

## TESTS WITH AERIAL SPRAYS OF MALATHION FOR THE CONTROL OF MOSQUITOES

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The effectiveness of DDT aerial sprays for the control of adults of several species of mosquitoes has been demonstrated by Lindquist (1946), Travis (1949), Blanton (1950), and others. The widespread use of aerial sprays by both civilian and military agencies has indicated the effectiveness of both chlorinated hydrocarbon and organic phosphorus compounds against the adults of a number of species, but little information is available regarding their effect on *Culex tarsalis* Coq. Large areas were sprayed with DDT for the control of this species during the California encephalitis outbreak in 1952. However, it is doubted that these sprays were very effective, especially since this species was resistant to chlorinated hydrocarbon insecticides in 1951.

The experiments reported herein were conducted in 1955, and were concerned principally with the aerial treatment of a 2-mile-square area near Merced, Calif., with a malathion spray for the control of *tarsalis* adults. They also gave information on the effectiveness of this spray against adults of *Aedes nigromaculis* (Lud.) as well as against the larvae of this species.

**APPLICATION OF THE SPRAY.**—The test area consisted mostly of irrigated pastures, but also included seven sets of farm buildings and the town of Planada with a popu-

lation of 1400. Prior to treatment of this area the spray was tested on adults of *nigromaculis* confined in screened cages and also on adults of the same species held in open containers under carbon dioxide anesthetization. Exposures were made in partially open buildings and also outdoors. Preliminary trials of the spray were also made on *nigromaculis* larvae in several plots.

The spray solution contained 7.5 percent of technical malathion, 4 percent of SAE 40 motor oil, 22 percent of Shell 42 solvent, and 66.5 percent of diesel oil. Application was made with three Aeronca sedan-type planes equipped with 30-foot booms. Number 4 discs were used in the nozzles, which were turned downward to a 45° angle. This arrangement produced spray particles having diameters ranging from 0.5 to 352 microns with a mass median diameter of 109 microns. The planes flew at a height of 65–70 feet, and the swath width was 60 feet. It was necessary to fly at this height because of television aerials. The planes were calibrated to deliver 3 quarts of spray, or ½ pound of malathion, per acre.

Spraying was begun at about 5:10 a.m. each day and continued for 2 hours on August 25th and for 3 hours on the 26th. The temperatures at 5:15 a.m. on the respective days were 52° and 50° F. On both mornings the wind was from west to northwest and almost at right angles to the direction of flight. The wind velocity during the spraying operations ranged from 1.1 to 2.3 miles per hour on the first day and from 2 to 5.5 miles on the second.

A 50-acre area consisting mostly of a fig orchard which extended along one side

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of the 2-mile square was not sprayed because the oil droplets caused burning of the leaves. A 1200-foot strip was resprayed on the second day to destroy mosquitoes that might have infiltrated into it. A 15-acre orchard near the center of the plot was treated with a malathion emulsion applied with a mist blower.

The effectiveness of the spray against female mosquitoes was determined from light-trap collections and from 10-minute collections with a suction tube in several selected buildings. Five New Jersey type traps were operated in the Planada area; one was placed near the center and the others were arranged in an irregular circle around it at distances ranging from  $\frac{1}{4}$  to  $\frac{3}{4}$  mile, depending on the location of electric current. Collections of mosquitoes resting in buildings were made for several days before and after the spray application. As a control index three traps were placed in a similar area about 6 miles distant. This area included the town of Le Grand, which is about the same size as Planada.

**DEPOSITION OF SPRAY PARTICLES.**—Many spray droplets which ranged from 0.5 to 5 microns were recovered on Cascade impactor and thermal heat precipitator slides at about midpoint of the spray operations each morning. This information and information on the amount of malathion deposited on 32-cm. filter papers were obtained by Culver *et al.* (1955).

Filter papers were placed on the walls and undersides of roofs of four chicken houses where daily suction-tube collections of adult mosquitoes were being made and

in four nearby locations in the open. The amounts of malathion collected on these filter papers are shown in table 1. On

TABLE 1.—Micrograms of malathion deposited per square inch in various chicken houses in Planada, Calif., test area. Data obtained by Culver *et al.* (1955).

House	Underside of roof		Flat surface in open near station
	Wall		
No. 13 Haskell Ave.	0.9	..	57.4
No. 14 Merced St.	1.6	0.8	59.4
No. 15 Merced St.	.6	.8	63.4
No. 16 Bigler Drive	.6	1.0	17.3 <sup>a</sup>
Average	.9	.9	49.4

<sup>a</sup> High trees may account for this low figure.

filter papers placed in the open near the chicken houses and in six other locations in the test area the deposit ranged from 10.3 to 63.4 micrograms and averaged 30.27 micrograms per square inch. This is equivalent to 0.42 pound per acre, as compared with the applied dosage of 0.47 pound. The average deposit on the chicken houses was approximately 3 percent of that found on open flat surfaces.

**EFFECTIVENESS AGAINST *Culex tarsalis*.**—Two nights' trap collections before and two after the application showed 70 percent reduction after the treatment, or 51 percent control on the basis of Abbott's formula (table 2). A drop of 5 degrees in temperature after the spray application may have been partially responsible for the reduction. Collections made at the same time with a suction tube in 10 build-

TABLE 2.—Effectiveness of malathion sprays against female mosquitoes near Merced, Calif.

Collection	Area	Number Taken in 2 Days		Percent control
		Before spray	After spray	
<i>Culex tarsalis</i>				
Traps	Test	1270	381	51
	Check	543	331	..
Buildings	Test	342	212	38
<i>Aedes nigromaculis</i>				
Traps	Test	19209	643	97
	Check	3635	3252	..

ings in the Planada area showed a 38 percent control in 8 of the buildings after the spray application.

**EFFECTIVENESS AGAINST *Aedes nigromaculis*.**—A 97 percent control of *nigromaculis* females occurred in the Planada area, according to collections taken in the five light traps (table 2).

Three locations in the area where fourth-instar *nigromaculis* larvae were present in moderate to large numbers were checked after the spray application. All larvae in open waters were killed, but in places heavily covered with grass or where larvae were concentrated in small water holes the kill was only partial.

In the preliminary outdoor trials all *nigromaculis* adults that were anesthetized in open containers were killed by the spray, but some of those in screen cages remained alive. This was expected, since wire netting screens out some of the spray particles. None of the adults exposed in partially open buildings were killed. However, workers at the USDA Aircraft and Special Equipment Center (1954) have shown that, even if several swath widths are sprayed over a set of buildings at a height of 70 feet, the particles may drift considerably before reaching the ground. The results of our preliminary tests could therefore not be considered conclusive.

**DISCUSSION.**—Many variable factors, such as temperature, air movement, and humidity, may have caused differences in the numbers of mosquitoes collected on different days. However, the percentages of *tarsalis* control as indicated by light-trap and building collections were substantially in agreement, and show that malathion sprays applied by airplane for the control of the adults of this species are only partially effective. The low kill of *tarsalis* as compared with *nigromaculis* appears to be due to failure of the insecticide to reach the insect, since in laboratory tests (Gjullin 1954) malathion aerosols were only slightly less effective against *tarsalis*. The day-time resting places of *tarsalis* provide pro-

tection from sprays and are probably responsible for the low kill obtained.

**SUMMARY.**—An experiment on the aerial application of malathion in an oil spray at 0.47 pound per acre over a 2-mile-square area near Merced, Calif., for the control of adults of *Culex tarsalis* Coq. was conducted during August 1955. The effect on adults and larvae of *Aedes nigromaculis* (Lud.) was also observed.

Light-trap collections indicated that the insecticide caused 51 and 97 percent reduction of *tarsalis* and *nigromaculis* females, respectively. Collections made in buildings indicated a 38 percent reduction of *tarsalis* females. Complete kills of larvae of *nigromaculis* occurred in open water but not in water that was heavily covered with grass.

Chemical analysis of filter papers exposed in four chicken houses showed that the papers contained 0.9 microgram of malathion per square inch, whereas those exposed in the open near the houses contained 49.4 micrograms. The average of all the papers exposed in the open, including those near the chicken houses, was 30.27 micrograms per square inch.

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