unit described consists of a 60-gallon fiberglass tank, an electric motor and control system, a positive displacement pump, Teflon hose and a stainless steel boom with provisions for 14 nozzles. Installation or removal of all equipment requires approximately 30 minutes. No structural modification of the aircraft is required. Droplet mass median diameters range from 25 to 50 microns using flat fan or hollow cone nozzle tips. The unit has demonstrated excellent operational performance dispersing malathion at 0.3 pound per acre for adult mosquito control.

THE EFFECT OF TEST CAGE MATERIALS ON ULV MALATHION EVALUATIONS [1]

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INTRODUCTION. Ultra-low-volume (ULV) applications require a correlation between droplet distribution of insecticide and mosquito mortality. When malathion is used, malathion-sensitive dye cards and confined adults or larvae are positioned so the number of droplets appearing per card or per square inch can be compared with percent mortality. Thus, it should be possible to determine the droplet distribution necessary for a given mortality of an exposed species. Also, many workers use caged insects, without associated indicators of insecticide distribution, to bioassay the effectiveness of ULV treatments. Ultra-low-volume experiments conducted by the Central America Malaria Research Station (CAMRS) in coastal El Salvador during 1969 revealed that the type of screening material used in test cage construction was of considerable importance in making proper evaluations.

During the first of ten aerial ULV treatments programmed for the 1969 dry season, there was a discrepancy between mortalities of adult *Anopheles albimanus* confined to cages and larvae of the same species in open containers as related to droplet distribution on adjacent dye cards. The correlation between droplet distribution and mortality was much higher with larvae than with adults even though adults were the primary target. Since the larval containers were open at the top and adults were in screened cages, it was surmised that droplets were not penetrating the cages in numbers sufficient to result in consistent adult mortality. Therefore, experiments were designed to measure the effect of test cage screening materials and to develop cages to allow maximum penetration of insecticide droplets.

PROCEDURE AND RESULTS. C-47 aircraft flying 160 mph at 125 feet altitude made all applications, delivering 3.0 fluid ounces of malathion ULV concentrate per acre. On February 18, 1969, stations at 40 sites were used to evaluate the ULV treatment of a 3,000-acre area of coastal El Salvador east of the port city of La Libertad. The mosquito target was the local vector species of malaria, *Anopheles albimanus*. Each station (Figure 1) consisted of a wooden platform, 18 inches high, on

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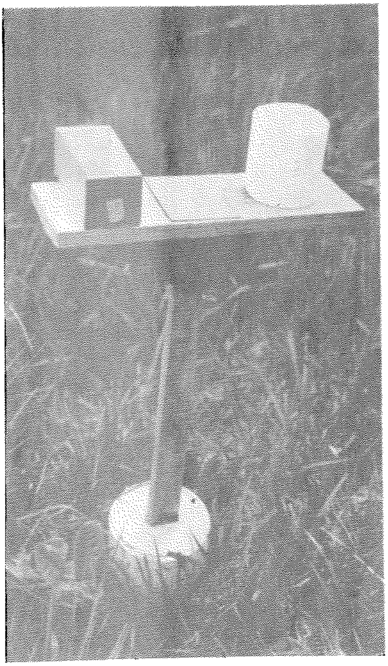

FIG. 1.—Platform station for ULV evaluation showing adult mosquito cage, oil red dye card, and larval mosquito container.

TABLE 1.—Twenty-four hour mortality of confined *Anopheles albimanus* adults and larvae and distribution of ULV malathion droplets on adjacent oil red dye cards, February 18, 1969.*

Station No.	No. Droplets ** per Square Inch	Percent Mortality	
		Larvae	Adults
12	12	100	50
35	12	95	100
7	13	100	47
37	13	86	85
10	16	100	33
30	17	90	100
31	20	80	95
23	24	100	100
2	24	100	50
33	30	90	100
18	30	100	50
36	32	85	100
26	36	100	100
38	38	100	31
32	42	100	100
17	46	100	61
9	47	100	82
29	47	100	100

* 25 larvae confined in each ice cream carton (4″ diameter, containing about 2″ water); 25 females confined in each aluminum screened cylindrical cage (3″ x 6″).

** Arranged in ascending order to include only those stations receiving 12 or more droplets per square inch.

which was placed a 20-mesh, 6″ x 3″ aluminum cage containing 25 adult females, a 4-inch diameter ice cream carton with 25 larvae in about 2 inches of water, and a 4″ x 5″ malathion-sensitive oil red dye card.

In our experience with this type of evaluation, a malathion droplet distribution on associated dye cards of 10 or more droplets per square inch resulted in consistently high adult mortality in the adjacent cage and less, more inconsistent larval mortality. Instead, in this spraying, the reverse was true. This is illustrated by the data in Table 1 which show that in droplet distributions ranging between 12 and 47 droplets per square inch, adult mortality ranged between 31 percent and 100 percent and was erratic. For example, one station receiving 12 droplets resulted in 50 percent adult mortality, while another receiving 12 droplets resulted in 100 percent mortality. Of two stations receiving 13 droplets, one had 47 percent mortality; another, 85 percent. A station with 36 droplets resulted in 100 percent mortality while one with 38 droplets showed only 31 percent mortality. In addition, no consistently high mortality developed above a given droplet distribution. On the other hand, larval mortalities ranged between 80 percent and 100 percent at all stations receiving more than 12 droplets, and 100 percent mortalities were obtained at all stations where 36 or more droplets were recorded on the adjacent dye cards.

Notwithstanding the possibility of other factors, the obvious difference between larval and adult mortality at the same station with a given droplet distribution caused concern that ULV droplets might not be penetrating the screen barrier of the adult cages. Thus, during a follow-up treatment of the same area on February 25, 1969, 20 evaluation stations of the type previously described were used to determine if the screening material was indeed interfering with droplet penetration. In this experiment, each platform station contained an aluminum cage of the type used in the treatment of February 18, 1969, with a dye card on the floor of the cage and an adjacent exposed dye card without a screen barrier. It was discovered that droplets were indeed not penetrating the 20-mesh aluminum screen cages in numbers comparable to those impinging on the exposed dye cards. The results, in Table 2, show that, in each of the 20 replicates, the exposed cards received substantially more droplets than did the caged cards. Overall, a total of 9,439 droplets (average of 472 per card or 23.6 per square inch) were counted on the 20 exposed cards, while only 3,186 (average of 159 per card or 8.0 per square inch) were counted from the 20 caged cards.

TABLE 2.—Number of ULV malathion droplets reaching exposed and caged dye cards, February 25, 1969.

Site No.	Exposed Cards * Per Card (20 Sq. In.)	Exposed Cards * Per Sq. In.	Caged Cards * Per Card (20 Sq. In.)	Caged Cards * Per Sq. In.
5	25	1.3	5	0.3
11	36	1.8	10	0.5
7	41	2.1	6	0.3
9	48	2.4	11	0.6
27	123	6.2	27	1.4
31	134	6.7	119	5.9
3	144	7.2	31	1.6
39	228	11.4	184	9.2
15	260	13.0	55	2.8
19	275	13.8	54	2.7
33	303	15.2	93	4.7
17	317	15.9	70	3.5
35	335	16.8	103	5.2
13	337	16.9	91	4.6
1	359	17.9	80	4.0
21	512	25.6	67	3.4
37	612	30.6	236	11.8
24	1,070	53.5	78	3.9
29	1,440	72.0	658	32.9
25	2,840	142.0	1,208	60.4
TOTAL	9,439		3,186	
Avg./Card	472		159	
Avg./Sq. In.		23.6		8.0

* Exposed cards were resting flat, adjacent to screen cage; caged cards were on bottom curvature inside cage.

This evidence resulted in efforts to find a screening material that would allow better penetration of droplets. On March 3, 1969, various screening materials were competitively compared against each other and against unscreened controls. Three platform stations were used, each with galvanized metal trays (4″ x 5″ x 1″) with a dye card (4″ x 5″) on the bottom and a different type screening material across the top (aluminum, 20-mesh; galvanized, 16-mesh; enameled, 13-mesh; bronze, 20-mesh; nylon, 20-mesh; and plastic, 16-mesh). Additionally, at each station, there were two controls: a screenless tray of the same construction contained a dye card and a flat metal plate another. The results, given in Table 3, show that mesh played little part and that galvanized or nylon screening offered the best possibilities for further development and use. These materials were essentially equal in the total number of penetrating droplets (212 and 216, respectively) and both compared favorably with the controls (tray, 256; plate, 220).

On the basis of the foregoing experiment, new cages were constructed of galvanized screen, and on March 29, 1969, these were competitively compared with the aluminum cages originally used, and with unscreened controls. Table 4 shows that, at each of the six stations, the galvanized cages allowed better droplet pene-

TABLE 4.—Number of ULV malathion droplets reaching dye cards (4″ x 5″) inside two types of cages, March 29, 1969.

Station No.	Aluminum Cages	Galvanized Cages	Unscreened Control
1	119	197	212
2	204	538	716
3	93	169	183
4	180	412	509
5	306	687	622
6	119	224	344
TOTAL	1,021	2,227	2,586
Avg./Card	170	371	431
Avg./Sq. In.	8.5	18.6	21.6

Table 3.—Number of ULV malathion droplets on dye cards using various screening materials as barriers to penetration, March 3, 1969.

Station No.	Metallic Materials				Synthetic Materials		Unscreened Control Tray	Unscreened Standard Plate
	Aluminum 20-mesh	Galvanized 16-mesh	Enameled 13-mesh	Bronze 20-mesh	Nylon 20-mesh	Plastic 16-mesh		
1	57	68	66	30	61	21	85	91
2	30	36	37	25	47	16	41	36
3	44	108	72	57	108	65	130	93
TOTAL	131	212	175	112	216	102	256	220

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.