NEW INSECTICIDES AS NONTHERMAL AEROSOLS FOR CONTROL OF ADULT MOSQUITOES[1]

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The continual development of resistance to insecticides by various species of mosquitoes emphasizes the need to search constantly for new compounds for their control. Such a search for adulticides has been carried on by this laboratory through many years. Essentially, it now consists of: (1) wind tunnel tests in the laboratory to select promising compounds; (2) preliminary field evaluations in which caged mosquitoes are exposed to thermal or nonthermal aerosols; and (3) aerial spraying and fogging against natural populations of mosquitoes. The present paper presents results of recent tests made during the second phase of these investigations.

Eight insecticides were compared with three standard insecticides as nonthermal aerosols against three species of mosquitoes, *Aedes taeniorhynchus* (Wiedemann), *Culex pipiens quinquefasciatus* Say, and *Anopheles quadrimaculatus* Say. Although these data were obtained with nonthermal aerosols, they indicate the results that could be expected from thermal aerosols since Mount *et al.* (1966) demonstrated that nonthermal and thermal aerosols are equal in effectiveness.

METHODS AND MATERIALS. The tests were conducted in an open field near Gainesville, Florida from April to October 1966. Most tests were performed between 6 and 9:00 p.m.; however, several tests in October were conducted between 4:30 and 6:00 p.m. Atmospheric conditions were favorable for all tests. Temperatures 5 feet above the ground ranged from 72 to 85° F and averaged about 80° F. Wind speeds ranged from <2–12 m.p.h. and averaged about 4 m.p.h.

[1] Mention of a proprietary product does not necessarily imply endorsement by the U. S. Department of Agriculture.

The insecticides tested were as follows:

- Sumithion® (*o,o*-dimethyl *o*-4-nitro-*m*-tolyl phosphorothioate)
- Bay 39007 (*o*-isopropoxyphenyl methylcarbamate)
- Schering 34615 (*m*-cym-5-yl methylcarbamate)
- Dursban® (*o,o*-diethyl *o*-3,5,6-trichloro-2-pyridyl phosphorothioate)
- Shell SD-8211 (2-chloro-1-(2,5-dichlorophenyl) vinyl dimethyl phosphate)
- Barthrin
- Abate® (*o,o*-dimethyl phosphorothioate *o,o*-diester with 4,4′-thiodiphenol)
- Shell SD-8447 (2-chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl phosphate)

Fenthion, naled, and malathion were included as standards.

Commercial emulsifiable concentrates were used with all compounds except barthrin and Schering 34615. The concentrations of the commercial preparations in lb./gal. were: Sumithion (4.75), Bay 39007 (1.5), Dursban (4), Shell SD-8211 (2), Abate (4), Shell SD-8447 (2), fenthion (4), naled (8), and malathion (5). The emulsifiable concentrate of barthrin was prepared by dissolving 2 pounds of technical barthrin in a gallon of a mixture of xylene and Triton X-100 emulsifier (9:1 ratio). The emulsifiable concentrate of Schering 34615 was prepared by mixing equal parts of a 25 percent emulsifiable concentrate with a solution of xylene and Triton X-100 emulsifier (9:1 ratio), since the commercial preparation of Schering 34615, 25 percent E.C., did not form a stable emulsion at the concentrations needed.

The nonthermal aerosol generator used to disperse the formulations was a truck-mounted Curtis Model 55,000 calibrated to deliver 40 gallons of liquid per hour. The generator was moved at 5 m.p.h. Adult female mosquitoes, 2–7 days old, were exposed in 16-mesh screen wire cages (25 per cage) which were suspended 5 feet above ground from stakes 150 and 300 feet downwind and in a row perpendicular to the line of travel of the generator. Three cages (one containing mosquitoes of each species) were hung on each stake, a total of six cages of mosquitoes for each replication. From 2–6 replications were conducted with each concentration of each insecticide. After the passage of the aerosol generator, the mosquitoes were transferred to plastic tubes lined with clean paper. Except during exposure to the aerosols, the mosquitoes were held in insulated chests containing ice in cans. Absorbent cotton pads dipped in 10 percent sugar-water solution were placed on the holding tubes when they were returned

TABLE 1.—Mortality of adult females of three species of mosquitoes 18 hours after exposure to nonthermal aerosols of various insecticides formulated as water emulsions.

		Percentage mortality of indicated species[a]			
Insecticide	Concentration (%)	*Aedes taeniorhynchus*	*Culex pipiens quinquefasciatus*	*Anopheles quadrimaculatus*	Average for 3 species
		New Insecticides			
Sumithion	0.5	18	46	21	28
	1	86	87	87	87
	2	92	99	100	97
	4	98	100	100	99
Bay 39007	.5	58	30	81	56
	1	75	44	89	69
	2	100	96	100	99
	4	100	93	100	98
Schering 34615	.5	20	44	9	24
	1	73	86	86	82
	2	63	99	70	77
	4	96	100	100	99
Dursban	0.5	13	42	4	20
	1	54	70	65	63
	2	76	98	87	87
	4	96	98	84	93
Shell SD–8211	1	45	53	34	44
	2	83	90	49	74
	4	97	100	87	95
Barthrin	2	23	18	61	34
	4	70	75	99	81
Abate	2	21	31	4	19
	4	74	88	49	70
Shell SD–8447	4	76	38	8	41
		Standards			
Fenthion	0.5	57	65	53	58
	1	93	83	84	87
	2	100	94	94	96
	4	100	99	99	99
Naled	.5	85	42	57	61
	1	80	54	68	67
	2	99	84	99	94
	4	100	99	96	98
Malathion	1	47	32	51	43
	2	83	80	85	83
	4	95	84	90	90
None (check)		5	3	4	4

[a] Average mortality at 150 and 300 feet.

to the laboratory. Mortality counts were made 18 hours after exposure to the aerosols.

RESULTS AND DISCUSSION. The mortality data obtained for all three species of mosquitoes are presented in Table 1; the respective estimated LC_{90}'s are shown in Table 2. On the basis of the combined average LC_{90}'s for the three species, Sumithion, with an LC_{90} of 1.3 percent, was about equal to the fenthion standard (1.2 percent) and slightly more effective than the naled standard (1.9 percent). Bay 39007 and Schering 34615, with LC_{90}'s of 1.6 percent and 2.1 percent, respectively, were about equal to naled and were twice as toxic as malathion. Previously Mount *et al.* (1967) reported that Sumithion and Bay 39007 were highly effective as nonthermal aerosols against caged female *A. taeniorhynchus,* and Lofgren *et al.* (1966) obtained good results with Bay 39007 and Bay 41831 (Sumithion) as nonthermal aerosols against *Culex tritaeniorhynchus* Giles and *C. p. quinquefasciatus.*

As shown in Table 2, Dursban and Shell SD-8211, with average LC_{90}'s of 2.5 percent and 3.2 percent, were less effective than fenthion and naled, but were more effective than the malathion standard (4 percent). In other tests with nonthermal aerosols, Mount *et al.* (1967) showed that Dursban was highly effective against *A. taeniorhynchus,* and Lofgren *et al.* found Shell SD-8211 to be effective against *C. tritaeniorhynchus* and *C. p. quinquefasciatus.* Shell SD-8211 was also demonstrated to be 1.3 times more toxic than malathion in laboratory wind-tunnel tests by Glancey *et al.* (1966). As shown in Table 2, barthrin, Abate, and Shell SD-8447 were generally less effective than malathion, but barthrin was more effective against *A. quadrimaculatus.*

In general, the results obtained with the 3 species of mosquitoes were about the same; however, Bay 39007 was less effective against *C. p. quinquefasciatus* than against the other species, whereas, Shell SD-8211 was least effective, and barthrin was most effective against *A. quadrimaculatus.*

TABLE 2.—LC_{90} values for adult females of three species of mosquitoes exposed to nonthermal aerosols of various insecticides formulated as water emulsions.

Insecticide	LC_{90} (%) for indicated species			
	Aedes taeniorhynchus	*Culex pipiens quinquefasciatus*	*Anopheles quadrimaculatus*	Average for 3 species
	New Insecticides			
Sumithion	1.6	1.1	1.1	1.3
Bay 39007	1.7	2.2	1.0	1.6
Schering 34615	2.7	1.1	2.4	2.1
Dursban	2.9	1.6	2.9	2.5
Shell SD-8211	2.7	1.9	>4	3.2
Barthrin	>4	>4	2.8	>4
Abate	>4	>4	>4	>4
Shell SD-8447	>4	>4	>4	>4
	Standards			
Fenthion	1.0	1.2	1.3	1.2
Naled	1.2	2.6	1.8	1.9
Malathion	2.7	>4	3.8	4

SUMMARY. Nonthermal aerosols of eight new insecticides and three standards (malathion, naled, and fenthion) were evaluated against caged female *Aedes taeniorhynchus* (Wiedemann), *Culex pipiens quinquefasciatus* Say, and *Anopheles quadrimaculatus* Say. Sumithion (*O,O*-dimethyl *O*-4-nitro-*m*-tolyl phosphorothioate) was about equal to fenthion and slightly more effective than naled. Bay

39007 (*o*-isopropoxyphenyl methylcarbamate) and Schering 34615 (*m*-cym-5-yl methylcarbamate) were about equal to naled and twice as effective as malathion. Dursban (*O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate) and Shell SD-8211 (2-chloro-1-(2,5-dichlorophenyl)= vinyl dimethyl phosphate) were less effective than fenthion or naled but were more effective than malathion. Barthrin, Abate (*O,O*-dimethyl phosphorothioate *O,O*-diester with 4,4′-thiodiphenol), and Shell SD-8447 (2-chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl phosphate) were generally less effective than malathion, but barthrin was more effective against *A. quadrimaculatus*.

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ULTRA-LOW VOLUME AND CONVENTIONAL AERIAL SPRAYS FOR CONTROL OF ADULT SALT-MARSH MOSQUITOES, *AEDES SOLLICITANS* (WALKER) AND *AEDES TAENIORHYNCHUS* (WIEDEMANN), IN FLORIDA[1]

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The past few years the concept of low volume spraying, that is, the use of undiluted or concentrated insecticide, for area control of insects has captured the imagination of many engaged in insect control. In large-scale insect control programs, the savings in cost, time, and labor that this technique offers are enormous. Credit for the modern-day interest in this method goes to the Methods Improvement Section of the Plant Pest Control Division (PPCD), ARS, USDA. The first experiments with this method (in grasshopper control) were reported by Messenger (1963, 1964).

Before proceeding, it is necessary to clarify terminology in this field. It is quickly obvious in talking to people involved in other aspects of insect control that the term "low volume" is not very descriptive. Researchers on cotton insects consider as "low volume" applications of technical or concentrated insecticide between ½ to 15 gallons per acre. One-half gallon or less is called "ultra-low volume." From this definition it is apparent that ultra-low and low volume sprays have been used for mosquito control for many years. In fact over 15 years ago Blanton *et al.* (1950) reported on tests in Alaska where

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