tration than did the aluminum cages as determined by dye cards placed inside the respective cages, and they compared favorably with the unscreened controls. Totally, the six galvanized screen cages averaged 371 droplets per card or 18.5 per square inch, while the six aluminum replicates averaged only 170 droplets per card or 8.5 per square inch. Unscreened controls averaged 431 droplets per card or 21.6 per square inch. As a result of this experiment, galvanized screening was adopted for constructing cages used in subsequent ULV evaluations.

Discussion and Summary. This study shows that the type screening material used in test cages for evaluating ULV malathion treatments is important in making proper evaluations. Some types of screening inhibit the penetration of droplets to the specimens inside cages. In this work, aluminum, bronze, and plastic screening materials interfered with penetration more than other materials tested, while nylon and galvanized materials interfered least. The latter materials allowed ULV droplet penetration almost equal to that of unscreened controls. Galvanized screening, when competitively compared to aluminum, consistently allowed better droplet penetration and was the material adopted for later ULV evaluations.

While galvanized screening proved better for our use than other materials tested, other workers using cages for mosquito tests in ULV studies should select cage materials based on their own evaluations and requirements since different insecticides and spraying equipment might affect the results.

ULTRA-LOW VOLUME AERIAL SPRAYS OF PROMISING INSECTICIDES FOR MOSQUITO CONTROL[1]

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Since the use of ultra-low volume (ULV) aerial sprays for control of mosquitoes has increased considerably over the past several years, this method of application was used to compare the effectiveness of four new insecticides with two standard insecticides against adult *Aedes taeniorhynchus* (Wiedemann) and *Anopheles quadrimaculatus* Say and larvae of *Culex pipiens quinquefasciatus* Say. In addition, common bait minnows *Notemigonus crysoleucas* (Dalenciennes) and crickets *Achita assimilis* F. were included in the tests to determine the effect of the insecticides on nontarget organisms, and cages made with various meshes of screen wire or fabric were included in some tests to determine whether the sprays penetrated sufficiently to kill the adult mosquitoes.

Materials and Methods. The tests were conducted in an open plot (about 40 acres) near Gainesville, Florida in April 1969. Treatments were made between 7:30 and 10:00 a.m., during favorable meteorological conditions. Air temperatures ranged from 64 to 83° F. and averaged about 73° F., and wind speeds ranged from <1 to 10 m.p.h. and averaged about 4 m.p.h.

The insecticides tested were as follows:

[1] Mention of a pesticide or a proprietary product does not constitute a recommendation or an endorsement by the U. S. Department of Agriculture.

Dursban ®	*O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate
Phoxim	
Geigy GS-13005	*O,O*-dimethyl phosphorodithioate *S*-ester with 4-(mercaptomethyl)-2-methoxy-Δ^2-1,3,4-thiadiazolin-5-one
Accothion ®	*O,O*-dimethyl *O*-4-nitro-*m*-tolyl phosphorothioate
Malathion	Standard
Fenthion	Standard

The ULV sprays were applied with a Stearman (PT-17) aircraft equipped with a self-contained carbon dioxide (CO_2) pressurized system. Polyethylene tubing was used to carry the insecticide from a 2½-gallon B & G stainless steel tank to TeeJet ® flat-fan nozzles. The nozzles were positioned at a 45 degree angle forward to the thrust line of the aircraft on a trailing-wing boom. The desired dose of each insecticide was obtained by varying the number and size of flat-fan nozzle tips and by line pressure. The aircraft was flown at a speed of 95 m.p.h., an altitude of 50–75 feet, and swath intervals of 200 feet.

Adult female mosquitoes, 2 to 7 days old, were placed in 16-mesh screen wire cages (25 per cage). For each replication, four cages of mosquitoes were placed at each of three stations 150 feet apart in a row perpendicular to the flight path and in the center of the plot. At each station, one cage of each species was hung on a stake at 5 feet above the ground, and one of each species was placed on the ground. Also, a wax paper cup containing 25 fourth-instar larvae in 125 milliliters of distilled water was placed on the ground at each station. From 2 to 3 replications were made with each application rate of each insecticide. Fifteen minutes after application, the adult mosquitoes were transferred to plastic tubes lined with clean paper. Except during exposure to the sprays, the mosquitoes were held in insulated chests containing ice in cans. Absorbent cotton pads moistened with 10 percent sugar-water solution were placed on the holding tubes when they were returned to the air-conditioned laboratory. Mortality observations were made on mosquito adults after 6 and 24 hours and on mosquito larvae after 24 hours.

Minnows were held and treated in 35-ounce, wax covered, cardboard buckets containing 500 milliliters of water. Three buckets of 10 minnows each were used per treatment. The water in the buckets was kept aerated by a portable battery-operated pump except during the 15-minute exposure period. Mortality observations were made at 6 and 24 hours after exposure, but the 24-hour data were discarded because of poor check survival.

Field crickets were held and treated in the same cage units used for adult mosquitoes. Three cages of 10 crickets each were exposed per treatment on the 5-foot stakes. These insects were given bran flakes as food during the post-treatment holding period. Mortality observations were made 6 and 24 hours after exposure.

In spray penetration tests, screen wire cages of 16, 32, and 60-mesh were used. Coverings for the fabric cages were constructed from cotton Tubegauze ®, a lightweight nylon (Sears women's stretch stockings), heavy nylon (Supphose ® support stockings), and a loosely-woven dacron-polyester.

RESULTS AND DISCUSSION. The mortality data for mosquitoes are presented in Table 1. With adult mosquitoes, the kills obtained with the new insecticides averaged about 20 percent higher in cages placed on 5-foot stakes than in those on the ground. This difference was expected since Rathburn *et al.* (1968) and Mount *et al.* (1969) previously obtained 15-percent differences in kill between mosquitoes in cages placed at ground level and 3 feet above ground. Phoxim, Geigy GS-13005, and Accothion were about equal to fenthion; all were superior to malathion. Dursban was much less effective than fenthion and slightly less effective at a dose of 0.1 pound per acre than malathion at 0.2 pound per acre. The mortality was

TABLE 1.—Mortality of mosquitoes exposed to ultra-low volume aerial sprays of various insecticides.[a]

Insecticide and active ingredient per gallon	Dose (pound per acre)	Volume (fluid ounces per acre)	Flat-fan nozzles (No.)	Flat-fan nozzles (Size)	Line pressure (pound per square inch)	Percent mortality in 24 hours of *Culex pipiens quinquefasciatus* larvae	Percent mortality of mosquito adults: *Aedes taeniorhynchus* 6 hours Stake & Ground	*Aedes taeniorhynchus* 24 hours Stake	*Aedes taeniorhynchus* 24 hours Ground	*Anopheles quadrimaculatus* 6 hours Stake & Ground	*Anopheles quadrimaculatus* 24 hours Stake	*Anopheles quadrimaculatus* 24 hours Ground	Average of both species at 24 hours
New Insecticides													
Dursban (4 pounds)	0.1	3.2	8	80015	33	100	29	58	54	53	75	56	61
Phoxim (6 pounds)	.05	1.05	4	8001	28	100	28	67	49	72	85	73	69
	.1	2.1	8	8001	28	96	61	98	85	81	97	85	92
Geigy GS-13005 (3 pounds)	.05	2.1	4	80015	40	99	66	96	49	63	95	51	73
	.1	4.2	8	80015	40	100	74	96	80	76	92	77	86
Accothion (8.34 pounds)	.05	.75	1 1	730116 80015	40	100	55	99	68	48	95	65	82
	.1	1.5	2 2	730116 80015	40	86	33	94	55	67	100	74	81
Standard Insecticides													
Malathion (9.7 pounds)	.2	2.63	4 4	730116 80015	49	63	42	84	52	69	76	86	75
Fenthion (9.67 pounds)	.05	.65	1 1	730116 80015	46	93	39	85	40	55	81	77	71
	.1	1.3	2 2	730116 80015	46	100	54	97	97	67	99	92	96

[a] All data corrected by Abbott's formula for check mortality which was 13 percent for adults and 5 percent for larvae.

always less at 6 hours than at 24 hours after exposure.

All insecticides gave high mortality (86–100 percent) of the mosquito larvae except malathion which gave 63 percent. Thus, lower rates need to be tested with the new insecticides to determine minimum lethal doses.

As shown in Table 2, Dursban at 0.1 pound per acre killed about the same proportion of the minnows as the malathion and fenthion standards at 0.2 and 0.05 pound per acre, respectively. Phoxim, Geigy GS-13005, and Accothion gave little or no kill of minnows within 6 hours after exposure. In the tests with crickets, Dursban and Geigy GS-13005 caused slightly higher kills (54 and 45 percent, respectively) than fenthion (32 percent); while Accothion, Phoxim, and the malathion standards produced low mortalities.

The data in Table 3 indicated that ULV aerial sprays did not readily penetrate either fine screen wire or several types of fabric cages. Very low mosquito mortalities were obtained with all the cages except the light nylon cages and the standard 16-mesh screen wire cages which gave an average of 66 and 91 percent mortality, respectively. Therefore, the light nylon could be a suitable cage cover for containing insects smaller than mosquitoes.

Table 2.—Effect of ultra-low volume aerial sprays of various insecticides on nontarget organisms.

Insecticide	Dose (pound per acre)	Percent mortality[a] Crickets 6 hours	Crickets 24 hours	Minnows 6 hours
	New Insecticides			
Dursban	0.1	18	54	33
Phoxim	.05	0	7	11
Geigy GS-13005	.05	8	45	0
Accothion	.05	0	21	0
	Standard Insecticides			
Malathion	.2	0	2	37
Fenthion	.05	20	32	28

[a] All data corrected by Abbott's formula for check mortality which was 3 percent for crickets and 10 percent for minnows.

Summary. Phoxim, Geigy GS-13005, and Accothion were about equal to fenthion and superior to malathion as ultra-low volume aerial sprays against caged adult mosquitoes, *Aedes taeniorhynchus* (Wiedemann) and *Anopheles quadrimaculatus* Say. In the same tests, Dursban was much less effective than fenthion and slightly less effective at 0.1 pound per acre than malathion at 0.2 pound per acre. At the doses required for adult mosquito control, all of these insecticides except malathion caused high mortality of larval *Culex pipiens quinquefasciatus* Say, (malathion gave only 63 percent).

In tests with nontarget organisms, Dursban at 0.1 pound per acre produced about the same mortality of minnows as malathion and fenthion at 0.2 and 0.05 pound per acre, respectively. Phoxim, Geigy GS-13005, and Accothion caused little or no kill of minnows. Against crickets, Dursban, Geigy GS-13005, and the fenthion standard caused moderate kills; Phoxim, Accothion, and malathion caused only low mortality.

ULV aerial sprays did not readily penetrate fine screen wire or several types of fabric cages, and only the standard 16-mesh screen wire and light nylon cages

TABLE 3.—Mortality of adult female *Aedes taeniorhynchus* (Wiedemann) 24 hours after exposure in various types of cages to ultra-low volume aerial sprays of insecticides.

Insecticide	Dose (pound per acre)	Screen wire cages (mesh size) 16	32	60	Fabric cages Light nylon	Heavy nylon	Dacron-polyester	Cotton gauze
Malathion	0.2	92	66	..	88	..	36	..
Accothion	.05	85	29	4	70	8	4	12
Geigy GS-13005	.05	97	16	8	40	24	..	0
Average		91	37	6	66	16	20	6

allowed good penetration of the insecticide droplets.

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RESULTS OF HUMAN EXPOSURE TO THERMAL AEROSOLS CONTAINING DURSBAN® INSECTICIDE

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The Dow Chemical Company, Lake Jackson, Texas, April 14, 1970.

INTRODUCTION. The principal active ingredient in DURSBAN ® insecticides, O,O-diethyl O-(3,5,6,-trichloro-2-pyridyl) phosphorothioate, hereafter referred to as Dowco ® 179, has shown biological activity against many species of insects as reported by Gray (1965) and Kenaga *et al.* (1965). Many authors have reported outstanding activity of Dowco 179 for control of mosquitoes; Gahan *et al.* (1966), Lewallen and Peters (1966), Ludwig and McNeill (1966), Jakob (1966), and Mulla *et al.* (1967). While aerial application is the major method of dispersing insecticides for larval control, insecticidal fogging is the preferred mode of application for control of adult mosquitoes by mosquito abatement districts. Miller *et al.* (1968), Ludwig and McNeill (1966), and Mount and Lofgren (1967) have demonstrated the efficacy of Dowco 179 when dispersed as either a thermal or cold fog.

In the use of any insecticide for thermal fog dispersion, the health hazards to man are of prime importance because the application is predominantly in urban areas.

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