Acute Toxicity of Copper, Nickel and Zinc Ions to Some Hudson River Fish Species

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The discharge of heavy metal ions into waterways poses a serious water pollution problem. These discharges can be toxic to aquatic life and cause other secondary effects upon water quality. The purpose of this investigation was to study the effect of some common industrial inputs upon the life expectancy of Hudson River fish species. The fish studied were caught in the estuary itself and maintained in an environment similar to their natural environment prior to bioassay. The toxicity results are expressed in terms of concentration of ion in ppm, and multiples of the background concentrations of these ions normally found in the estuary. (1)

METHODS - Specimen collecting was done with shore seining at sites within a few miles North and South of Poughkeepsie. The only exception to this were the striped bass fingerlings caught at Peekskill. Once the fish were caught they were allowed to stand in a holding tank for 24 hours before transferring them to the bioassay tanks.

The fish chosen for the study were species that were fairly easy to maintain. New fish were added to the holding tank twice weekly in order to insure random sampling. In general no fish longer than 20 cm were used. Attempts were made to maintain some the same size and weight for each fish studied.

The bioassays were conducted as described by APHA (2) and all tanks were filled with river water and river water was used for all dilutions. The toxic metals were weighed as their nitrates and then the analytical concentrations were determined on water samples prior to and during an experiment. Atomic absorption spectroscopy was chosen as the analytical tool. (3)

Since toxicity will be a function of many water characteristics, hardness, pH and temperature were monitored during each run and air was pumped into the tanks to maintain the dissolved oxygen at 6.5 ppm.

TL_m (median tolerance limit) for 24, 48 and 96 hour intervals were determined. Ten or more of each species were chosen for each experiment and an equal number for the control. The mortality-concentration data were analyzed by the average angle

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method (4) with the aid of an IBM 360-65 computer. This method will yield both TL_m values and confidence limits.

RESULTS & DISCUSSION

Table I contains the water quality characteristics that were monitored during the experiments. These parameters were measured before the test was started and at the completion of the test period.

TABLE I

Temperature 17°C	pH 7.8
Hardness 53 mg/l	D.O. 6.5 mg/l

Table II contains the results of the toxicity studies.

TABLE II

Species	Metal	TL_m 24 hr	TL_m 48 hr	TL_m 96 hr	background*
banded killifish	Cu^{++}	1.5	0.92	0.86	0.028
(Fundulus diaphanus)	Zn^{++}	22.6	20.7	19.1	0.062
	Ni^{++}	63.2	50.8	46.2	0.006
striped bass	Cu^{++}	8.3	6.2	4.3	0.028
(Roccus saxatilis)	Zn^{++}	11.2	10.0	6.7	0.062
	Ni^{++}	10.0	8.4	6.2	0.006
pumpkinseed	Cu^{++}	3.8	2.9	2.4	0.028
(Lepomis gibbosus)	Zn^{++}	25.2	21.8	20.0	0.062
	Ni^{++}	16.4	12.0	8.1	0.006
white perch	Cu^{++}	11.8	8.0	6.2	0.028
(Roccus americanus)	Zn^{++}	13.6	10.2	14.3	0.062
	Ni^{++}	18.4	16.2	13.6	0.006
American eel	Cu^{++}	10.6	8.2	6.4	0.028
(Anguilla rostrata)	Zn^{++}	21.6	20.0	14.6	0.062
	Ni^{++}	14.0	13.2	13.0	0.006
carp	Cu^{++}	2.1	1.0	0.81	0.028
(Cyprinus carpio)	Zn^{++}	14.3	9.3	7.8	0.062
	Ni^{++}	38.2	29.1	10.6	0.006

* All concentrations expressed in mg/l

The following generalizations seem to be valid:

Copper- Copper was the most toxic to all six species. The range of concentration for 24 hours was 1.5 ppm for the banded killifish to 11.6 ppm for the white perch. These concentrations are slightly larger than other published values for similar species. (5,6,7) However the use of fish that are native to the estuary and also using estuary water as a matrix could account for higher values.

Nickel- Nickel was the least toxic metal for all species except the American eel. There was only a slight difference between the 96 hour and 24 hour TL_m for the eel.

Zinc- Zinc is more toxic than nickel and for the striped bass the toxicity is almost the same as that for nickel. It appears that the 96 hour TL_m values for nickel and zinc are very similar for all species studied except the killifish and pumpkinseed.

TABLE III

Species	Metal	24 hr toxic / Background	48 hr toxic / Background	96 hr toxic / Background
banded killifish	Cu^{++}	54	33	31
	Ni^{++}	10533	8647	7700
	Zn^{++}	364	334	260
striped bass	Cu^{++}	296	100	69
	Ni^{++}	6000	1400	1033
	Zn^{++}	181	162	108
pumpkinseed	Cu^{++}	136	104	86
	Ni^{++}	2733	2000	1350
	Zn^{++}	406	352	324
white perch	Cu^{++}	421	286	221
	Ni^{++}	3066	2700	2267
	Zn^{++}	219	165	231
American eel	Cu^{++}	379	293	229
	Ni^{++}	2333	2200	2166
	Zn^{++}	348	324	235
carp	Cu^{++}	75	36	29
	Ni^{++}	6366	4850	1767
	Zn^{++}	231	150	125

Table III relates the TL_m concentrations to the existing background concentrations of the ions being studied. One can see for example that for 96 hour TL_m values to be exceeded the copper concentration in the estuary would have to increase by a factor of 10 to 10^2, the nickel by a factor of 10^3 to 10^4 and the zinc by a factor of 10^2.

It is not reasonable to assume that the Hudson estuary is going to experience such increases in metal ion concentrations. It is however necessary to consider this information when one designs inputs near tidal pools or man made lagoons. It is possible that other inputs such as nutrients, heat, etc. will cause these sites to become desireable feeding or spawning grounds. An accidental metal discharge could under these conditions cause a significant fishkill.

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