

## FIELD TESTS WITH FOUR PHOSPHORUS INSECTICIDES AGAINST SALT-MARSH MOSQUITOES IN FLORIDA

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DDT resistance in salt-marsh mosquitoes, *Aedes taeniorhynchus* (Wied) and *A. sollicitans* (Wlkr.), in Florida was first reported by Deonier *et al.* (1950). By the summer of 1955 DDT, BHC, and dieldrin were giving unsatisfactory control in the same districts that originally reported the failure of DDT. In the fall of 1955 Gahan *et al.* (1956) obtained excellent control of adults with malathion and of larvae with Bayer 21/199 in these areas.

The experiments herein reported were conducted in 1956 to evaluate aerial applications of four organic phosphorus compounds against salt-marsh mosquitoes. Malathion, Chlorthion, and Dipterex were tested as sprays against adults. These three materials and Bayer 21/199 were evaluated as larvicides applied in fuel oil solutions and attapulgitic granules.

**TESTS AGAINST ADULTS.** Four of the plots treated for adult control were located in Pinellas County, two were in Indian River County, and 19 in Brevard County. The Pinellas plots each comprised 50 acres of salt marsh with mangrove and buttonwood coverage. The Indian River plots each included 170 acres of wooded area where trees and undergrowth formed a canopy. The Brevard plots, which varied in size from 50 to 100 acres, consisted of seven marshes covered with pickleweed and salt-marsh Bermuda grass and twelve

100-acre sections of citrus groves. The cover was more dense in the mangrove marshes and wooded areas than in the citrus groves. *Aedes sollicitans* was the predominant species in the open marshes but *A. taeniorhynchus* predominated in all other tests.

The malathion was used in a fuel oil solution, Dipterex in a water solution, and Chlorthion was dissolved in an auxiliary solvent, cyclohexanone, at a ratio of 1:4, and then mixed with fuel oil.

All sprays were dispersed at 3 or 4 quarts per acre from airplanes. The Pinellas plots were sprayed with a Piper Cub flying 45-foot swaths at 50 m.p.h. and an altitude of 50 feet. The Indian River and Brevard plots were treated with a Stearman plane. In the Indian River tests the pilot flew 125-foot swaths 75-100 feet high at 70 m.p.h., and in the Brevard tests 100-foot swaths 50-100 feet high at 85 m.p.h. All treatments were made between daybreak and 8 a.m. at wind velocities varying from less than 1 m.p.h. to occasional gusts up to 10 m.p.h. The flight lines were cross-wind of all test plots and marked with a flag attached to a bamboo pole.

The relative abundance of mosquitoes before and 3, 6, and 24 hours after treatment was determined from the number of mosquitoes landing per man per minute on two observers at 20 stations in each plot.

The results of these tests are shown in Table 1. The maximum reduction was usually observed after 6 hours, whereas the 24-hour counts showed the effect of infiltration from untreated areas. Since the infiltration was not uniform in all tests, only the results obtained after 6 hours will be discussed.

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TABLE 1.—Control of adult salt-marsh mosquitoes with aerial sprays of three phosphorus insecticides.

County	Terrain	Dosage (pound/ acre)	Date (1956)	Pretreat- ment Count <sup>a</sup>	Percent Reduction after—		
					3 hours	6 hours	24 hours
Malathion							
Brevard	Citrus grove	.5	Aug. 1	278	99+	100	92
		.25	2	104	72	91	63
			Oct. 4	362	99+	100	38
Pinellas	Open marsh	.25	July 13	290	..	99+	59
	Mangrove marsh	.25	8	287	..	64	54
		.1	8	183	..	70	50
Indian River Brevard	Wooded area	.1	25	80	..	23	8
	Citrus grove	.1	Oct. 24	86	86	99	78
	Open marsh	.1	Sept. 20	177	95	99+	0
			Oct. 2	466	99	93	85
Chlorthion							
Brevard	Citrus grove	.5	Aug. 1	93	85	98	74
		.25	2	161	94	99	90
			Oct. 4	455	51	82	15
			24	124	61	96	84
Pinellas	Open marsh	.25	July 13	364	..	96	61
	Mangrove marsh	.25	8	114	..	56	58
		.1	8	218	..	83	18
Indian River Brevard	Wooded area	.1	25	47	..	22	0
	Open marsh	.1	Sept. 20	488	83	74	50
			Oct. 2	294	83	94	76
Dipterex							
Brevard	Citrus grove	.5	Aug. 1	115	88	96	61
			Oct. 24	64	20	77	92
		.25	Aug. 2	87	5	63	60
			Oct. 4	470	3	25	6
			Sept. 20	270	53	53	0
			Open marsh	.1			

<sup>a</sup> Average per man per minute.

TABLE 2.—Control of salt-marsh mosquito larvae with aerial sprays of four phosphorus insecticides.

County	Dosage (pound/acre)	Date (1956)	Pretreatment Count <sup>a</sup>	Percent Reduction in 24 Hours
Malathion				
Brevard	0.25	July 13	238	99
Pinellas	.25	8	304	89
	.1	8	102	78
Chlorthion				
Brevard	.25	July 13	154	99+
Pinellas	.25	8	54	97
	.1	8	390	60
Bayer 21/199				
Brevard	.25	July 22	67	92
Dipterex				
Brevard	.25	July 22	87	93

<sup>a</sup> Average number of larvae per dip.

At dosages of 0.1 to 0.5 pound per acre malathion gave good control (more than 90 percent) in citrus groves and open marshes, and Chlorthion gave good control in these environments in five of seven tests. Neither insecticide gave good control in wooded areas or mangrove marshes. Dipterex at 0.5 pound per acre gave good control only in one of two tests in citrus groves.

**TESTS WITH OIL SPRAYS AGAINST LARVAE.** Tests were conducted on 25- to 60-acre salt marshes to compare malathion, Chlorthion, Bayer 21/199, and Dipterex in oil sprays against mixed populations of fourth-instar salt-marsh mosquito larvae. These test areas were in Brevard and Pinellas Counties. Applications were made with the same airplanes and at the same rate of dispersal as in the tests against adults.

Fuel oil was used as the solvent and carrier, but Chlorthion and Bayer 21/199 were first dissolved in trichloroethylene at ratios of 1:5 and 1:9, respectively, and Dipterex in cyclohexanone at 1:4.

The effectiveness of the treatments was determined by comparing the number of larvae collected in 50 dips the day before and 24 hours following treatment. Aerial applications of oil sprays frequently fail to give satisfactory control of salt-marsh mosquito larvae, owing to the loss of spray through impingement on vegetation. For this reason only the open portions of the treated marshes were inspected.

Results of these tests are presented in Table 2. All four larvicides gave good control at 0.25 pound per acre. Malathion and Chlorthion were not effective at 0.1 pound.

**TESTS WITH GRANULES AGAINST LARVAE.** Tests with granules were conducted on salt marshes in Indian River County against mixed populations of fourth-instar salt-marsh mosquito larvae. The granules were 16/30-mesh attapulgit carrying 5 and 2.5 percent of malathion, 5 and 2 percent of Chlorthion, 1 and 0.5 percent of Bayer 21/199, and 5 percent of Dipterex. Granules with 1 percent of BHC were used as a standard.

All applications were made with a Stearman airplane flying at 80 m.p.h. and an altitude of 25 to 50 feet. The plane was equipped with a cockpit tank duster adjusted to deliver 10 pounds of granules per acre on 30-foot swaths. Applications were made during the afternoons of August 23 and 24 with variable winds up to 15 m.p.h., and on September 12 in the early morning or late afternoon with wind velocities of 15 to 22 m.p.h. Effects of the wind were offset somewhat by flying at an altitude of 25 feet whenever possible. Good coverages were obtained on all plots, as evidenced by the number and pattern of the granules observed on the ground and in the water. The effectiveness of the treatments was based on the difference in 50 to 100 dipping counts

TABLE 3.—Effectiveness of aerial applications of several granulated insecticides against salt-marsh mosquito larvae.

Dosage (pound/acre)	Date (1956)	Pretreatment Count <sup>a</sup>	Percent Reduction in 24 Hours
Bayer 21/199			
0.1	Aug. 23	48	97
		77	99
.5	Sept. 12	133	99+
	Aug. 24	54	99
Chlorthion			
.05	Sept. 12	100	100
		231	99+
.2	do.	44	97
		24	79
Malathion			
.5	Aug. 23	139	78
	24	114	64
.25	Sept. 12	95	99
	do.	140	99
	Aug. 24	201	81
Dipterex			
.75 <sup>b</sup>	Sept. 12	27	99+
.5	Aug. 23	159	79
	24	105	0
BHC			
.1 <sup>c</sup>	Sept. 12	73	45

<sup>a</sup> Average number of larvae per dip.

<sup>b</sup> 15 pounds of 5.0 percent granules per acre.

<sup>c</sup> Gamma isomer.

before and 24 hours after treatment. Counts were made in mangrove, pickleweed, and open marsh.

Results of these tests appear in Table 3. Bayer 21/199 gave good control at 0.1 and 0.05 pound, Chlorthion at 0.5 but not at 0.2 pound, and Dipterex at 0.75 but not 0.5 pound per acre. Malathion gave good control at 0.5 and 0.25 pound per acre in some tests but not in others. BHC failed to give good control at 0.1 pound of gamma isomer per acre.

**SUMMARY.** Field tests were conducted with aerial applications of four organic-phosphorus compounds against resistant salt-marsh mosquitoes, *Aedes taeniorhynchus* (Wied.) and *A. sollicitans* (Wlkr.).

Against adults, oil sprays of malathion and Chlorthion gave more than 90 percent control at 0.1 pound per acre in grove or marsh areas, and less than 60 percent control at 0.25 pound in mangrove

marshes. A water solution of Dipterex gave 77 to 96 percent control at 0.5 pound per acre in groves, but was less effective at lower concentrations. In tests against larvae, oil solutions of Bayer 21/199, Chlorthion, malathion, and Dipterex gave more than 90 percent control at 0.25 pound per acre. As granular larvicides Bayer 21/199 gave 97 to 99 percent control at 0.1 pound per acre; at 0.5 pound per acre Chlorthion gave 97 to 100 percent control, malathion 64 to 99 percent, and Dipterex 0 to 79 percent.

#### References Cited

DEONIER, C. C., CAIN, T. L., JR., and McDUFFIE, W. C. 1950. Aerial spray tests on adult salt-marsh mosquitoes resistant to DDT. *Jour. Econ. Ent.* 43(4):506-510.

GAHAN, J. B., BERTHOLF, J. H., DAVIS, A. N., JR., and SMITH, C. N. 1956. Field tests with two phosphorothioates against resistant salt-marsh mosquitoes. *Mosquito News* 16(2):91-93.

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**Officers and Directors of the American Mosquito Control Association please note that the annual business meeting will be held at 10:00 a.m. on February 23 at the Willard Hotel in Washington, D. C.**