the *Aedes sollicitans* and *Aedes taeniorhynchus* due to the fact that the standards were established not for the individual species but rather for the salt-marsh *Aedes* group as a whole.

FINDINGS. Table I summarizes the results of tests conducted with larvae collected in the Key West Navy area. Extensive, careful field surveys on Key West, Boca Chica Key, Geiger Key, Big Coppitt Key and Stock Island revealed only three locations with larvae in sufficient numbers for tests. Two factors may explain this. A period of heavy rains had occurred prior to the field party's arrival and these continued during the first three days of the visit. High tides had also inundated a number of areas not ordinarily affected by normal tides.

² Public Health pesticides, 1956 report from the Communicable Disease Center, Public Health Service, U. S. Department of Health, Education and Welfare. Pest Control 24(3):9-10 et seq.

Although the results of these tests were considered as preliminary in nature, they were nevertheless highly indicative of true insecticide resistance in the populations tested.

In one location the number of larvae collected was sufficient to make three replications each with DDT, dieldrin and lindane. In a second location enough larvae were collected for three tests with DDT and one with dieldrin. The results of all tests indicate that the salt-marsh *Aedes* populations encountered are significantly resistant to this group of chlorinated hydrocarbon insecticides. This is entirely possible in view of the fact that either DDT, BHC or dieldrin have been used repeatedly and extensively in all the areas in question for adult and larval control operations over a period of at least eight years. During the 1956 season no synthetic insecticides had been used in larval control operations. Diesel fuel oil had been used for this purpose.

Additional confirmatory tests were to be made by Medical Department personnel assigned to the Base Sanitation Office with the insecticides DDT, dieldrin and lindane (and possibly others) using the same techniques.

CONCLUSIONS. The tests reported here establish strong positive presumptive evidence of the presence of resistance to the chlorinated hydrocarbon insecticides by salt-marsh *Aedes* in the Key West navy area. This resistance is probably passed on to the adult stage and so to succeeding generations.

ILLINOIS MOSQUITO CONTROL ASSOCIATION

EXECUTIVE COMMITTEE

President

WM. J. BUCHANAN
So. Cook County
Mosq. Abate. Dist.
Harvey

Vice-President

ROY McGEE
Carbondale Mosq.
Abate. Dist.
Carbondale

Past-President

RALPH K. GIBSON
Cairo Mosq.
Abate. Dist.
Cairo

Member

R. E. FAVREAU
Illinois Dept. of
Public Health
Carbondale

Member

CHARLES F. SCHEEL
DesPlaines Valley
Mosq. Abate. Dist.
Lyons

Secretary-Treas.

OSCAR V. LOPP
So. Cook County
Mosq. Abate. Dist.
Box 30
Harvey, Illinois