PN-AAE-342

[Reprinted from MOSQUITO NEWS, Vol. 25, No. 2, June, 1965]

REPRINT NUMBER

54

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DDT AND DIELDRIN RESISTANCE IN *ANOPHELES QUADRIMACULATUS* FROM HARTWELL AND CLARK HILL RESERVOIRS, GEORGIA

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Resistance to DDT was demonstrated in *Anopheles quadrimaculatus* collected from Clark Hill Reservoir near Augusta, Georgia, in 1959 (Mathis *et al.*, 1960). After this detection, DDT as an aerial larvicide treatment (0.08 to 0.20 pound DDT per acre) on selected areas was replaced by a malathion-lethane application (0.1 lb. of malathion/acre). Such treatment during the 1960–1962 period was effective in controlling *A. quadrimaculatus*.

At Hartwell, a reservoir located approximately 25 miles north of Clark Hill Reservoir on the same river, the first DDT larvicidal treatments were made in 1961. Based on adult counts in designated stations, satisfactory control was obtained with these treatments both in 1961 and 1962. However, in August 1962, susceptibility tests of adults collected at Hartwell Reservoir indicated resistance to DDT and to dieldrin.

All susceptibility tests were made with the World Health Organization procedures (1960). Data are presented for (1) field-collected females from both reservoirs; (2) colonized strains from each reservoir; and (3) a colonized strain from

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Hartwell Reservoir after selection with DDT residues. Initial tests with the field-collected Hartwell adults in 1962 were in August. Progeny from the colonized strains were tested in November 1962, and specimens from the DDT-selected Hartwell were tested in March 1963.

Table 1 gives results obtained with the exposure to DDT of field-collected females from Clark Hill and Hartwell Reservoirs and from the colonized strains from each location. In 1959 the field-collected females from Clark Hill Reservoir showed a high degree of DDT resistance. Little, if any, DDT resistance was apparent in the 1962 specimens from that reservoir. In the field-collected females from Hartwell Reservoir, the level of DDT resistance was almost equal to that obtained in the 1959 tests with specimens from the Clark Hill Reservoir. However, after the Hartwell strain was colonized, it was equally as susceptible to DDT as the Savannah laboratory colony.

Table 2 shows the responses of field-collected and laboratory-reared females from each reservoir to dieldrin. Susceptibility levels for the field-collected females from Clark Hill Reservoir in 1959 and 1962 were similar, thus indicating that dieldrin resistance apparently was not affected by the cessation of DDT larvicidal treatments. Essentially the same degree of dieldrin resistance was found with specimens from Hartwell Reservoir as with those from Clark Hill. However, after being colonized, each strain lost most of the resistance to dieldrin.

The occurrence of dieldrin resistance in *A. quadrimaculatus* was unexpected at either reservoir since dieldrin or closely related compounds have never been used for mosquito control therein. Related compounds such as BHC and aldrin are used in agricultural practices, so run-off from the watershed may be a factor involved in the dieldrin resistance in the anopheline populations at these reservoirs. Presumably these agricultural pesticides

TABLE 1.—Percent mortality of 3-day-old female *Anopheles quadrimaculatus* after 60-minute exposure to various concentrations of DDT.[1]

Percent DDT Risella oil	Clark Hill Strain			Hartwell Strain	
	Field Collected 1959	Field Collected 1962	Colony 1962	Field Collected 1962	Colony 1962
1.0	0(82) [2]	18(130)	4(185)	3(74)	3(78)
2.0	1(84)	39(122)	25(187)	[illegible](75)	26(84)
4.0	0(82)	73(128)	86(180)	17(75)	98(80)

[1] 1, 33, and 93 percent mortality with Savannah laboratory strain with 1.0, 2.0, and 4.0 percent papers.
[2] Numbers of individuals tested are shown in parentheses.

TABLE 2.—Percent mortality of 3-day-old female *Anopheles quadrimaculatus* after 60-minute exposure to various concentrations of dieldrin.[1]

Percent dieldrin Risella oil	Clark Hill Strain			Hartwell Strain	
	Field Collected 1959	Field Collected 1962	Lab. Colony 1962	Field Collected 1962	Lab. Colony 1962
0.4	28(74) [2]	20(75)	13(95)	29(76)	4(46)
0.8	31(81)	26(77)	92(87)	38(77)	73(52)
1.6	36(80)	46(127)	99(108)	22(77)	79(72)

[1] 1, 66, and 94 percent mortality with Savannah laboratory strain with 0.4, 0.8, and 1.6 percent papers.
[2] Numbers of individuals tested are shown in parentheses.

exerted the necessary pressure on the mosquito population to initiate and maintain the dieldrin resistance.

As the loss of DDT resistance in the colonized Hartwell strain may not have eliminated but merely suppressed the genetic expression of resistance, the Hartwell colony was placed under DDT selection. Exposure to DDT was obtained by the insertion of a plywood panel (12" x 20") treated with DDT (25 mg./sq.ft.) in the colony cage (20" x 18" x 23"). The effect of this selection is shown by the results in Table 3 which indicate that the resistance to DDT was restored in the F-2 and F-4 generations to a level essentially equal to that of the field-collected specimens (Table 1).

TABLE 3. Percent mortality of 3-day-old female *Anopheles quadrimaculatus* from DDT-selected colony, 60-minute exposure to DDT-impregnated papers

Percent DDT Risella oil	Hartwell Strain % Mortality at Generation F-1	F-2	F-4
1.0	5(98) [1]	0(102)	1(96)
2.0	8(99)	2(100)	0(99)
4.0	27(103)	12(106)	5(92)

[1] Number of individuals tested are shown in parentheses.

Of particular interest is the fact that the F-2 adults exposed to dieldrin-treated papers had kills of only 0, 13, and 11 percent at concentrations of 0.4, 0.8, and 1.6 percent dieldrin, respectively. These data indicate that with the Hartwell strain of *A. quadrimaculatus* the resistance to dieldrin can be re-established by selection with DDT. On this basis, it could be assumed that loss of resistance to DDT in either strain would be coupled with a loss of dieldrin resistance. However, at Clark Hill Reservoir (Tables 1 and 2), such a parallel loss of resistance did not occur. Since the population at Clark Hill Reservoir was under exposure to malathion-lethane treatment in the period 1960–62, it is possible that such applications exerted an effect on the susceptibility of the mosquito to dieldrin but not to DDT. It also is conceivable that the populations at the two reservoirs are not identical from a genetic standpoint.

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