Mirex Incorporation in the Environment: Toxicity in Selected Freshwater Organisms

by
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Mirex residues detected in a number of invertebrate organisms (MARKIN et al., 1972; NAQVI and DE LA CRUZ, In Press) and various groups of vertebrate species (MARKIN et al., 1972; ALLEY, In Press) monitored from the wild are indicative of the widespread occurrence of this pesticide in nature. The ecological significance, however, of Mirex incorporation in the environment lies in its effects on the biota chronically exposed to it. The toxicity of Mirex to non-target organisms has been reported for selected species of estuarine invertebrates (LOWE et al., 1971), freshwater crayfish (LUDKE et al., 1971), larval crabs (BOOKHOUT et al., 1972) and certain vertebrate species (VAN VALIN et al., 1968; GAINES and KIMBROUGH, 1970). The paucity of information on the toxicity of Mirex to non-target species prompted us to conduct bioassay tests on selected freshwater invertebrates commonly found in farm ponds located in areas designated for the fire ant control program. In this brief communication, we are presenting our findings regarding the toxicity of Mirex to five species of pond invertebrates. This effort is a part of our continuing investigation on the toxicity, physiological and ecological effects of Mirex to non-target species supported by a grant under Cooperative Agreement no. 12-14-100-10, 935-33 with the USDA Agricultural Research Service.

METHODS

Specimens of a species of amphipod (Hyallela azteca), a dragonfly nymph (Macromia sp.), a gyrinid beetle (Dineutes americanus), a water strider (Gerris remigis) and a shrimp (Palaemonetes kadiakensis) were collected with dip nets from a garden pond located on the Mississippi State University campus and from a managed lake on the Noxubee National Wildlife Refuge. Both places supposedly have not received any direct application of Mirex bait although the counties where they are located (Oktibbeha and Noxubee counties respectively) are included in the fire ant control program, and have received the prescribed dosage of Mirex treatments since 1968. The different species collected from the field were pooled and held in separate glass containers for 48 hr prior to bioassay.

Bulletin of Environmental Contamination & Toxicology,
Vol. 10, No. 5 © 1973 by Springer-Verlag New York Inc.

Bioassay solutions were prepared by serial dilution with tap water from a 1% stock solution of technical grade Mirex in acetone. Solutions used as control were prepared in a similar manner from an equivalent acetone stock. The tap water used in all preparations was allowed to stand for at least 24 hr and was treated with saturated sodium thiosulfate to dechlorinate the 6 ppm chlorine present in the tap water. Batches of 25-50 animals of each species were transferred in 3-5 dm^3 glass containers. All experiments were conducted in triplicate in an environmental chamber at 23-25°C.

LD_{30}, LD_{50}, LD_{99} and upper and lower limits of lethal concentrations in parts per million for Gerris, Dineutes and Palaemonetes were determined by probit analysis on an IBM 360-40 digital computer using the program of DAUM and KILCREAS (1966). Percent mortalities but not LD values were considered for Hyallela and Macromia nymph at 1 ppb and 1 ppm Mirex concentrations. Percentages of mortality were calculated according to the formula used by LUDKE et al. (1971) as follows:

$$M_x = \frac{Sc - St}{Sc} \times 100$$

where M_x = % mortality caused by Mirex
Sc = % of surviving control animals
St = % of surviving treated animals

In all cases, an animal was considered dead when it failed to respond to the prod of a probe.

RESULTS AND DISCUSSION

The LD_{30}, LD_{50}, and LD_{99} values together with the upper and lower lethal concentrations of Mirex for the water strider Gerris remigis and the gyrinid beetle Dineutes americanus are given in Table 1A; LD values for the shrimp Palaemonetes kadiakensis are given in Table 1B. Due to high mortality in the control of Gerris, this experiment was terminated after 24 hr. Palaemonetes did not exhibit significant mortality after 24 and 48 hr exposures. Comparative tolerances of the 3 species appeared to be Palaemonetes > Dineutes > Gerris.

Corrected percent mortalities for Hyallela and Macromia nymph at 1 ppb and 1 ppm Mirex respectively for different periods of time are shown in Table 2. The difference in concentration used and the differences in the periods of exposure between Hyallela and Macromia precluded any comparison of toxicities not to mention the great variation in the sizes of these two arthropods. The delayed mortality effect of Mirex was evident from the results presented here. LUDKE et al. (1971) and LOWE et al. (1971) have already pointed out this phenomenon of delayed effect.

TABLE 1A

LD_{30}, LD_{50} and LD_{99} values in ppm Mirex determined for Gerris remigis at 24 hr exposure and Dineutes americanus at 24, 48, and 72 hr exposures. Values in parentheses are the upper and lower limits.

Species		24 hr	48 hr	72 hr
Gerris	LD_{30}	0.060 (0.002-0.137)	-	-
	LD_{50}	0.13 (0.02-0.39)	-	-
	LD_{99}	1.38 (0.88-6.83)	-	-
Dineutes	LD_{30}	1.12 (0.82-2.21)	0.05 (0.013-0.090)	0.02 (0.002-0.033)
	LD_{50}	2.06 (1.36-4.53)	0.11 (0.05-0.17)	0.04 (0.012-0.072)
	LD_{99}	3.94 (1.96-5.01)	2.75 (0.93-3.54)	2.16 (0.65-1.64)

TABLE 1B

LD_{30}, LD_{50} and LD_{99} values in ppm Mirex determined for Palaemonetes kadiakensis at 72, 96, 120 hr exposures. Values in parentheses are the upper and lower limits.

	72 hr	96 hr	120 hr
LD_{30}	0.90 (0.09-1.14)	0.44 (0.06-1.22)	0.09 (0.01-1.12)
LD_{50}	1.01 (0.22-2.40)	0.51 (0.07-1.95)	0.19 (0.05-2.11)
LD_{99}	2.31 (0.88-3.61)	1.88 (0.83-2.02)	0.84 (0.90-1.43)

TABLE 2

Percent mortalities observed for the amphipod (Hyallela azteca) and the dragonfly nymph (Macromia sp.) at 1.0 ppb & 1.0 ppm Mirex exposure respectively.

Species	Mirex Concentration	Exposure (hr)	Animals (no.)	Mortality (%)
Hyallela	1.0 ppb	240	50	1.07
		288	50	12.64
		480	50	13.66
		576	50	38.89
		600	50	53.57
Macromia	1.0 ppm	24	25	31.92
		48	25	48.11
		72	25	79.63
		96	25	88.01
		120	30	92.40
		144	30	96.31

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