HEAVY METAL CONTENT IN FISH FROM "BACKWATER TISZA" (BISER ISLAND)

S.Maletin, N. Djukic and B.Miljanovic

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Abstract. Concentration of 8 heavy metals (Zn, Fe, Mn, Cd, Cu, Ni, Co, Pb) and that of Al were analyzed in certain tissues and organs (gills, liver, spleen, kidney, gonads and muscles) in 7 fish species with different habitats and nutrition types *(Cyprinus carpio, Carassius auratus, Abramis brama, Lepomis gibosus, Stizostedion lucioperca, Esox lucius* and *Silurus glanis)* caught by electroagregate during 1991. High bioaccumulation of Zn was found in gills and anex glands of benthivores, while in predators high amount of Al was found in gonads. Concentration of Fe is constantly high in most organs in fish investigated. Other heavy metals were found in considerably lower amounts.

Keywords: accumulation, benthivores, freshwater, piscivores.

S.Maletin, N. Djukic and B.Miljanovic, Institute of Biology, University of Novi Sad, 21000 Novi Sad, Yugoslavia

Introduction

Increase of concentration of heavy metal ions in hydroecosystems is caused by influence of not properly treated waste waters, or as a consequence of disperse pollutants. These elements can, in higher concentrations, act on hydrobionts as direct intoxicants, or, more often, be carried through food chains and accumulate in organs and tissues of fish. Their presence in water habitat is a special problem, different from other pollutants which can be decomposed or otherwise eliminated from water.

Heavy metal content in water and sediments of river Tisza and its backwaters was investigated during last decade, especially in Hungary. Extreme load of these pollutants was found at some parts of river, being under influence of industrial waste waters (Fügedi and Fekete, 1980; László and Berta, 1981; Fekete, 1984). At the same time, high content of these intoxicants was found in invertebrates and certain organs and muscles of the fish in Danube and its affluents by Wachs (1982, 1983, 1985), Gaál et al. (1985), Yevtusenko et al. (1990) and Pujin et al. (1990), but no selectivity in accumulation and level of concentration in hydrobionts, depending on amount of these agents in environment.

Material and methods

Material was caught during 1991, using electroagregate. Concentration of 8 heavy metals (Zn, Fe, Mn, Cd, Cu, Ni, Co, Pb) and of Al was analyzed in muscles, gills, liver, spleen, kidneys and gonads of 7 fish species from different habitats and with different types of feeding. Two ecological groups were investigated: benthivores *(Cyprinus carpio, Carassius auratus gibelio* and *Abramis brama)* and predators *(Lepomis gibbosus, Stizostedion lucioperca, Esox lucius* and *Silurus glanis)* five specimens of each. Samples were prepared by standard methods and measured on flame AAS Perkin Elmer. Heavy metal content was shown as mean values in mg/kg fresh weight.

Results and discussion

Total amount of heavy metals bioaccumulation was different in tissues and organs of investigated fish species (Fig. 1). It was 3.33-fold higher in muscles of predators than in those of benthivores, which is connected with state of analyzed species in food chains. At the same time, concentration of heavy metals (and of Al) was 3.34-fold higher in gills of benthivores than in those of predators. This

result can be explained by different conditions of heavy metals amount in water and in mud.

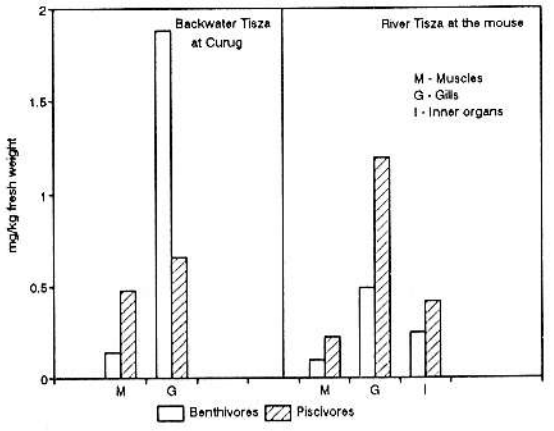

Fig. 1. Total heavy metal content in some fish groups according to feeding type. Sequence of total selectivity: I>G>M (Backwater Tisza); G>I>M (river Tisza). See text for abbreviations.

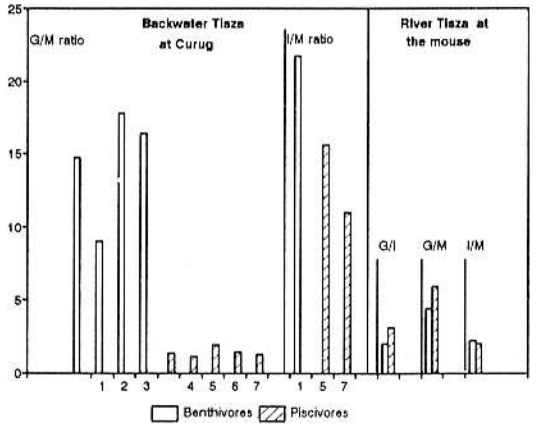

Fig. 2. Relationships between total heavy metal content of organs in some fish groups and species. Bars without number are averages of groups.

The total heavy metal content in gills and muscles, as well as internal organs and muscles, is different, depending on the investigated group, as well as species. Namely, concentration of heavy metals was 15-fold higher in gills of benthivores than in muscles, whereas in predators this relationship is only 1.34. In certain benthivore species, this ratio ranges between approximately 9 and 18, and in predators between 1.25 and 1.88. Significantly higher differences were obtained between two examined groups in relationship between total heavy metal amount of internal organs and that of muscles. In *C. carpio*, which is benthivore, this value was 21.77, whereas in predators it ranged between 11.13 *(S. glanis)* and 15.73 *(S. lucioperca)*, Fig. 2.

Selectivity of certain tissues and organs in bioaccumulation of heavy metals is very similar for both ecological groups. Sequence was in benthivores *(C. carpio)* as follows: S > Gi > H > Go > M, and in piscivores: S > Go > H > Gi > M *(S. lucioperca)* and K > Go > S > Gi > M *(S. glanis)*. (Abbreviations: S = spleen, Gi = gills, H = liver, Go = gonads, M = muscles, K = kidney.) Generally, it can be concluded that highest accumulation of heavy metals occurred in internal organs (mostly spleen and kidney), then following gills and at last muscles.

When comparing heavy metal content of fish caught in Tisza mouth, somewhat different situation can be noted. Benthivores have lower concentration of total heavy metals amount than predators. Least difference was established in internal organs (1.68), then in muscles (1.90), and highest in gills (2. 58), (Figs. 1 and 2).

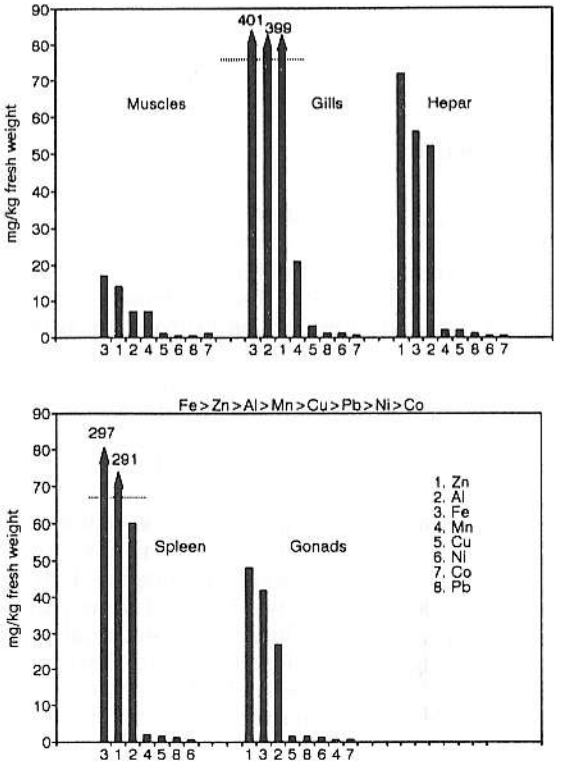

Fig. 3. Accumulation of heavy metals in benthivore fish species

Ratio between total heavy metals concentration in certain organs of groups examined varies from approx. 2 to 6. Smallest

values were found for ratio between gills and internal organs in benthivores, as well as between internal organs and muscles in predators, and higher between gills and muscles in both groups.

The same sequence was established in both groups: Gi > I > M, (I = intestinum) in selectivity of investigated organs to bioaccumulation of heavy metals.

Sequence of certain heavy metal bioaccumulation in organs of investigated fish from Backwater Tisza was very similar for both ecological groups. According to these investigations, following sequence would be formed for benthivores: Fe > Zn > Al > Mn > Cu > Pb > Ni > Co, while Cd was not found (Fig. 3). At the same time, the same sequence was found in piscivores, with minor differences for certain species and organs, and with Cd at the end, stored in liver and kidneys. High concentrations of Fe, Zn and Al were found in gills and anex glands of benthivores, as well as in internal organs of predators (Fig. 4).

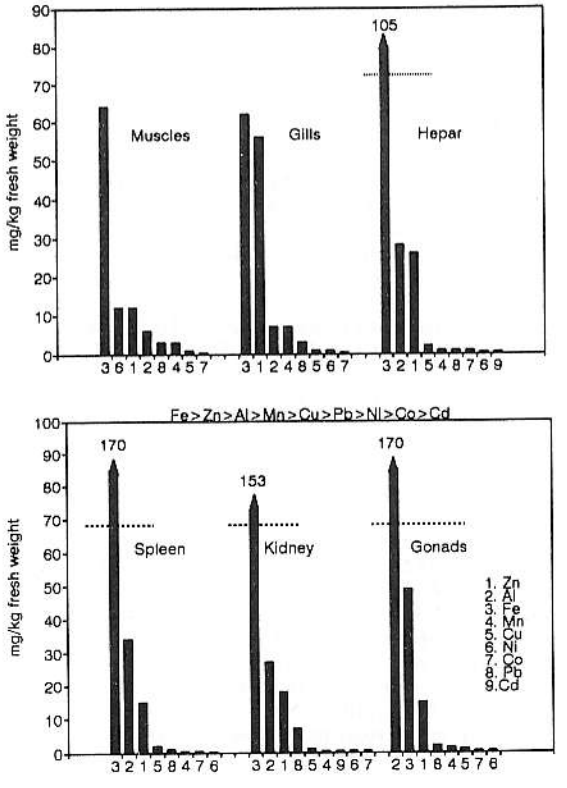

Fig. 4. Accumulation of heavy metals in predators.

Concentration of other metals was significantly lower. In this group, Mn was prominent in benthivores gills, and Ni in piscivores muscles *(E. lucius)*.

In order to do detailed analysis of heavy metals concentration in certain tissues of fish, relationship was established between internal organs and muscles, gills and muscles, as well as between internal organs and gills. Higher concentration of all 9 elements was found in internal organs than in muscles of examined benthivores and some piscivores *(S. lucioperca* and *S. glanis)*. These values ranged from several to even 103.21-fold (Al in *C. carpio*). On the contrary, 5 times more Pb was found in muscles of *E. lucius* than in internal organs. Similar situation was in examined benthivores, where level of certain metals was 1.19 to 33.73-fold higher than in breathing organs.

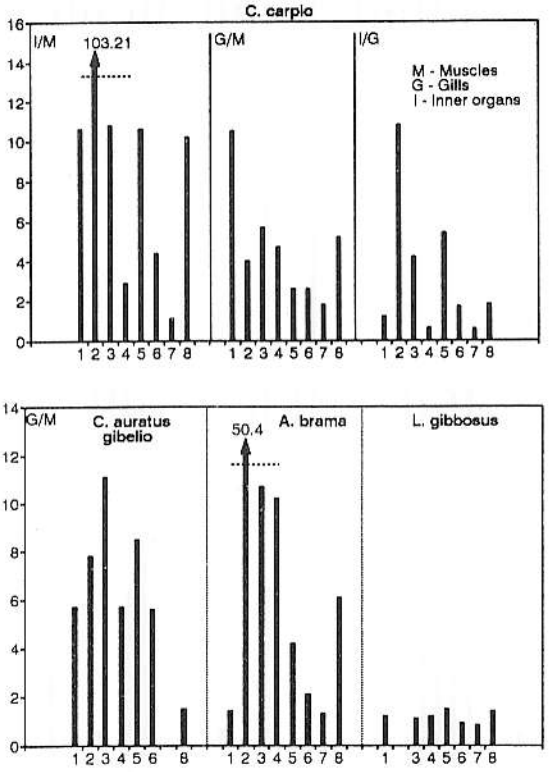

Fig. 5. Ratio of some heavy metals between organs in fish species (mostly benthivores).

However, somewhat different sequence was found in predators, so some intoxicants were more accumulated in muscles. Highest values were found for Ni (40.6-fold), while for others - Al, Fe, Cu and Pb - this relationship was up to 5-fold. Accumulation of certain metals was also found in higher concentration in internal organs compared to gills, with highest values for Al in predators (60.63-fold in *S. lucioperca* and 41.33-fold in *S. glanis*). Reversed relationship was established for

all predators and *C. carpio*, but with lower values for Pb, Co and Zn (4 to 6-fold), (Figs. 5 and 6).

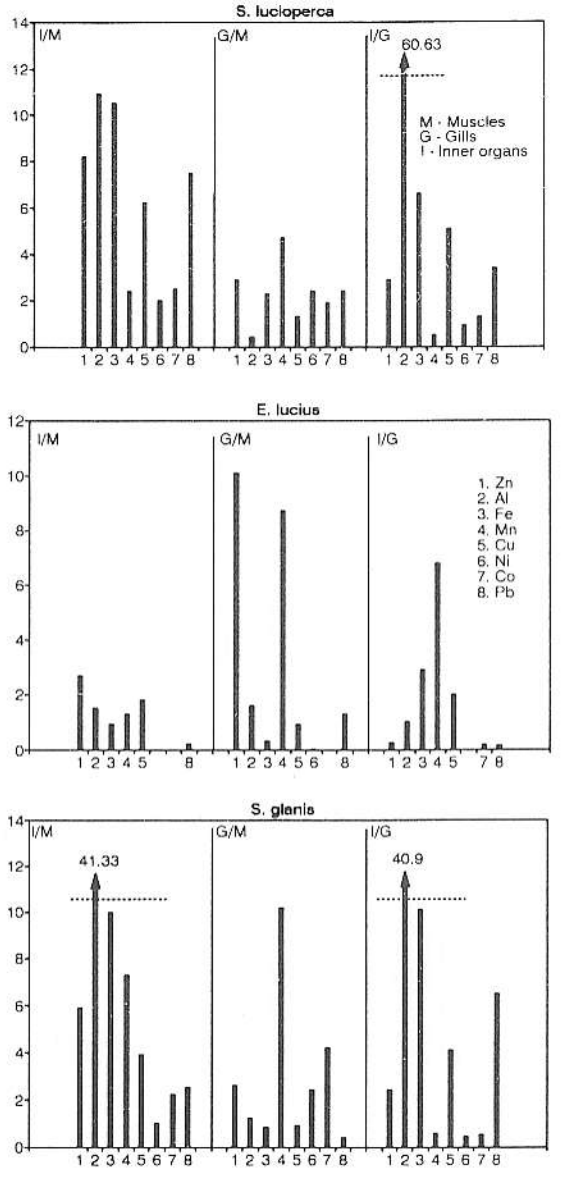

Fig. 6. Ratio of some heavy metals between organs in predatory fish.

By investigating heavy metals concentration in similar backwaters Alpár and Lakitelek, Fekete (1984) also found highest values for Cu, Zn, Fe and Mn in water. Fügedi and Fekete (1980) examined content of heavy metals in water and mud in Hungarian part of Tisza, also finding highest values for Cu and Zn, mostly at mouths of affluents, while László and Berta (1981) found also high concentrations of Fe on the same area.

Conclusion

By the analysis of ways and final locations of certain heavy metals deposition in tissues and organs of fish from Backwater Tisza, it can be concluded that most of them are accumulated in high concentrations in internal organs (spleen, liver, kidneys, gonads). Lower concentrations was found in gills, and the end of this sequence are muscles, where most of heavy metals are least deposited. Predators are exception, especially *E. lucius*, where in muscles and gills higher concentration was found for Ni, Pb, Co and Zn.

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