EFFECTS OF A SYNTHETIC PYRETHROID, SD43775, ON NONTARGET ORGANISMS WHEN UTILIZED AS A MOSQUITO LARVICIDE

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ABSTRACT. A synthetic pyrethroid, SD43775 [Benzeneacetic acid, 4-chloro-alpha-(1-methyl-ethyl)-, cyano (3-phenoxyphenyl) methyl ester], showed relatively high activity on 2-day-old mosquito fish, *Gambusia affinis* (Baird and Girard), when applied at rates used for mosquito control. Populations of plankton crustaceans and mayfly nymphs were also affected but recovered within a short period of time. Populations of corixid, notonectid, and aquatic beetles were slightly affected, and the effects were sustained throughout the experiment. Chironomid larval populations were suppressed and emergence inhibited. No deleterious effects were observed against rotifer populations.

Insecticides with different modes of action are urgently needed in California because resistance to chlorinated hydrocarbons and OP compounds has become severe and widespread in populations of important mosquito species (Schaefer and Wilder 1970; Womeldorf et al. 1972). This laboratory, therefore, evaluated the biological activity of new synthetic pyrethroids and other compounds in the laboratory and field against mosquitoes (Schaefer et al. 1976). Concurrently, studies were initiated to investigate their effects on nontarget organisms.

This report presents the results of the laboratory and field tests conducted to

evaluate effects of SD43775 [Benzeneacetic acid, 4-chloro-alpha-(1-methylethyl)-, cyano (3-phenoxyphenyl) methyl ester] on organisms commonly associated with mosquito breeding habitats.

MATERIALS AND METHODS. Thirty-two species or species groups were collected from the experimental plots. They are as follows: 1 genus of planarians, *Bothromesostoma* spp.; 1 genus of rotifers, *Asplanchna* spp.; 3 genera of cladocerans, *Ceriodaphnia* spp., *Moina* spp., *Alona* spp.; 1 genus of ostracods, *Cyprois* spp.; 2 genera of copepods, *Cyclops* spp., *Diaptomus* spp.; 1 species of side swimmers, *Hyalella azteca* (Saussure); 1 genus of mayflies, *Callibaetis* spp.; 1 genus of dragonflies, *Pantala* spp.; 1 genus of damselflies, *Enallagma* spp.; 1 genus of corixids, *Corisella* spp.; 1 species of notonectids, *Notonecta unifasciata* Guerin; 4 species and 1 genus of dytiscid beetles, *Thermonectus basillaris* (Harris), *Cybister explanatus* LeConte, *Copelatus chevrolati renovatus* Guignot, *Eretes sticticus* (L.), *Laccophilus* spp.; 3 species and 1 genus of hydrophilid beetles *Hydrophilus triangularis* Say, *Tropisternus lateralis* (F.), *Enochrus hamiltoni pacificus* Leech, *Helophorus* spp.; 2 species and 1 genus of chironomid midges, *Chironomus stigmaterus* Say, *Goeldichironomus holoprasinus* (Goeldi), *Tanypus* spp.; 1 genus of biting midges, *Culicoides* spp.; 1 genus of rattailed maggots, *Xylota* spp.; 1 species of shore flies, *Brachydeutera argentata* (Walker); 1 group of oribatid mites; 1 species of spiders, *Pardosa ramulosa* (McCook); and 1 species of mosquito fish, *Gambusia affinis* (Baird and Girard).

Technical grade material was used for evaluation of toxic effects on mosquito fish fry in the laboratory (temp ca. 24°C—27°C); serial dilutions were prepared by adding aliquots of stock acetone solution to glass aquaria (25 x 16 x 18 cm) containing 4 liters of tap water and 15 three-day-old or younger fry. Each concentration was run in triplicate and tested twice. Mortality was checked daily for 4 days.

A simulated field test against crustacean organisms was conducted outdoors in 5-gal aquaria. One aquarium was treated at 0.053 ppm with SD43775 (in acetone), and one was left as check. Techniques used for population census were previously described (Miura and Takahashi, 1973).

Bioassays of treated water (0.2 ppm) were conducted utilizing 1 m^2 disposable ponds (270-liter capacity) at Fresno, California (Schaefer et al., 1974). Three 100 ml water samples from treated and untreated ponds were filtered through a fine nylon screen and placed into Pyrex® custard cups, and 20 to 50 mixed stages of laboratory-acclimatized (24°C–27°C) mixed cultures of cladocerans, ostracods, and rotifers were added to each cup. Mortality was checked daily for 6 days.

Field tests were conducted at the Tracy experimental plots (0.05 acre, 30.5 x 6.1 m each) located about 20 miles northwest of Bakersfield, California. Treatments were made with a hand sprayer using EC formulations (Schaefer et al., 1976). Methods for field evaluation of effects on nontarget organisms were described previously (Miura and Takahashi, 1973, 1975). The techniques used for monitoring plankton organisms and small immature insects were as follows: a bucketful of water from each plot immediately pre- and post-treatment (ca. 5 to 7 liters) was collected at random across the test plot with a long-handled dipper (450 ml) and transported to the laboratory where population changes were monitored daily. In the laboratory a known amount of the sample water (usually 4 to 5 liters) was randomly dipped from the bucket and the filterable component was concentrated into a plastic tube, 30 mm in diam and 80 mm long, with a fine nylon mesh at one end. Organisms in the concentrator were then gently washed into a Pyrex® custard cup (5 oz.), siphoned into a pipet (1 ml), counted under a stereomicroscope, and then returned to their respective containers. In addition to monitoring organisms in the pre- and post-treatment samples in the laboratory (as described above), population changes in treated field plots also were censused by making daily water collections and counting organisms present.

Counts to measure fluctuations in abun-

dance of free-moving aquatic insects in treated plots were made daily using minnow traps modified by lining the inner side of each trap with window screening. Unbaited traps were set in the plot water in the morning and retrieved the next morning for counts.

RESULTS AND DISCUSSION. Table 1 shows biological activity of SD43775 against mosquito fish fry in the laboratory. It is toxic against very young fry (less than 3-day-old at the start of the test); the LC_{50} is about 0.0026 ppm at the end of 3 days exposure.

Susceptibility to the chemical seems to decrease with maturity. Preliminary tests demonstrated that females, exposed to concentrations of 0.001 ppm and 0.01 ppm for 3 days, showed no deleterious signs. Exposure to 0.1 ppm showed 100% mortality.

Table 1. Biological activity (%) of SD43775 on mosquito fish fry (3-day-old or younger).

Concn (ppm)	Test no.	Post-treatment (hr) 24	48	72	96
Control[a]	1	0	0	0	0
	2	0	0	0	0
0.0008	1	0	0	0	0
0.001	1	0	0	0	0
0.002	1	0	2.2	2.2	6.7
	2	6.7	23.3	26.7	33.3
0.003	2	36.7	73.3	76.7	76.7
0.004	1	42.2	62.2	71.1	71.1
	2	70	93.3	100	
0.005	2	83.3	100		

[a] Acetone only.

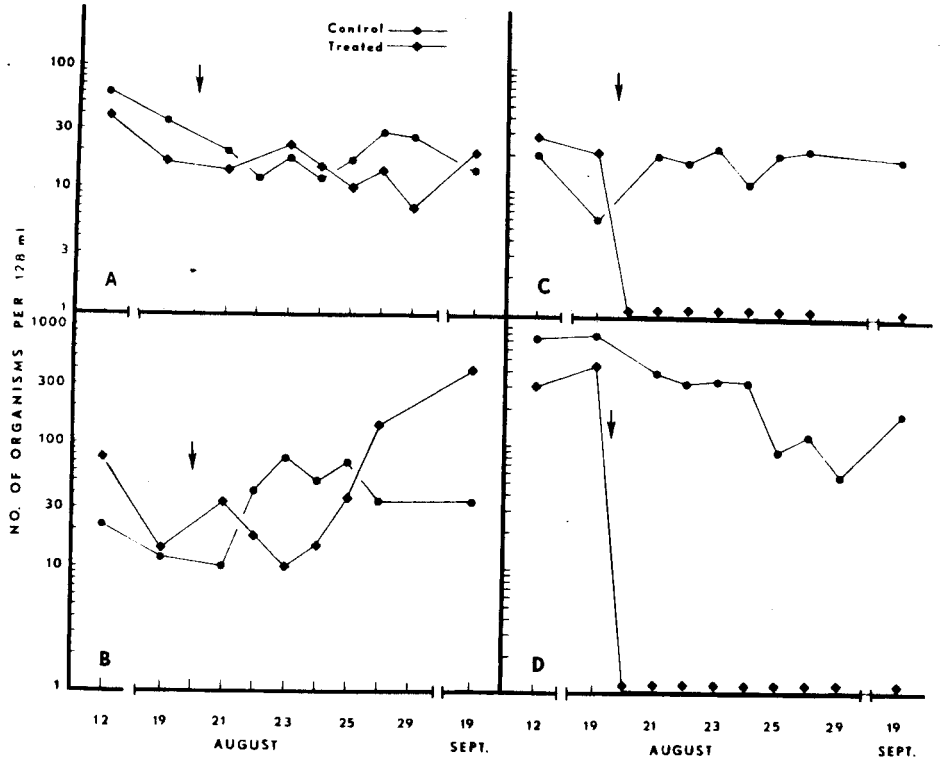

Fig. 1. Outdoor tests in 5-gal aquaria: Effects of SD43775 (0.053 ppm) against (A) Copepods; (B) Ostracods; (C) Amphipods; (D) Cladocerans. The arrow indicates application day.

Table 2. Toxicity of water samples from ponds treated with SD43775 (0.2 ppm) on August 5, 1975 (F. T. No. 75–22) at Fresno, CA (in % mortality of organisms after 24-hr exposure).

Organism	Sample collection day (after application)						
	0[a]	1	2	3	4	5	6
Ceriodaphnia spp. (cladocerans)	98.4	38.1	33.3	9.1	12.9	4.7	3.4
Control	0	2.8	4.0	[b]	–	–	–
Alona spp. (cladocerans)	100	20.8	41.4	21.7	10.0	5.0	0
Control	0	5.2	6.0	–	–	–	–
Cyprois spp. (ostracods)	77.8	13.5	3.5	0	6.0	0	0
Control	0	0	0	–	–	–	–
Asplanchna spp. (rotifers)	0	0	0	–	–	–	–
Control	0	0	0	–	–	–	–

[a] Sampled 2 hr after treatment.
[b] – = no water sample was taken on this day.

Possible cross-resistance with the organochlorine R-strain of mosquito fish to pyrethroids has been reported by Fabacher and Chambers (1972).

Tests with SD43775 in outdoor 5-gal aquaria containing crustaceans are shown in Fig. 1. Copepods and ostracods showed relative tolerance to the compound, but cladoceran and amphipod populations were eliminated within 1 to 2 days after the treatment.

The persistence of biological activity of the compound in water under natural conditions is shown in Table 2. It is relatively stable compared to other larvicides. Even 3 to 4 days after the application, some activity persisted.

Possible effects of SD43775 on nontarget organisms when utilized as a mosquito larvicide were examined on 5 separate field tests (F. T. Nos. 10, 12, 15, 18, and 21). The rates tested were 0.025, 0.05, 0.075, and 0.1 lb AI/acre. It is impractical to include all results; therefore, only representative data and a summary of results are given in this report. The unreported information is similar and confirms the data presented. It is available to interested persons.

Table 3 summarizes the effects on plankton organisms and some small immature insects. Most of the plankton organisms showed some effect by the rates applied. Mayfly, chironomid, and culicoid larvae died when collected in the water sample taken immediately after treatment and held

Table 3. Effects of SD43775 on nontarget organisms: Applied at 0.075 lb AI/acre against pasture mosquitoes, July 29, 1975 (F. T. No. 75–18).

Organism	July			August	
	29	30	31	1	2
	No. of organisms in the pre-treatment water, (2,250 ml)[a]				
Rotifers	+[b]	+	+	+	+
Cladocera	8	5	5	10	15
Copepods	162	223	211	238	257
Mayflies N[c]	93	272	281	288	315
Midges L[d]	6	46	94	134	134
Biting midges L	0	2	2	3	3
	No. of organisms in water (2,250 ml) collected immediately after treatment				
Rotifers	+	+	+	+	+
Cladocera	7	1	0	0	0
Copepods	18	4	0	0	0
Mayflies N	14	0	0	0	0
Midges L	1	0	0	0	0
Biting midges L	4	3	0	0	0
	No. of organisms in water (2,250 ml) from daily field collections				
Rotifers		+	+	+	+
Cladocera		0	0	1	87
Ostracods		0	0	0	3
Copepods		2	11	1	13
Midges L		0	5	7	350

[a] Water samples (pre-treatment and immediately after treatment) were held in the laboratory, and organisms were observed daily.
[b] + = present, but not counted.
[c] N = nymphs.
[d] L = larvae.

Table 4. Effects of SD43775 on nontarget insects: Applied at 0.025 lb AI/acre against pasture mosquitoes, July 22, 1975 (F. T. No. 75–15).

Insect	July 22	23	24	25	26
	No. of insects collected from check field by a minnow trap				
Water boatmen	2	2	0	0	–
Back swimmers	1	9	14	3	–
Laccophilus spp. A[a]	13	3	5	0	–
T. lateralis A	26	17	10	0	–
H. triangularis A	0	2	1	0	–
	No. of insected collected from treated field by a minnow trap				
Water boatmen	5	6 (28)[b]	15 (4)	3	4
Back swimmers	2	4 (5)	20 (5)	6	3
Laccophilus spp. A	8	5 (1)	4	3	1
T. lateralis A	18	15 (6)	7 (2)	4	7
H. triangularis A	1	0	1	1	0
Helophorus spp. A	0	1	0	0	0

[a] A = adults.
[b] Number in parentheses indicates number of dead specimens.

in the laboratory for observation. Those results are in agreement with the data obtained from the supplemental field collections. Morbidity from the synthetic pyrethroid is rapid; very few copepods and mayfly nymphs were found in the water samples collected immediately after treatment. Rotifers showed no noticeable effects.

Free-moving insect populations were not noticeably affected in the treated ponds; however, a few dead water bugs and beetles were found in the water (Table 4). The compound caused a very rapid hyperexcitation and then complete paralysis. Recovery of affected bugs and beetles was also noticed.

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