MOSQUITO COLLECTIONS IN EL SALVADOR WITH ULTRA-VIOLET AND CDC MINIATURE LIGHT TRAPS WITH AND WITHOUT DRY ICE

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ABSTRACT. Field tests of an updraft ultraviolet light trap in El Salvador failed to indicate any increase in catch of the malaria vector *Anopheles albimanus*, due to dry ice supplementation. In comparison tests dry ice produced no increase in numbers of species taken by either the UV trap or the CDC miniature trap but did result in larger total numbers of mosquitoes for both trap types. The magnitude of the increase was substantially greater for the CDC trap, but with minor exceptions, the UV trap captured larger numbers without dry ice than did the CDC trap with dry ice. Dry ice is a worthwhile adjunct to traps with an incandescent light source, but the increment in catch to be expetced with an ultraviolet trap may not justify the trouble and expense of obtaining the dry ice.

For light traps such as the New Jersey and CDC miniature traps, which have an incandescent light source, the use of carbon dioxide as a supplemental attractant has resulted in substantial increases in the numbers and species of mosquitoes collected. Huffaker and Back (1943) obtained an 8-fold increase in total catch with New Jersey light traps operated for 3 hours after dusk when CO_2 (dry ice) was used. Bordash et al. (1972) reported a 5- to 18- fold increase in all-night catches of a New Jersey trap modified for battery operation when dry ice was suspended adjacent to the trap. Similarly, Newhouse et al. (1966) recorded a 4-fold or greater increase in mosquito catches with the battery-powered CDC miniature trap and a 20–25% increase in species diversity both attributable to the addition of dry ice. The value of CO_2 supplementation of the CDC trap has been amply confirmed in a number of subsequent reports (Carestia and Savage 1967, Carestia and Horner 1968, Miller et al. 1969, Stryker and Young 1970, Herbert et al. 1972).

Laboratory studies have indicated that ultraviolet light may be useful for the capture of certain malaria vectors (Wilton and Fay 1972) and field experience has established the effectiveness of an updraft ultraviolet trap for *Anopheles albimanus* Wiedemann in El Salvador (Wilton, in press) and in Haiti (Taylor et al. 1975). Little is known, however, regarding the effect of CO_2 on mosquito collections made with ultraviolet light. This report presents the results of field trials in El Salvador which 1) compared catches of *A. albimanus* by an updraft ultraviolet trap with and without dry ice and 2) assessed for various mosquito species the relative value of this attractant with the ultraviolet and CDC miniature light traps.

METHODS AND EQUIPMENT. In the first

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series of trials, made at intervals during January, February, and March 1974, catches of *A. albimanus* by CO_2- supplemented and non-supplemented ultraviolet traps were made at San Diego, a small beach community situated on a narrow strip of land between the Pacific and an estuary which parallels the shore. During the November-May dry season, the river-fed estuary becomes a mosquito source when its outlet to the ocean is blocked by a sand bar. Four houses, mainly of cane pole and palm thatch construction, and not less than 150 feet apart on the bank of the estuary, were chosen as trap sites. A trap was suspended 5–6 feet above the ground outside each of the 4 houses on the side facing the estuary. During each trap run ca. 1 lb of dry ice, wrapped in newspaper, was suspended beside 2 of the traps (Newhouse et al. 1966). The remaining 2 were operated without dry ice. Trap positions followed a scheduled rotation among the 4 houses and each house was assigned a dry ice supplemented and a non-supplemented trap an equal number of times. Tests were also run with 1 of the traps at each corner of 1 of the houses. Trap positions were rotated as before and each corner of the house was tested an equal number of times with and without dry ice.

In a second series of trials, a pair of the ultraviolet traps plus a pair of CDC miniature traps were used in a similar fashion at 4 stations outside the pens of a cattle stable on the seacoast at La Zunganera some 20 km to the east of the San Diego location. These tests were started in April at the end of the 1974 dry season and extended well into the rainy season to early September so that, in addition to the estuary, flooded pastures, ditches, and similar accumulations of water contributed to mosquito production. Data were recorded on numbers and species of mosquitoes captured, with and without dry ice, by both types of trap.

At San Diego, trap operation was from 6 to 8 pm only. The pronounced peak of flying and biting activity immediately after sunset which characterizes *A. albimanus* in El Salvador made this short trapping period feasible. For comparability with the San Diego tests, the same schedule of trap operation was followed at La Zunganera.

The updraft ultraviolet trap is an experimental model equipped with a horizontally-mounted 4-watt BLB fluorescent lamp with peak emission in the near ultraviolet at 3650 Å. A 2-blade fan positioned above the lamp creates an updraft air stream to move attracted insects into a cloth holding cage above the trap. Power for both the lamp and fan motor comes from a 12-volt auto battery. A Tran-Bal[2] inverter ballast is used to operate the fluorescent lamp from the DC power source. The trap and holding cage have been described in greater detail and pictured (Wilton, in press).

The CDC miniature traps were as described by Sudia and Chamberlain (1962) except for 6-volt motors in place of the 4-volt motors of earlier models. These traps were powered by packs of four 1.5-volt dry cells changed for each trap run to ensure proper trap operation.

RESULTS AND DISCUSSIONS. Twelve trap runs were made at San Diego, 8 with one trap assigned to each of 4 houses and 4 with a trap placed at each corner of the same house. The most characteristic feature of the results of these trials was their variability. Catches of *A. albimanus* in non-supplemented traps exceeded those in supplemented traps on 8 occasions for females and 7 for males. Few males were trapped, however, and none of the traps proved to be highly effective for their capture.

Total numbers of females trapped with and without dry ice are recorded in Table 1 by house and by corner position at the house which yielded the largest collection. Larger total numbers of *A. albimanus*

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[2] The Bodine Co., Inc., Collierville, Tenn. 38017. Use of trade names and commercial sources is for identification purposes only and does not constitute endorsement by the Public Heatlh Service or the U.S. Department of Health, Education, and Welfare.

were caught without dry ice. The reasons for this are not entirely clear, but a pronounced and unexpected variability among the sampling stations appears to be partly responsible. Catches at the most productive house (No. 1) exceeded those at the least productive (No. 2) by a factor greater than 4 for both supplemented and nonsupplemented traps. Moreover, collections *without* dry ice at house No. 1 exceeded the combined catch *with* dry ice at the other 3 houses. Similar relationships are evident among the corners of house No. 1. Narrow flight paths have been postulated for host-seeking females of *Anopheles gambiae* in West Africa (Odetoyinbo 1969). In the present study the existence of similar flight paths leading from the breeding sites to the test houses might have exerted more influence over the distribution of trap catches than the dry ice attractant.

Table 1. Numbers of *Anopheles albimanus* females captured at San Diego Community by updraft ultraviolet traps with and without dry ice

	House	Without Dry Ice	With Dry Ice	Totals
	1	93	95	188
Traps at	2	19	22	41
4 houses	3	61	28	89
	4	21	24	45
Total		194	169	363
	Corner			
Traps at	A	14	12	26
4 corners	B	56	41	97
of house	C	13	20	33
No. 1	D	33	9	42
Total		116	82	198

The results obtained with the ultraviolet and CDC miniature traps at La Zunganera are summarized in Table 2. Dry ice had no effect on the number of mosquito species taken by either type of trap, but total numbers captured were increased. Total increments recorded for the ultraviolet traps were 1.5- and 2.5-fold for females and males, respectively. The comparable increases with the CDC traps were 8.7- and 11.0-fold. Further indication of a differential effect from dry ice supplementation of the 2 trap types is furnished by the increases obtained for females of individual species. The ultraviolet traps showed a comparatively narrow range of increase from 1.2-fold for *Culex* spp. to 2.4-fold for *Mansonia titillans*. In contrast, dry ice used with the CDC traps resulted in increments ranging from 2.2-fold for *Anopheles albimanus* to 23.0-fold for *Aedes taeniorhynchus*. This range of increase accords reasonably well with that reported by Newhouse et al. (1966) for the CDC trap.

Although dry ice produced increases of greater magnitude in the number of mosquitoes caught by the CDC traps, the actual numbers taken by the ultraviolet traps were generally larger. In fact, with the exceptions of *Aedes scapularis* and *Culex* spp., the ultraviolet traps captured larger numbers without dry ice than did the CDC traps with dry ice.

It should be noted that the only males captured in substantial numbers were *Mansonia titillans* and that this species accounts almost entirely for the increased male catches with dry ice. Carbon dioxide acts as a host-stimulating mosquito attractant (Brown 1951, Reeves 1953) and augmented catches of females in light traps supplemented with dry ice are readily explained on this basis. The positive response to dry ice shown by male *M. titillans* in the present study is anomalous, however, and remains unexplained.

Ultraviolet light traps are an effective means of collecting a number of mosquito species. Although the use of dry ice (or other source of CO_2) as an adjunct to light trap operation has proven highly successful with traps having an incandescent light source, the present results suggest that the increment in catch to be expected from the addition of dry ice to an ultraviolet trap may not justify the trouble and expense of obtaining the dry ice.

References Cited

Bordash, G. J., D. S. Adam, W. R. Gusciora, O. Sussman and M. Goldfield. 1972. A comparison of mosquito collections taken from dry ice

Table 2. Mosquitoes trapped at La Zunganera by ultraviolet updraft and CDC Miniature Light Traps with and without dry ice (totals from 27 two-hour trap runs)

	Females			Males		
	Without Dry Ice	With Dry Ice	Fold Increase	Without Dry Ice	With Dry Ice	Fold Increase
			Ultraviolet Updraft Trap			
Anopheles albimanus	2,776	3,950	1.4	39	42	1.1
Anopheles pseudopunctipennis	9	7	...	0	0	...
Aedes taeniorhynchus	551	741	1.3	22	8	...
Aedes scapularis	8	12	1.5	0	0	...
Psorophora confinnis	54	100	1.9	0	1	...
Psorophora varipes	41	3	...	0	0	...
Culex spp.	426	495	1.2	84	74	...
Mansonia titillans	750	1,795	2.4	370	1,150	3.1
Uranotaenia sp.	2	1	...	0	0	...
	4,617	7,104	1.5	515	1,275	2.5
			CDC Miniature Trap			
Anopheles albimanus	47	105	2.2	1	0	...
Anopheles pseudopunctipennis	2	1	...	0	0	...
Aedes taeniorhynchus	15	345	23.0	0	2	...
Aedes scapularis	2	24	12.0	0	0	...
Psorophora confinnis	0	5	...	0	0	...
Psorophora varipes	0	3	...	0	0	...
Culex spp.	71	542	7.6	2	0	...
Mansonia titillans	32	451	14.1	8	119	14.9
Uranotaenia sp.	0	0	...	0	0	...
	169	1,476	8.7	11	121	11.0

supplemented and non-supplemented modified New Jersey light traps. Ann. Mtg. N. J. Mosquito Exterm. Assoc. Proc. 59:132–146.

Brown, A. W. A. 1951. Studies of the responses of the female *Aedes* mosquito. Part IV. Field experiments on Canadian species. Bull. Ent. Res. 42:575–582.

Carestia, R. R. and K. O. Horner. 1968. Analysis of comparative effects of selected CO_2 flow rates on mosquitoes using CDC light traps. Mosq. News 28:408–411.

Carestia, R. R. and L. B. Savage. 1967. Effectiveness of carbon dioxide as a mosquito attractant in the CDC miniature light trap. Mosq. News 27:90–92.

Herbert, E. W., R. P. Meyer and P. G. Turbes. 1972. A comparison of mosquito catches with CDC light traps and CO_2-baited traps in the Republic of Vietnam. Mosq. News 32:212–214.

Huffaker, C. B. and R. C. Back. 1943. A study of the methods of sampling mosquito populations. J. Econ. Ent. 36:561–569.

Miller, T. A., R. G. Stryker, R. N. Wilkinson and S. Esah. 1969. Notes on the use of CO_2 baited CDC miniature light traps for mosquito surveillance in Thailand. Mosq. News 29:688–689.

Newhouse, V. F., R. W. Chamberlain, J. G. Johnston and W. D. Sudia. 1966. Use of dry ice to increase mosquito catches of the CDC miniature light trap. Mosq. News 26:30–35.

Odetoyinbo, J. A. 1969. Preliminary investigation on the use of a light-trap for sampling malaria vectors in the Gambia. WHO Bull. 40: 547–560.

Reeves, W. C. 1953. Quantitative field studies on a carbon dioxide chemotropism of mosquitoes. Amer. J. Trop. Med. Hyg. 2:325–331.

Stryker, R. G. and W. W. Young. 1970. Effectiveness of carbon dioxide and L (+) lactic acid in mosquito light traps with and without light. Mosq. News 30:388–393.

Sudia, W. D. and R. W. Chamberlain. 1962. Battery-operated light trap, an improved model. Mosq. News 22:126–129.

Taylor, R. T., M. Solis, D. B. Weathers and J. W. Taylor. 1975. A prospective study of the effects of ultralow volume (ULV) aerial application of malathion on epidemic *Plasmodium falciparum* malaria. II Entomologic and operational aspects. Amer. J. Trop. Med. Hyg. 24: 188–192.

Wilton, D. P. (in press). Field evaluations of three types of light traps for collection of *Anopheles albimanus* Wiedemann (Diptera: Culicidae). J. Med. Ent.

Wilton, D. P. and R. W. Fay. 1972. Air flow direction and velocity in light trap design. Entomol. Exp. et Appl. 15:377–386.