

## DEVELOPMENT OF ORGANOPHOSPHATE TOLERANCE IN FIELD POPULATIONS OF *CULEX PIPIENS QUINQUEFASCIATUS* SAY IN LOUISIANA<sup>1</sup>

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**ABSTRACT.** In a 5-year study, *Culex pipiens quinquefasciatus* Say larvae from 2 Louisiana Mosquito Control Districts (MCD) developed varying degrees of tolerance to chlorpyrifos, malathion and naled. Larvae collected in the Jefferson Parish Mosquito Control District exhibited an approximate 2x decrease in susceptibility to the 3 compounds in 1975 when compared to base lines established in 1970. Larvae collected from septic

ditches in the St. Tammany Parish Mosquito Control District were approximately 25x less susceptible to naled in 1975 when compared to data obtained in 1970 (LC<sub>50</sub> data). Susceptibility to malathion and chlorpyrifos decreased 10x and 5x, respectively, during the 5-year period. There was no evidence of increased tolerance to these chemicals in larval populations collected in the Orleans Parish MCD.

The importance of the southern house mosquito, *Culex pipiens quinquefasciatus* Say, as a vector of the St. Louis strain of encephalitis (Chamberlain et al. 1959) and the dog heartworm, *Dirofilaria immitis* (Leidy) (Villavaso and Steelman 1970) necessitated the development of larvicide programs by Louisiana mosquito control districts. Effective and economical control of *C. p. quinquefasciatus* has been achieved by the application of various organophosphate insecticides to the larval habitat.

The value of establishing dosage-mortality data on mosquito species that are currently being controlled by larvicidal treatments has been established (Boike and Rathburn 1968, 1969, 1972 and 1975; Mount et al. 1971 and 1974; and Seawright and Mount 1975). These reports indicated that certain populations of *Aedes taeniorhynchus* (Wiedemann) had developed resistance to malathion in Florida along most of the east coast, the lower half of the west coast, and in the Florida Keys.

In 1970, The Louisiana Mosquito Control Association Board of Directors established a grant-in-aid with the Department of Entomology at Louisiana State University to determine the susceptibility of

natural populations of mosquito larvae to various insecticides. Mosquito larvae from various Louisiana mosquito control districts (MCD) have been tested annually since 1970 to determine possible development of resistance that might occur as a result of insecticide application programs in the abatement districts.

**METHODS AND MATERIALS.** Mosquito larvae were collected in Jefferson, Orleans, St. Bernard and St. Tammany Parish Mosquito Control Districts (MCD), and transported to the laboratory in essentially the same manner as described by Craven and Steelman (1968). All larvae were collected for susceptibility tests prior to insecticide treatment. Mortality of *C. p. quinquefasciatus* larvae to the selected test insecticides was determined by the procedure described by the World Health Organization (1963) except that emulsifiable concentrate formulations of the insecticides were used. The desired concentrations were obtained by serial dilutions of the emulsifiable concentrates with deionized water.

Since chlorpyrifos is a frequently used larvicide to control *C. p. quinquefasciatus* breeding in septic ditches in Louisiana and either malathion or naled is used as an adulticide, these three insecticides were selected for the dosage-mortality tests. Dosage-mortality data were determined at least 6 times per year for the Jefferson and St.

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Tammany Parish MCD's and the average LC<sub>50</sub> and LC<sub>90</sub> for the year calculated. Dosage-mortality data were determined in 1971 for St. Bernard MCD and in 1971, 1972, and 1975 in the Orleans Parish MCD.

**RESULTS AND DISCUSSION.** The lethal concentrations (in ppm) for *C. p. quinquefasciatus* larvae collected from the MCD's and tested against chlorpyrifos, malathion and naled are shown in Table 1. These data indicate that little if any variation had occurred in the susceptibility of *C. p. quinquefasciatus* larvae collected in Orleans MCD over the 5-year period. However, it should be noted that only limited data have been available from the Orleans Parish MCD. No comparative data were obtained for the St. Bernard Parish MCD.

A slight change in the susceptibility of the larvae collected in Jefferson Parish to chlorpyrifos, malathion and naled was observed in the dosage-mortality tests over the 5-year period. The LC<sub>50</sub> and LC<sub>90</sub> in

1975 of chlorpyrifos were about 2x times higher than the values recorded in 1970. Similarly, a 2x increase had occurred in the LC<sub>50</sub> of naled and malathion during the 5-year period.

Larvae from the St. Tammany MCD showed a 10x decrease in susceptibility to malathion between 1972 and 1973 in both the LC<sub>50</sub> and LC<sub>90</sub> values. This decrease in susceptibility to malathion continued through 1974 and in 1975 there was a greater than 100x decrease in susceptibility as shown by the LC<sub>50</sub> value and greater than 250x increase in the LC<sub>90</sub> value. The larvae were approximately 20x (LC<sub>50</sub>) and 50x (LC<sub>90</sub>) less susceptible to naled in 1975 as compared to the data obtained in 1970. A decrease in susceptibility of *C. p. quinquefasciatus* larvae to chlorpyrifos was detected in 1974. These data indicate that a 15x decrease in susceptibility occurred between 1974 and 1975 in the LC<sub>90</sub> value and approximately 4x in the LC<sub>50</sub> value.

Mosquito control activities were initiated

Table 1. Susceptibility of *Culex pipiens quinquefasciatus* Say larvae from Jefferson, Orleans, St. Bernard and St. Tammany Parish Mosquito Control Districts, Louisiana, to chlorpyrifos, malathion and naled, 1970-75.

Year	Lethal Concentration (ppm) LC <sub>50</sub> /LC <sub>90</sub>		
	Chlorpyrifos	Malathion	Naled
Jefferson MCD			
1970	.00024/.00090	.0760/0.710	.015/0.740
1971	.00020/.00050	.0600/0.110	.010/0.710
1972	.00010/.00060	.0220/0.105	-
1973	.00005/.00030	.0420/0.150	-
1974	.00050/.00300	.1630/0.671	.050/0.211
1975	.00037/.00170	.1400/0.650	.036/0.135
Orleans MCD			
1971	.00013/.00032	.0430/0.123	.021/0.074
1972	.00006/.00031	.0050/0.121	.024/0.135
1975	.00004/.00020	.0190/0.020	.020/0.180
St. Bernard MCD			
1971	.0001/.00026	.0380/0.190	.011/0.056
St. Tammany MCD			
1970	.00030/.00040	.0220/0.081	.009/0.026
1971	.00007/.00034	.0016/0.014	-
1972	.00014/.00050	.0040/0.014	-
1973	.00008/.00020	.0450/0.140	-
1974	.00037/.00340	.3980/1.624	.176/1.396
1975	.00150/.01700	.6100/3.825	.225/1.610

in 1965 by the Jefferson Parish MCD and in 1968 by the St. Tammany MCD. Chlorpyrifos has been utilized by both of these mosquito control districts as a larvicide treatment for the control of *C. p. quinquefasciatus* breeding in septic ditches. Either malathion or naled applied by ULV ground equipment has been used as an adulticide by these 2 mosquito control districts. In addition to the adult control obtained by the ULV ground application units, a certain amount of larval mortality could have occurred as a result of larger aerosol particles falling into the open septic ditches as the adulticide equipment moved along the adjacent roadways. Coombes et al. (1973) reported that ULV application of technical (95%) malathion with ground equipment at a rate of 35 ml/hectare caused 94% mortality to *Psorophora columbiae* (Dyar and Knab) larvae 15m downwind from the path of an ULV generator. Therefore, it is logical that some populations of *C. p. quinquefasciatus* larvae could have been pressured with these 3 organophosphate insecticides (chlorpyrifos, malathion and naled).

Data from this 5-year study indicate that the application of chlorpyrifos as a larvicide and malathion and naled as adulticides have resulted in the development of tolerance to these three organophosphate insecticides in 2 Louisiana Mosquito Control Districts. These insecticides applied according to the labeled rates are currently providing effective control of *C. p. quinquefasciatus* populations in the Louisiana MCD's.

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