TOXICITY OF PYRETHROID INSECTICIDE AEROSOLS TO *ANOPHELES QUADRIMACULATUS* SAY AND *PSOROPHORA COLUMBIAE* (DYAR AND KNAB) IN ARKANSAS[1, 2]

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ABSTRACT. Nine new synthetic pyrethroids were tested as contact aerosols in a laboratory wind tunnel against field-collected adult female *Anopheles quadrimaculatus* Say and *Psorophora columbiae* (Dyar and Knab) in Arkansas. Propoxur and fenitrothion, potentially useful carbamate and organophosphorus adulticides, were also included in most of the tests. Malathion was included in all tests as a standard for comparison. In general, the pyrethroids were highly effective against both mosquito species. An exception to this high order of toxicity was noted with permethrin (3-phenoxyphenyl) methyl (±) *cis, trans* - 3 - (2, 2 - dichloroethenyl) - 2, 2 - dimethylcyclopro - panecarboxylate) against *Ps. columbiae,* since it was only 2.1x more toxic than malathion against this species. Propoxur and fenitrothion were 2.6—5x more effective than malathion in these tests.

A cooperative research program on the development of new insecticides for rice land mosquito control was initiated between the University of Arkansas and the U. S. Department of Agriculture in 1971 (Mount et al. (1972), Coombes et al. (1973) and Pierce et al. (1973).) During 1975–76 laboratory wind tunnel research with selected pyrethroid insecticides was continued with the 2 most important rice land species of mosquitoes, *Anopheles quadrimaculatus* Say and *Psorophora columbiae* (Dyar and Knab). The objective of these experiments was to establish the toxicity of the new pyrethroids relative to a malathion standard. Propoxur and fenitrothion, potentially useful carbamate and organophosphous compounds, respectively, were also included in most of the tests for comparison.

METHODS AND MATERIALS. The pyrethroid insecticides evaluated were: d-trans resmethrin (5-benzyl-3-furyl) methyl *trans* -(±)-2,2-dimethyl-3-(2-methyl-propenyl)-cyclopropanecarboxylate); Roussel Vclaf RU-11679 ((5-benzyl-3-furyl) methyl *trans* - (±) - 3 (cyclopentlidenemethyl) - 2, 2 - dimethyl - cyclopropanecarboxylate); d - phenothrin (3 - phenoxyphenyl) methyl *cis trans* - (±) - 2, 2 - dimethyl - 3 - (2 - methylpropenyl) cyclopropanecarboxylate); *d - trans* allethrin (*trans* - (+) - 2, 2 - dimethyl - 3 - (2 - methylpropenyl) cyclopropanecarboxylic acid ester with (+) - 2 - allyl - 4 - hydroxy - 3 - methyl - 2 - cyclopenten - 1 - one); permethrin (3 - phenoxyphenyl) methyl (±) *cis, trans* - 3 - (2, 2 - dichloroethenyl) - 2, 2 - dimethylcylopropanecarboxylate; *d - cis* permethrin (3 - phenoxyphenyl) methyl *cis* - (±) - 3 - (2, 2 - dichloroethenyl) - 2, 2 - dimethylcylopropanecarboxylate); NRDC - 156 (cyano (3 - phenoxy - phenyl) methyl *cis* - (±) 13 - (2, 2 - dibromoethenyl) - 2, 2 - dimethyl - cyclopropanecarboxylate); NRDC - 161 ((S) - [cyano (3 - phenoxyphenyl) methyl] *cis* - (+) - 3 - (2, 2 - dibromoethenyl) - 2, 2 - dimethylcyclopropanecarboxylate); *d - trans* permethrin (3 - phenoxyphenyl) methyl *trans* - (+) - 3 - (2, 2 - dichloroethenyl) - 2, 2 - dimethyl cyclopropanecarboxylate) - supplied by the World Health Organization.

The mosquitoes used in the experiments were adult female *An. quad-*

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[1] This paper reflects the results of research only. Mention of a pesticide, commercial or proprietary product in this paper does not constitute a recommendation or an endorsement of this product by the Arkansas Agricultural Experiment Station and Cooperative Extension Service or the U. S. Department of Agriculture, nor does it imply registration under FIRFA as amended.

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rimaculatus and *Ps. columbiae* field collected near Lonoke and Stuttgart, Ark. respectively. The specimens were drawn into plastic holding tubes with battery powered aspirators and held in insulated chests containing ice, and moist cotton, while being transported to the laboratory. The mosquitoes were anesthetized with carbon dioxide and transferred into cardboard exposure cages, 8.65 cm x 5.12 cm high, with 16-mesh galvanized screen wire ends. Approximately 25 mosquitoes were placed in each cage for exposure to insecticidal aerosols. Each insecticide treatment was tested across a complete range of discriminating concentrations (4–8) with 4–6 replications of 25 mosquitoes per concentration. The wind tunnel and testing procedures used were the same as those described by Mount et al. (1976). Concentration-morality (and concentration-knockdown) data obtained in these tests were analyzed with a probit analysis program written according to the procedures given by Finney (1971).

RESULTS AND DISCUSSION. The LC_{50}'s, LC_{90}'s, respective 95% confidence limits, and LC_{90} ratios to malathion for the mosquito adulticides tested are given in Tables 1 and 2 for *An. quadrimaculatus* and *Ps. columbiae,* respectively. LC_{90}'s (knockdown concentrations) and 95% confidence limits are also given in Table 1. The adulticides are ranked in order of decreasing toxicity (LC_{90}) in both tables. *An. quadrimaculatus* and *Ps. columbiae* exposed only to acetone in the wind tunnel and handled in the same manner as those exposed to insecticides showed 7% and 5% mortality, respectively.

The results with *An. quadrimaculatus* indicated that RU-11679 and *d-trans* resmethrin both alone and synergized with piperonyl butoxide were extremely toxic (35–77 x malathion) against this species (Table 1). These results agree fairly well with data reported by Mount and Pierce (1975) in wind tunnel tests with these pyrethroids against a colony strain of *An. quadrimaculatus.* RU–11679 was potentiated ca. 2 x by the addition of the synergist whereas *d trans* resmethrin was unpotentiated in these tests. Permethrin *d*-phenothrin, and S–Bioallethrin both alone and synergized were all highly effective against *An. quadrimaculatus* being 6–42 x more toxic than malathion. These compounds were all potentiated ca. 3 x by synergism. Propoxur was 5 x more effective than the malathion standard against this species. By comparison, Mount et al. (1975) reported that propoxur was 3.2 x

Table 1. Toxicity of aerosols to field-collected female *Anopheles quadrimaculatus* exposed in a wind tunnel at Lonoke, Ark., 1975.

Adulticide	1 hr. KC_{90}[b] (ppm)	12 hr. LC_{50}[b] (ppm)	12 hr. LC_{90}[b] (ppm)	Reciprocal LC_{90} ratio to malathion
synergized RU—11679[a]	37(28–55)	3(2–4)	20(15–27)	77
d-trans Resmethrin	12(10–13)	7(5–8)	21(18–26)	73
synergized *d-trans* Resmethrin[a]	35(27–58)	9(5–12)	33(25–50)	46
synergized Permethrin	94(69–153)	4(2–6)	36(24–61)	42
RU—11679 (Bioethemomethrin)	44(33–72)	5(3–7)	44(30–75)	35
synergized +Phenothrin	118(91–165)	6(4–9)	63(45–96)	24
synergized *d-trans* Allethrin	30(25–39)	10(5–15)	85(59–143)	18
Permethrin	223(173–304)	27(21–33)	117(90–163)	13
+Phenothrin	197(146–289)	31(24–39)	160(118–236)	9
d-trans Allethrin	45(33–446)	39(27–52)	250(180–387)	6
propoxur	220(155–264)	93(47–128)	301(236–437)	5
Malathion (standard)		62	1541	1

[a] Synergized at a ratio of 1 part pyrethroid to 5 parts piperonyl butoxide.
[b] 95% confidence limits in parentheses.

Table 2. Toxicity of aerosols to field-collected female *Psorphora columbiae* exposed in a wind tunnel at Stuttgart, Arkansas, 1976.

Adulticide	24 hr. LC_{50} (ppm) [a]	24 hr. LC_{90} (ppm) [a]	Reciprocal LC_{90} ratio to malathion
NRDC—161	10(7–12)	79(54–138)	18.0
NRDC—156	19(15–23)	86(68–116)	17.0
d-cis-permethrin	30(25–36)	114(39–160)	13.0
d-trans-permethrin	74(64–85)	228(188–292)	6.3
Propoxur	161(136–187)	454(373–591)	3.2
Fenitrothion	176(141–212)	562(443–786)	2.6
Permethrin	139(115–166)	689(527–982)	2.1
Malthion (standard)	279(224–340)	1442(1082–2148)	1.0

[a] 95% confidence limits in parentheses.

greater than malathion when both were applied as ULV aerosols against a colony strain of *An. quadrimaculatus*.

NRDC 156, *d-trans*-permethrin, *d-cis* permethrin, and NRDC 161 were 6.3–18x more toxic than malathion against *Ps. columbiae* (Table 2). The relatively low toxicity of permethrin to this species was unexpected since it had been 4.2–21x more toxic than malathion against 3 other species (Mount, unpublished data). Future tests to study possible natural tolerance with permethrin against both *Ps. columbiae* and *Aedes taeniorhynchus* (Wiedemann) should include synergist combinations. Propoxur and fenitrothion compared favorably with the most toxic organophosphorus adulticides previously tested as aerosols against *Ps. confinnis* [= *columbiae*] (Pierce et al. 1973).

These data revealed the high order of efficacy of pyrethroid insecticides against rice land mosquitoes. Results of these experiments should aid in the development of these and/or related pyrethroids for use in future mosquito control programs.

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