Bull. Environ. Contam. Toxicol. (1986) 37:719–721

Environmental Contamination and Toxicology

Toxicity of Toxaphene to *Bosmina longirostris* and *Daphnia* spp. (Crustacea)[1]

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Residues of toxaphene have been found in fish collected in virtually all areas of the world (Ribick et al. 1982). As an indication of the bioaccumulation of this persistent pesticide in the aquatic food chain, toxaphene concentrations in whole lake trout (Salvelinus namaycush) sampled from southeastern Lake Michigan in 1979 for the National Pesticide Monitoring Program averaged 6.8 ug/g (wet weight; Schmitt et al. 1983). Inasmuch as toxaphene is known to be highly toxic to both fish and aquatic invertebrates (Rice and Evans 1984), we initiated studies to evaluate the hazard of toxaphene to invertebrates in the food of Great Lakes fish. Among the more ecologically important zooplankters in the Great Lakes is the cladoceran Bosmina longirostris. Recent studies showed that this cladoceran was more sensitive to two representative contaminants (DDT and arsenic) than were commonly employed bioassay species of Daphnia (Novak et al. 1982; Passino and Novak 1984). Our objectives, therefore, were to measure the acute toxicity of toxaphene to B. longirostris, to provide comparative toxicity data for Daphnia pulex and D. magna, and to estimate the threat posed by toxaphene to these cladocerans in freshwaters.

MATERIALS AND METHODS

The test organisms were offspring (< 24 h old) of parthenogenetically producing females of Bosmina longirostris, Daphnia pulex, and D. magna. The neonates were reared and tested in reconstituted hard water (160 mg/L total hardness as $CaCO_3$) at 17°C according to the procedures of Passino and Novak (1984), except that an additional algal species Ankistrodesmus falcatus (32×10^3 cells/mL) was added to the culture medium. Rearing and testing procedures met the standards of the American Society for Testing and Materials (1980).

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Static bioassays lasted for 48 h, during which time the organisms were not fed. We dosed the test water with toxaphene (chlorine content 68.5%, US Environmental Protection Agency, Research Triangle Park, N.C.) dissolved in acetone. Each test consisted of a water control, an acetone control (0.5 mL/L), and six or seven concentrations of toxaphene; 10 organisms were placed in each beaker, in 150 mL of test water. The nominal toxicant level in each treatment was 0.6 of the next higher one. The 48-h EC50s, based on immobilization, were determined by probit analysis (Passino and Novak 1984). We compared EC50s by using Student's *t* tests.

RESULTS AND DISCUSSION

The mean 48-h EC50 (Table 1) for *Bosmina longirostris* was significantly lower than that for either *Daphnia pulex* ($P < 0.05$) or *D. magna* ($P < 0.01$), indicating that the sensitivity of the bosminid exceeded that of the *Daphnia* spp.

Table 1. Toxicity of toxaphene ($\bar{x} \pm$ SE, measured as immobilization)

Organism	48-h EC50 ug/L	Number of tests
Bosmina longirostris	1.4	2
Daphnia pulex	8.2 ± 1.0	4
Daphnia magna	11.3 ± 2.5	4

Our 48-h value for *D. magna* was not significantly different ($P < 0.05$) from the value of 10 ug/L reported by Sanders (1980). However, our 48-h EC50 value for *D. pulex* was significantly different ($P < 0.01$) from the value of 15 ug/L reported by Sanders and Cope (1966), possibly due to differences in water hardness and temperature. Using an application factor of 0.01 determined for *D. magna* with toxaphene (Sanders 1980), we estimated the following safe concentrations (ug/L) based on data from Table 1: 0.01 for *B. longirostris*, 0.08 for *D. pulex*, and 0.1 for *D. magna*. Although recognizing the limitations of applying laboratory data to the field, we believe that the water quality criterion of 0.005 ug/L (US Environmental Protection Agency 1976) and the water quality objective of 0.008 ug/L for the Great Lakes (International Joint Commission 1977) are adequate to protect these cladocerans. Our estimated safe concentrations are also above the concentrations of 0.0001 to 0.001 ug/L reported for Lakes Superior and Huron (Rice and Evans 1984); concentrations of toxaphene in the other Great Lakes are unknown.

REFERENCES

American Society for Testing and Materials (1980) Standard practice for conducting acute toxicity tests with fishes, macroinvertebrates, and amphibians. Am Soc Test Mat Philadelphia, E729-80

International Joint Commission (1977) New and revised Great Lakes water quality objectives Vol 2. Intern Joint Comm, Windsor

Novak AJ, Berry DF, Walters BS, Passino DRM (1982) New continuous-flow bioassay technique using small crustaceans. Bull Environ Contam Toxicol 29:253-260

Passino DRM, Novak AJ (1984) Toxicity of arsenate and DDT to the cladoceran Bosmina longirostris. Bull Environ Contam Toxicol 33:325-329

Ribick MA, Dubay GR, Petty JD, Stalling DL, Schmitt CJ (1982) Toxaphene residues in fish: Identification, quantification, and confirmation at part per billion levels. Environ Sci Technol 16:310-318

Rice CP, Evans MS (1984) Toxaphene in the Great Lakes. In: Nriagu JO and Simmons MS (ed) Toxic contaminants in the Great Lakes. John Wiley & Sons, New York, p 163-194

Sanders HO (1980) Sublethal effects of toxaphene on daphnids, scuds, and midges. US Environ Protect Agency, Duluth, EPA-600/3-80-006

Sanders HO, Cope OB (1966) Toxicities of several pesticides to two species of cladocerans. Trans Am Fish Soc 95:165-169

Schmitt CJ, Ribick MA, Ludke JL, May TW (1983) National pesticide monitoring program: Organochlorine residues in freshwater fish, 1976-79. US Fish Wildl Serv, Washington, DC, Resource Pub No 152

US Environmental Protection Agency (1976) Quality criteria for water. US Environ Protect Agency, Washington, DC

Received December 11, 1985; accepted December 18, 1985