The Acute Toxicity of some Heavy Metal Ions toward Benthic Organisms

by
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A great deal of information is being gathered about the acute toxicity of heavy metal ions toward fish and in fact review articles are available (1,2). It is also important however to attempt to determine the effect of heavy metal ions upon benthic organisms since they may in fact be more sensitive and prove to be good indicator organisms. Warnick has summarized some data pertaining to aquatic insects (6) and the effect of copper upon a variety of benthic organisms has been studied (7,8).

This laboratory has been investigating the effects of heavy metals upon the aquatic environment of the Hudson River in the fresh water region near Poughkeepsie (3,4). This study was initiated to determine the acute toxicity of some heavy metals toward representatives of the benthic organisms in this reach of the river.

The organisms chosen were those most common to the area as determined by a survey conducted by Pierce (5) in 1971. The organisms were collected by this laboratory and transferred to holding vessels for the bioassay work.

METHODS

Bottom mud samples were obtained with a modified Eckman dredge. Weed samples were used to furnish Gammarus and Amnicola. These were simply uprooted at low tide.

Analytical determinations and data processing were carried out as previously described (3).

Bioassay tanks were 50 ml beakers which were placed in a large trough of water to maintain temperature stability. Air was pumped into the beakers to prevent deoxygenation.

RESULTS AND DISCUSSION

Table I contains the water quality parameter measured and maintained during the course of an experiment.

TABLE I

Temperature 17°C	pH 7.6
Hardness 50 mg/l	D.O. 6.2 mg/l

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Table II contains the results in terms of analytical concentration (ppm) of metal ion in the water, TLM (50%) and ratio of added toxin to ambient river concentration.

A number of tentative conclusions can be drawn from Table II.

It is apparent mercury ion is the most toxic ion studied and is more toxic toward the benthic organisms in this reach of the river than toward the fish studied in the same area (3).

It also appears that, with the exception of the Chironomous and the Gammarus, benthic organisms tend to be more able to withstand heavy metal inputs than fish. Warnick (6) has noted this previously in a study performed on aquatic insects.

One final note a toxicity can be seen in the toxicity values for the Amnicola adults and Amnicola eggs. The eggs are less susceptible to the inputs than the adults. Hokanson (10) has observed that in a toxicity study of linear alkylate sulfonate (LAS) toward the bluegill the bluegill eggs were less susceptible to damage. This can be explained on the assumption the egg is a self contained unit which provides its own nutrient internally and therefore is not as sensitive to water quality. This apparently holds true for the snail eggs as well.

TABLE II

Organism	Metal Ion	* TLm 24-96 hr	** TLm - ratio 24-96 hr
bristle worm (Oligochaeta)	Cu^{++}	2.3 - .09	143 - 6
	Zn^{++}	21.2 - 18.4	2650 - 2300
	Ni^{++}	16.2 - 14.1	675 - 588
(Nais sp.)	Cd^{++}	4.6 - 1.7	767 - 283
	Hg^{++}	1.9 - 1.0	633 - 330
	Cr^{+++}	12.1 - 9.3	24000-19000
scud (Amphipoda)	Cu^{++}	1.2 - 0.91	75 - 57
	Zn^{++}	10.2 - 8.1	1275 - 1013
	Ni^{++}	15.2 - 13.0	633 - 541
(Gammarus sp.)	Cd^{++}	.14- .07	15 - 10
	Hg^{++}	.09- .01	30.0 - 3.3
	Cr^{+++}	6.4 - 3.2	128000-64000

TABLE II

Organism	Metal Ion	TLm * 24-96 hr	TLm - ratio ** 24-96 hr
caddis fly (Tricoptera)	Cu^{++}	12.1 - 6.2	387 - 256
	Zn^{++}	62.6 - 58.1	7825 - 7263
Unidentified	Ni^{++}	48.4 - 30.2	2016 - 1510
	Cd^{++}	5.1 - 3.4	930 - 566
	Hg^{++}	5.6 - 1.2	1860 - 400
	Cr^{+++}	58 - 50	106000 - 100000
damsel fly (Zygoptera)	Cu^{++}	10.2 - 4.6	687 - 288
	Zn^{++}	32 - 26.2	4000 - 3275
Unidentified	Ni^{++}	26.4 - 21.2	1100 - 883
	Cd^{++}	11.0 - 8.1	1850 - 1350
	Hg^{++}	3.2 - 1.2	1060 - 400
	Cr^{+++}	46 - 43.1	92000 - 86000
midge (Diptera)	Cu^{++}	.65- .03	6.1 - 3.1
	Zn^{++}	21.5 - 18.2	2620 - 2275
(Chironomous sp.)	Ni^{++}	10.2 - 8.6	425 - 359
	Cd^{++}	5.1 - 1.2	850 - 200
	Hg^{++}	.06- .02	20 - 6
	Cr^{+++}	16.5 - 11.0	33000 - 22000
snails (Gastropoda)	Cu^{++}	4.5 - 9.3	285 - 581
	Zn^{++}	28.1 - 20.2	3512 - 2550
(Amnicola sp.)	Ni^{++}	26.0 - 11.4	108 - 467
	Cd^{++}	5.1 - 3.8	850 - 633
eggs	Hg^{++}	6.3 - 2.1	2100 - 700
	Cr^{+++}	15.2 - 12.4	30400 - 24800
snails (Gastropoda)	Cu^{++}	1.5 - 0.9	100 - 6.2
	Zn^{++}	16.8 - 14.0	2100 - 1750
(Amnicola sp.)	Ni^{++}	21.2 - 14.3	883 - 596
	Cd^{++}	10.1 - 8.4	1683 - 1400
adults	Hg^{++}	1.1 - .08	336 - 26
	Cr^{+++}	10.2 - 8.4	20400 - 16800

* mg/l

** ratio toxic/background

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