

Heavy Metal Concentrations in Ontario Fish

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INTRODUCTION

Pollution in the Great Lakes has received considerable attention in recent years, particularly with reference to the effect due to the increasing concentration of heavy metals.

Interest has largely been focused upon mercury. The appreciation of the hazardous nature of this element, particularly in its organic form in which it may be present in piscine tissues, has resulted in detailed examination of this problem by federal and provincial governments in Canada (Department of Lands and Forests, Ontario 1972) and responsible agencies throughout the world. Heavy metal contamination may arise from urban and industrial wastes as well as from agricultural and natural sources, such as the Canadian Shield. These trace heavy metals may have an effect on the ecosystem as great or greater than those of the more common pollutants (LUCAS *et al.* 1970). The complex role of trace heavy metals in the biosphere is little understood. However, it is well known that large concentrations of trace heavy metals are toxic to the ecosystem as a whole and to man in particular, since he is at the end of a variety of food chains by virtue of his variegated diet. Many of these trace heavy metals are important in the maintenance of normal physiological function of the body, particularly iron, copper, zinc and cobalt. The margin between required concentration and toxic concentration is often small so that a mere doubling of it may prove toxic to the more sensitive species (BOWEN 1966; JONES 1964). Fish readily absorb dissolved heavy metals and this serves as a reliable indication of the extent of the pollution by these materials. However, it should be stressed that there is a wide variation of species insofar as the metabolic pathways are concerned, and no one fish species can truly be said to act as a reliable indicator of pollution. This causes difficulty in the assessment of the significant level of heavy metals in fish. Some species of fish such as trout (*Salvelinus fontinalis*), pike (*Esox lucius linnaeus*) and bass (*Micropterus salmoides*) are predators and may provide more information as to heavy metal pollution than non-predators. The present study concerns the distribution of heavy metals in fish samples taken from Lake Huron at Baie du Doré and Toronto Harbour during the year 1973, and of these two areas Toronto Harbour represents a high level of pollution and Baie du Doré a minimum level.

The following metals have been studied since they have been shown to be toxic to fish or necessary for their growth and development: copper, cadmium, lead, zinc and mercury.

METHODS

Total mercury determination

Fish tissue was submitted to a cold digestive process using a mixture of equal parts of concentrated nitric acid and sulfuric acid. This mixture was then treated by a method developed by HATCH and OTT (1968), and mercury measurement made by Coleman MAS 50.

Heavy metal determination

Fish samples were digested in a mixture of 5:1 nitric-perchloric acid at 125°C. The resultant solution was diluted to an appropriate concentration and analysed for cadmium, copper, lead and zinc by atomic absorption spectrophotometry. Sediment samples were digested in 10 ml of 1:1 nitric-perchloric acid at 175°C for 4 hours. After filtering the acid solution was diluted and analysed by atomic absorption spectrophotometry. Background corrections have been made for interfering substances.

RESULTS

Concentrations of cadmium, copper, lead, zinc and mercury have been determined in 15 species totalling 90 fish from Baie du Doré, Lake Huron and Toronto Harbour, Lake Ontario. Measurements were made in muscle, liver and kidney. A summary of the results is given in Table 1.

The species of fish studied were alewife, brown bullhead, carp, freshwater drum, gizzard shad, golden shiner, lake whitefish, largemouth bass, longnose sucker, pumpkinseed, rainbow smelt, rock bass, white bass, white sucker and yellow perch. It was found that the concentrations of metals were similar in the various species studied.

Table 1 gives the average value and range for all species studied. The ratios for cadmium, copper, lead, zinc and mercury in fish muscle between Baie du Doré and Toronto Harbour were 1:2, 1:4, 1:9, 1:8 and 1:4 respectively. The ratios of heavy metals in relationship for muscle:liver and muscle:kidney is given in Table 2. These ratios may be expected in consideration of biological functions of the organs concerned.

Heavy metals in sediment obtained from Toronto Harbour and Baie du Doré have been determined and there is close agreement between the distribution of metals in the sediment and that present in fish which are non-migratory, see Figs. 1 and 2. The relative abundance of five heavy metals in fish muscle from both areas in

TABLE 1

Comparison of heavy metal concentrations in fish (ppm - wet weight) of Baie du Doré and Toronto Harbour 1973

Tissue	Heavy Metal	Baie du Doré			Toronto Harbour		
		No. of Samples	Mean	Range	No. of Samples	Mean	Range
Muscle	Cd	40	0.06	0.01- 0.16	50	0.13	0.02- 0.25
	Cu	40	0.45	0.12- 1.14	50	1.93	0.54- 4.01
	Pb	40	0.19	0.09- 0.36	50	1.78	0.13- 2.35
	Zn	40	4.69	2.85- 9.20	47	36.02	16.08- 81.98
	Hg	40	0.06	0.03- 0.15	50	0.24	0.01- 0.67
Liver	Cd	40	0.16	0.02- 0.50	23	0.13	0.04- 0.45
	Cu	40	5.22	0.62-21.84	23	16.45	1.48- 68.40
	Pb	40	0.24	0.05- 0.57	23	1.52	0.22- 2.19
	Zn	40	15.10	7.58-27.06	23	89.04	39.62-239.56
Kidney	Cd	39	0.40	0.05- 0.93	23	0.42	0.08- 1.26
	Cu	39	4.69	0.27-20.17	23	4.34	1.88- 13.58
	Pb	39	1.42	0.16- 6.76	23	6.60	0.66- 61.40
	Zn	39	26.09	6.51-54.46	23	59.41	44.99-277.78

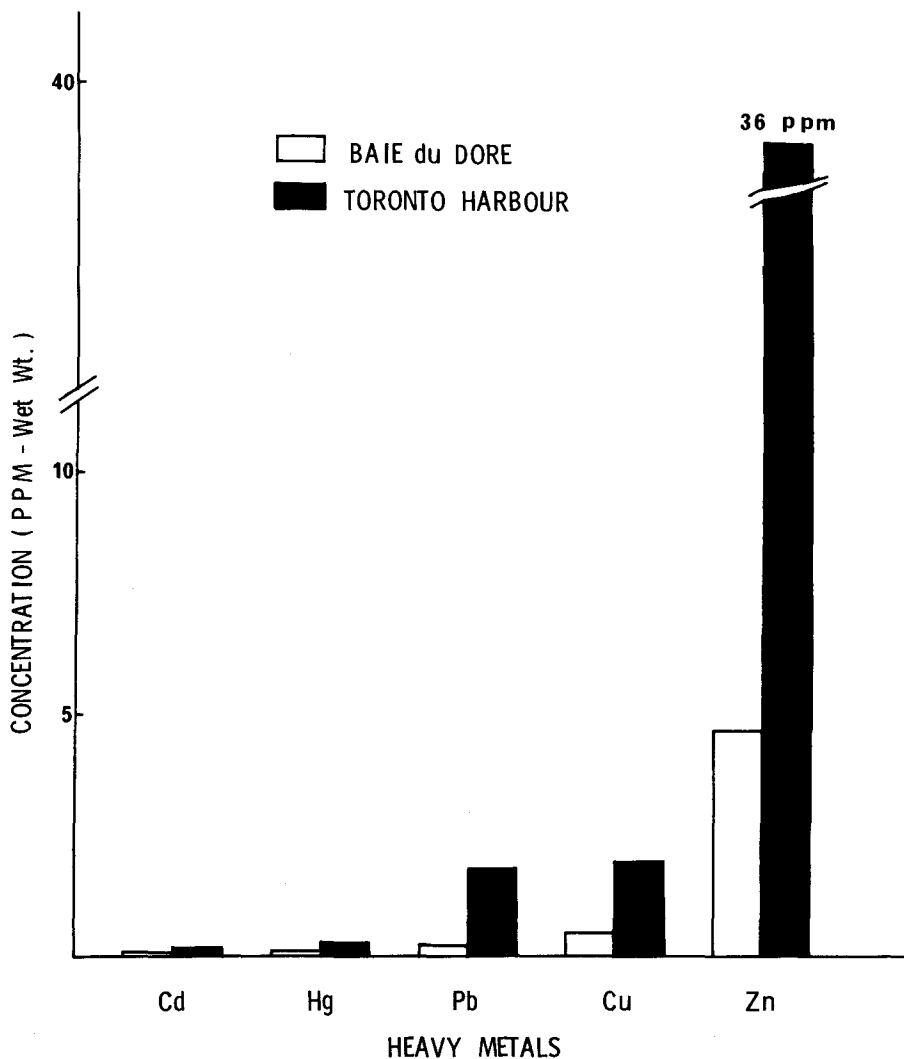


FIG.1 COMPARISON OF HEAVY METAL CONCENTRATION IN FISH MUSCLE OF BAIE du DORE & TORONTO HARBOUR

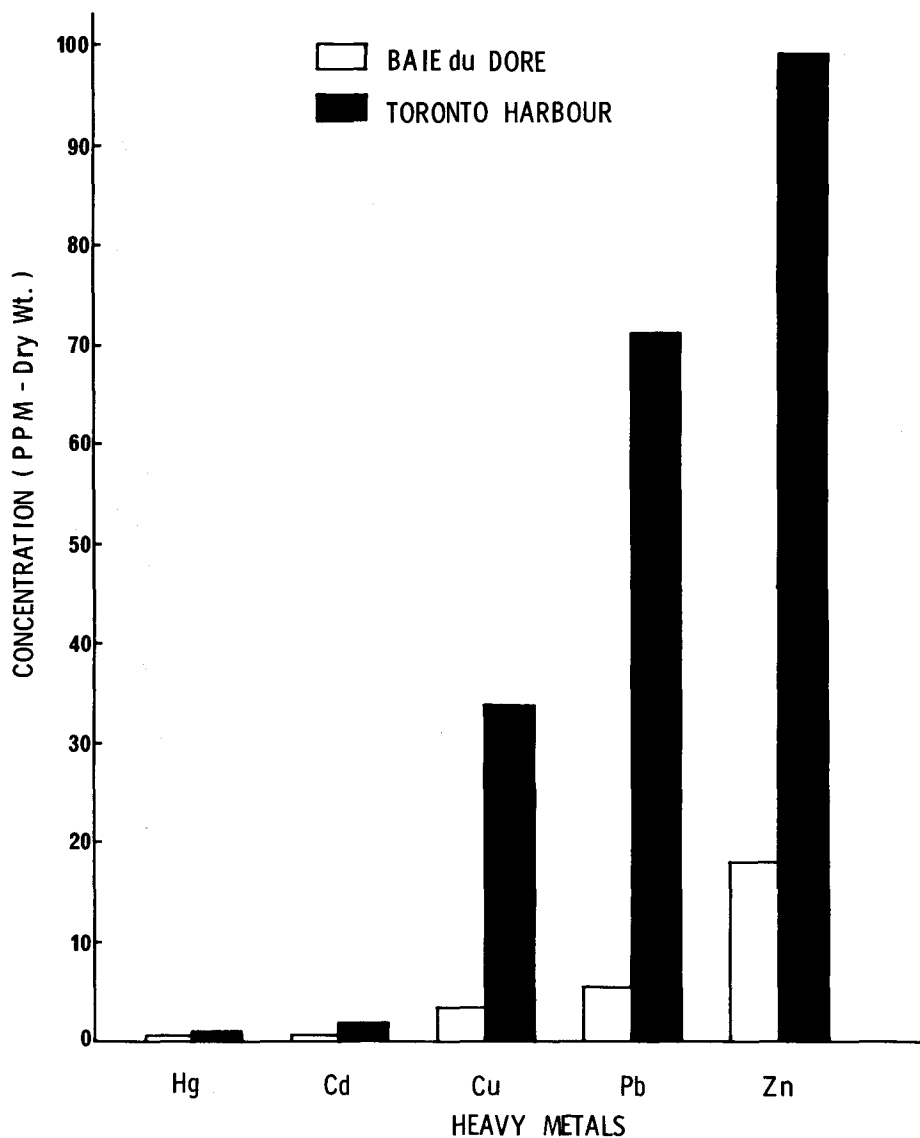


FIG. 2 COMPARISON OF HEAVY METAL CONCENTRATION IN SEDIMENT
OF BAIE du DORE & TORONTO HARBOUR

TABLE 2

The ratios of heavy metals in fish tissue

Heavy Metal	Baie du Doré		Toronto Harbour	
	Muscle:Liver	Muscle:Kidney	Muscle:Liver	Muscle:Kidney
Cd	1:3	1:7	1:1	1:3
Pb	1:1	1:7	1:1	1:4
Cu	1:12	1:10	1:9	1:2
Zn	1:3	1:6	1:2	1:2

ascending order are cadmium, mercury, lead, copper and zinc, whereas, in sediment it is mercury, cadmium, copper, lead and zinc.

DISCUSSION

The concentration of cadmium, copper, lead, zinc and mercury in muscle taken from fish caught in Toronto Harbour is higher than those found in Baie du Doré. This reflects the concentration of these elements in the sediment. Metal concentrations in the sediment of the Don River (draining a concentrated industrial area) are high in comparison with Baie du Doré, which has minimal industrial effluent drainage.

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