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Toxicities of Five Organochlorine Compounds in Water and Sediment to *Nereis virens*

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The Ocean Dumping Control Act of Canada limits organohalogens in materials to be dumped in the marine environment to "quantities not exceeding 0.01 parts of a concentration shown to be toxic to marine animal and plant-sensitive species...." To date, information on the lethality to aquatic organisms of such compounds in sediment is limited. Crabs and shrimp exposed to sediment containing 60 mg/kg of Aroclor 1254 were not killed (NIMMO et al. 1971), and Aroclor 1254 in sediment at concentrations up to 500 mg/kg were not lethal to the minnow, Pimephales promelas (HALTER & JOHNSON 1977). Chlordane, DDT, dieldrin, endosulfan and endrin in water and in sediment were extremely toxic to shrimp, Crangon septemspinosa. The 96-h LC50's for the compounds in water ranged from 0.2 to 2.0 µg/L and in sediment from 4 to 120 µg/kg. In contrast, the 96-h LC50's for Aroclor 1242, Aroclor 1254, and hexachlorobenzene in water were 13, 12 and greater than 7 µg/L, respectively, and in sediment were greater than 780, 3400 and 300 µg/kg, respectively (McLEESE & METCALFE 1980). Apparently, adsorption to sediment mitigated the toxicity.

The polychaete worm, Nereis virens, lives in more direct contact with sediment than the shrimp, Crangon septemspinosa, and it is possible, therefore, that organochlorine compounds adsorbed to the sediment could be more toxic to the worm. However, the long-term LC50 of dieldrin in water for the polychaete worm, Ophrytrocha diadema, was greater than 10 µg/L for larvae and about 60 µg/L for adults (HOOFTMAN & VINK 1980). These values are considerably higher than the 96-h LC50 of dieldrin with shrimp (0.4 µg/L, McLEESE & METCALFE 1980), possibly indicating that polychaete worms generally may be more resistant to organochlorine compounds than shrimp.

In this study, the lethalities of chlordane, endosulfan, endrin, DDT and dieldrin in water and in sediment to Nereis were investigated to allow a comparison of the sensitivity of Nereis with that of Crangon.

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MATERIALS AND METHODS

The lethality of each compound in water was determined in static tests with five worms (range 2.5 to 10 g) in 2 L of sea water in glass beakers. The animals were transferred to beakers with freshly prepared solutions every 48 h and the tests were terminated at 288 h (12 d).

Sediment tests were static with five worms in 2-L beakers containing 500 g of sandy sediment (3 cm deep) and 250 mL of sea water (1.5 cm). The worms were transferred to newly prepared sediment every 96 h and tests were terminated at 288 h.

The tests were conducted at 9 to 10°C and the solutions were aerated gently.

Water samples (50 mL) were taken from beakers with intermediate test concentrations at 0, 2, 6, 24 and 48 h and from the remaining tests at 2, 24 or 48 h. Similarly, sediment samples (20 g) and samples of the surficial water (50 mL) were taken from selected sediment tests at 24, 48 and 96 h and from the remaining tests at 24, 48 or 96 h.

For comparative purposes, methods and procedures in this study followed closely those described in McLEESE & METCALFE (1980). Included are methods for adding compounds to the beakers, determining the concentration of the compounds in water samples, calculating average concentration of the compounds during tests, estimating times to 50% mortality (LT50), and calculating the concentration of a compound that causes 50% mortality in a specified time, in this case, 288 h (288-h LC50).

The organic carbon content of the sediment was determined by a modified Walkley-Black method (AKAGI & WILDISH 1975). To determine the concentration of the compounds in sediment, approximately 15 g wet weight of a sediment sample were dried with pesticide-grade acetone (3 x 10 mL washings). The acetone from the washing was brought to at least 100 mL with distilled water and extracted with hexane (3 x 10 mL). The dried sediment was extracted with hexane for 1 h in a Soxhlet apparatus. The combined hexane extracts were evaporated on a roto-evaporator and brought to final volume. The samples were analyzed on a gas chromatograph equipped with a ^{63}Ni electron capture detector. Conditions were as described by McLEESE & METCALFE (1980).

RESULTS AND DISCUSSION

The sediment used in the tests contained sand (17%), silt and clay (83%), and had a low organic carbon content (2%). The worms burrowed into the sediment soon after they were placed in the beakers and usually soon after transfer to newly prepared sediment.

Worms under stress in water tests everted the proboscis, lost equilibrium and, depending on the severity of the stress, became immoblized and died. When under stress in sediment tests, worms emerged from the sediment by 24 to 96 h and subsequently did not burrow even after sediment changes. Following emergence, the behavior pattern followed that of worms under stress in water tests.

There were no deaths by 96 h with endosulfan and chlordane but behavior abnormalities were observed at the highest concentrations. Consequently, observations for these and the other compounds were not terminated until 288 h.

LT50's ranging from 135 to 265 h were obtained with endosulfan in the water and sediment tests and LT50's ranging from 220 to 270 h were obtained with chlordane. The estimated 288-h LC50's are 0.1 mg/L and 0.34 mg/kg for endosulfan and 0.22 mg/L and ≤5.8 mg/kg for chlordane (Table 1).

There were no deaths by 288 h among worms tested with dieldrin, DDT or with endrin in water (Table 1). Two of five worms died at the higher concentration of endrin in sediment. The surviving worms appeared to be in excellent condition with normal burrowing behavior at 288 h.

TABLE 1. LC50's (288 h) of organochlorine compounds in water and sediment to Nereis virens.

	Sea water tests[a]	Sediment tests[a]	
	288-h LC50	288-h LC50 sediment	288-h LC50 surficial water
Compound	(mg/L)	(mg/kg)	(mg/L)
Endosulfan	0.10	0.34	0.10
Chlordane	0.22	≤5.8	0.19
Endrin	ND(0.11)	2/5D (28)	2/5D(0.11)
Dieldrin	ND(0.17)	ND (13)	ND(0.02)
DDT	ND(0.03)	ND (16.5)	ND(0.01)

[a]ND means no deaths at highest concentration tested (in brackets); 2/5D means two of five dead at specified concentration at 288 h.

Because of the early emergence of worms from sediment in tests with endosulfan, the major portion of the exposure was in the surficial water. Not surprisingly, there was close agreement between LT50's for worms exposed to endosulfan in water and LT50's

of worms exposed to sediment when the latter were expressed in relation to average concentration in the surficial water (Figure 1). This indicates that the major contribution to lethality was from endosulfan in the surficial water. Death was not caused by lack of contact with sediment because worms maintained in water in control and other tests did not die (Table 1).

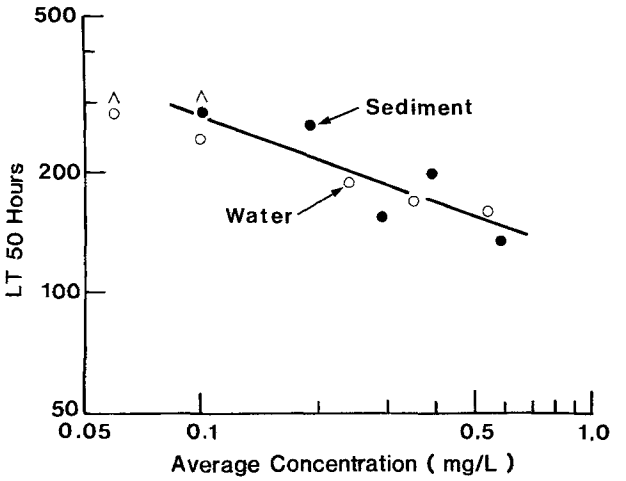

Figure 1. Lethality line for Nereis exposed to endosulfan in water at 9°C with LT50's from sediment tests plotted against average concentration in surficial water.

Similar comparisons cannot be made for the other compounds because of insufficient lethality data. Only one LT50 was obtained for chlordane in sediment and, as mentioned before, none were obtained for endrin, dieldrin or DDT.

For animals of equal sensitivity, it would be expected that the 288-h LC50 would be equal to or less than the 96-h LC50. However, the 288-h LC50's of endosulfan and chlordane in water and in sediment for worms are 75 to 500 times greater than the respective 96-h LC50's for shrimp. This and the lack of mortality among worms exposed to endrin, dieldrin and DDT at the highest concentrations tested indicate that Nereis is considerably more resistant than Crangon to these organochlorine compounds.

REFERENCES

AKAGI, H. M. and D. J. WILDISH: Fish. Res. Board Can. MS Rep. 1370, 15 p. (1975).

HALTER, M. T. and H. E. JOHNSON: In Aquatic Toxicology and Hazard Evaluation. Ed. Mayer, F. L. and J. L. Harmelink. ASTM Tech. Publ. 634, 107 (1977).

HOOFTMAN, R. N. and G. J. VINK: Ecotoxicology and Environmental Safety 4, 252-262 (1980).

McLEESE, D. W. and C. D. METCALFE: Bull. Environm. Contam. Toxicol. 25, 921-928 (1980).

NIMMO, D. R., P. D. Wilson, R. R. BLACKMAN and A. J. WILSON: Nature 231, 50 (1971).