Bioaccumulation of certain heavy metals by fish populations in the Criş/Körös[1] rivers

Andrei Sárkány-Kiss, Michaela Ponta,
Alpár Fodor & Ilie Telcean

Abstract

The study displays in tables and graphs the content of heavy metal (Cu, Zn and Mn) of the water, of the sediment and of some fish species along Criş/Körös rivers. It was established that these fish species contain quantities that exceed about 16-24 times the permitted standards.

Keywords: Criş/Körös rivers, Pisces, heavy metals.

Introduction

Fish species usually accumulate small quantities of heavy metals, but predatory fishes sometimes accumulate greater quantities than the rest of aquatic organisms. (Svobodová and Hejtmánek, 1985).

Hallebach demonstrates the fact that the heavy metals first of all penetrate through the mucous membrane of the branchia, from where they spread after some day and accumulate in the kidneys and the liver. In the cells these metals are bound by cystein-rich proteins called metallothioneines, but these proteines also have the main role in their elimination. (Ábrahám, 1996; Grahl et all. 1985).

Numerous studies analysed the content of the metals in the flesh of the fishes and compare them with the nourishing normatives elaborated in this sense (Gaál et all., 1985).

Our purpose was to determine in what measure represents contamination danger by heavy metals the consumption of fish from the Criş/Körös rivers for the local human population and if this bioaccumulation endangers the continuance of the fish populations in these rivers.

Taking into consideration the mining in the upper zones of these rivers it was to be expected such a pollution.

1 The first name is Romanian, and the second Hungarian.

Fig. 1. Copper content in water, sediment and fishes along the Crişul Alb River Valley

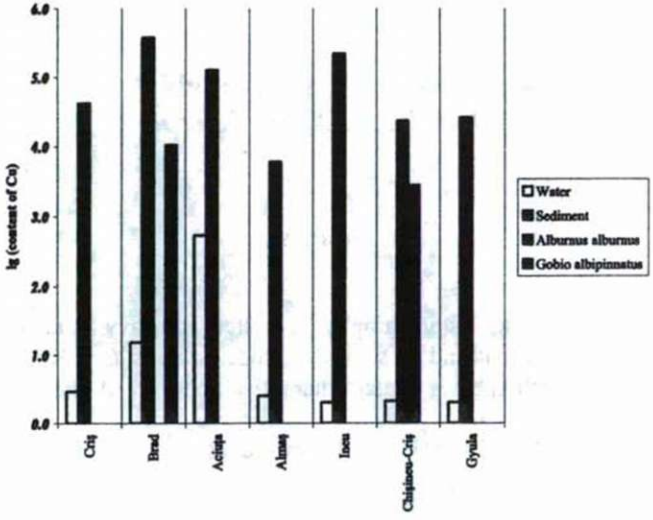


Fig. 2. Zink content in water, sediment and fishes along the Crişul Alb River Valley

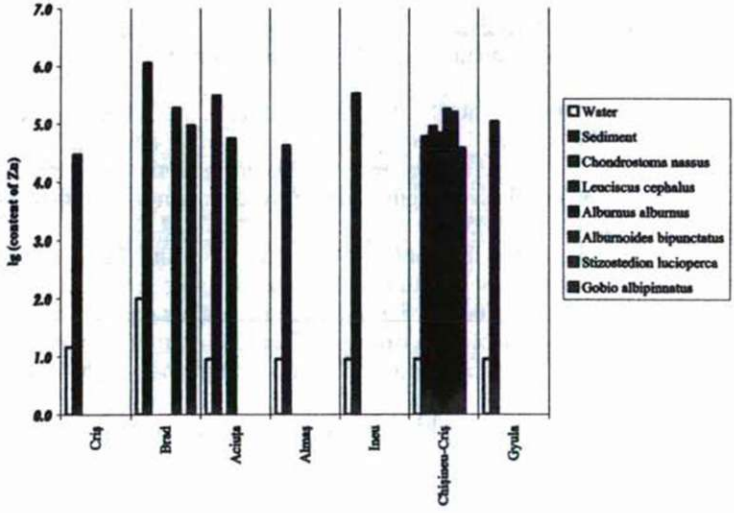


Fig. 3. Zink content in water, sediments and fihes along the Crişul Negru, Kettős- and Hármas Körös Rivers Vallies

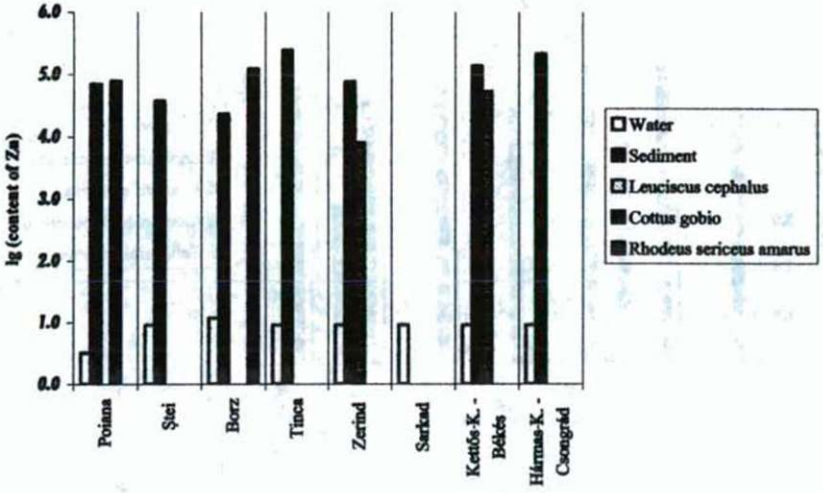


Fig. 4. Mangan content in water, sediments and fishes along the Crişul Alb River Valley

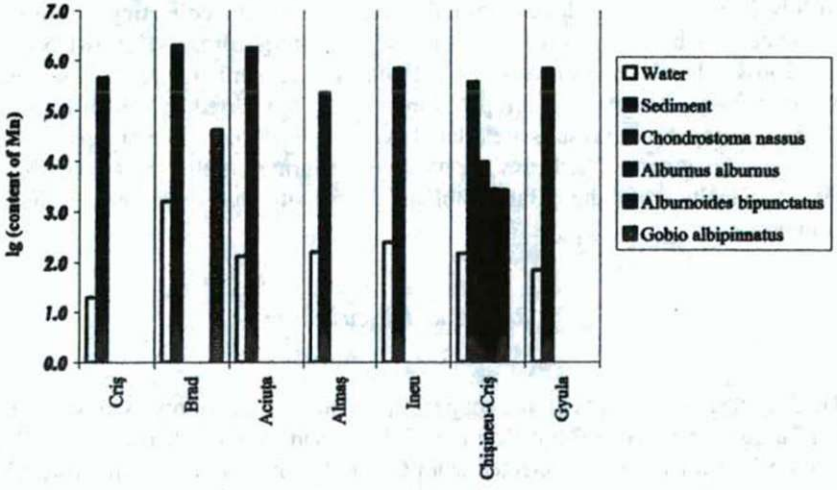
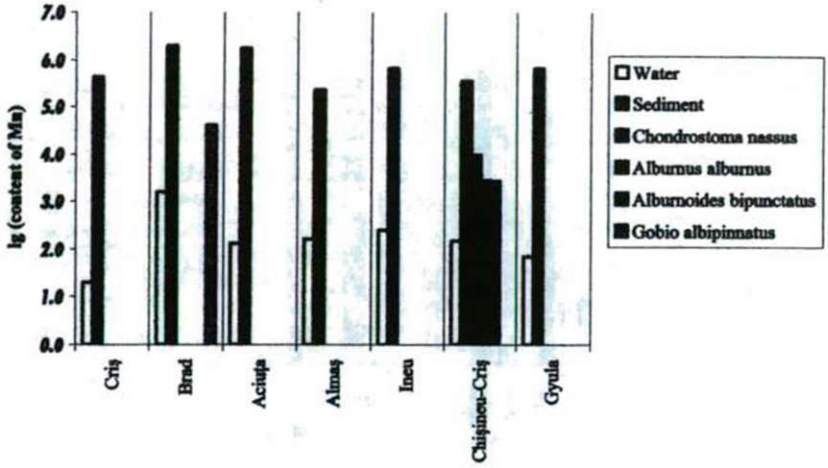


Fig. 5. Mangan content in water, sediments and fishes along the Crişul Alb River Valley



Materials and Methods

In July 1994 we collected different fish species from some collecting stations on the rivers Crişul Alb/Fehér-Körös, Crişul Negru/Fekete-Körös, Kettős-Körös and Hármas-Körös. The fishes were eviscerated and cleaned similarly to the method with nourishing purpose. The material prepared in this way was dried in a disinfector (100 - 105°C) at the camp. So our results are related to the dry material of the organs.

The determinations of the heavy metals were performed in the analytical labs of the Chemistry Faculty of the Babeş-Bolyai University using atomic absorption spectrophotometer.

Results and discussions

The European normatives for the copper content of fish flesh admit as maximum value a 10 mg Cu/kg content. As it results from the Table 1. and from the diagram on the Fig. 1., the *Gobio albipinatus* species collected from Crişul Alb, below Brad, contains 10,52 mg Cu/kg of dry substance. Related to fresh weight this means that it exceeds approximately 8 times the permitted values of the above mentioned standards. The *Alburnus alburnus*

sample from the same river at Chişinău-Criş also exceeds considerably the permitted values.

The permitted maximum concentration of zinc is 50 µg/kg in fish flesh. As the zinc has a high rate of accumulation in all aquatic organisms (Hallebach, 1985; Wachs, 1985). And the fact that in the rivers taken in study, these elements are present in large quantities, all the examined samples contain quantities that exceed about 16 - 24 times the permitted standards (Table 2., 3. and Fig. 2., 3.), taking into consideration the fact that the numbers from the table refer to the concentrations received from the dry substance.

The researched species in the Crişu Alb are: *Condrostoma nasus, Leuciscus chephalus, Alburnus alburnus, Alburnoides bipunctatus, Stizostedion lucioperca* and *Gobio albipinatus.* The zinc quantities identified in populations of these species represent a bioaccumulation of 900 to 19 000 times higher than the quantities found in the water.

In the rivers Crişul Negru and Kettős-Körös were investigated 3 species, *L. cephalus, Cottus gobio* and *Rhodeus sericeus amarus* which accumulation rate varied from 5 000 to 24 000 (recalculated values at fresh flesh), regarded to the zinc in the water.

Considering our results, bioaccumulation of manganese in fishes has lower values as compared to those established in unionide shell. Though there are no data proving a toxic effect of manganese, in the European standards the maximum concentration permitted in the flesh of the fishes is 8 mg / kg. As it appears from the Table 4., 5. and Fig. 4., 5. the number of the samples are more informative, they being placed where the water concentrations represent maximum and minimum values. Species in which the content of manganese was investigated are: *Condrostoma nasus, Alburnus alburnus, Alburnoides bipunctatus, Gobio albipinatus, Cottus gobio* and *Rhodeus sericeus amarus.* The values recalculated for fresh weight, exceed from 2 to 373 times the above mentioned standards.

The significant concentrations of Cu and Zn identified in the studied fish populations indicate the fact that they are very affected and the danger of their disappearance is obvious. This opinion is supported by the fact that the great majority of the samples are reduced in dimension and the abundance of the populations is less lower regarding to the values of the last decades.

Conclusions and proposals

The flesh of the fishes from Crişul Alb, Crişul Negru and Kettős-Körös, according to their Cu and Zn content, cannot be recommended for consumption and it is necessary to take urgent measures in this sense.

In the case that urgent measures will not be taken to reduce the pollution by the heavy metals in these rivers, valuable and sensitive elements of fish fauna will disappear within a very short time.

Table 1.

Cu	Criş	Brad	Aciuţa	Almaş	Ineu	Chişineu-Criş	Gyula
Water (µg/l)	2.9	15.3	536	2.5	2	2.1	2
Sediment (µg/kg)	42100	377900	126200	6000	217200	23400	26000
Alburnus alburnus (µg/kg weight)						2800	
Gobio albipinnatus (µg/kg weight)		10520					

Table 2.

Zn	Criş	Brad	Aciuţa	Almaş	Ineu	Chişineu-Criş	Gyula
Water (µg/l)	14.5	100	9	9	9	9	9
Sediment (µg/kg)	29300	1139200	307000	42400	328100	59800	107200
Chondrostoma nassus (µg/kg weight)						89100	
Leuciscus cephalus (µg/kg weight)			55590			69280	
Alburnus alburnus (µg/kg weight)						176560	
Alburnoides bipunctatus (µg/kg weight)		187830				157090	
Stizostedion lucioperca (µg/kg weight)						37460	
Gobio albipinnatus (µg/kg weight)		93560					

Table 3.

Zn	Poiana	Ştei	Borz	Tinca	Zerind	Sarkad	Kettos K.-Békés	Harmas K.-Csongrád
Water (µg/l)	3.2	9	11.7	9	9	9	9	9
Sediment (µg/kg)	69800	37800	23400	242600	75800		137000	216400
Leuciscus cephalus (µg/kg weight)					7960		53240	
Cottus gobio (µg/kg weight)	78060							
Rhodeus sericeus amarus (µg/kg weight)			122180					

Table 4.

Mn	Criş	Brad	Aciuţa	Almaş	Ineu	Chişineu-Criş	Gyula
Water (µg/l)	20	1590	130	160	250	150	70
Sediment (µg/kg)	439050	1995400	1765500	224600	678200	367200	675300
Chondrostoma nassus (µg/kg weight)						9610	
Alburnus alburnus (µg/kg weight)						2800	
Alburnoides bipunctatus (µg/kg weight)						2690	
Gobio albipinnatus (µg/kg weight)		40960					

Table 5.

Mn	Criş	Brad	Aciuţa	Almaş	Ineu	Chişineu-Criş	Gyula
Water (µg/l)	20	1590	130	160	250	150	70
Sediment (µg/kg)	439050	1995400	1765500	224600	678200	367200	675300
Chondrostoma nassus (µg/kg weight)						9610	
Alburnus alburnus (µg/kg weight)						2800	
Alburnoides bipunctatus (µg/kg weight)						2690	
Gobio albipinnatus (µg/kg weight)		40960					

References

Ábrahám Magdolna (1996): Xenobiotikumokat metabolizáló molekuláris rendszerek halakban. - Biokémia, 20, 1, 21 - 27.

Dévai, Gy., Dévai, I., Czégény, I., Harman, B., Wittner, I. (1993): A bioindikáció értelmezési lehetőségeinek vizsgálata különböző terheltségű ésszakkelet - magyarországi víztereknél. (Studies on the interpretation of bioindication phenomes) - Hidrológiai Közlöny, 73, 4, 202 - 211.

Gaál, S., I. Füzesi and B. Pénzes (1985): Heavy metal content of the fishes of Lake Balaton, Danube and Tisza during the period of 1979 - 1982. - in Heavy metals in water organisms (Ed. Salánki, J.), Akad. Kiadó, Budapest, 91 - 104.

Grahl, K., P. Franke and R. Hallebach (1985): The excretion of heavy metals by fish. - in Heavy metals in water organisms (Ed. Salánki, J.), Akad. Kiadó, Budapest, 357 - 365.

Hallebach, R. (1985): Trouts (Salmo gairdneri Rich.) as biointegrators for pollutants. A new method of recording pollutants. - in Heavy metals in water organisms (Ed. Salánki, J.), Akad. Kiadó, Budapest, 273 - 283.

Svobodová, Z. and M. Hejtmánek (1985): Total mercury content in the components of running water, reservoir and pond ecosystems in Czechoslovakia. - in Heavy metals in water organisms (Ed. Salánki, J.), Akad. Kiadó, Budapest, 171 - 178.

Wachs, B. (1985): Bioindicators for the heavy metal load of river ecosystems. - in Heavy metals in water organisms (Ed. Salánki, J.), Akad. Kiadó, Budapest, 179 - 190.

Andrei Sárkány-Kiss
University Babeş-Bolyai
Department of Ecologii-Genetics
Str Clinicilor 5-7.
3400 Cluj, Romania

Michaela Ponta and Alpár Fodor
University Babeş-Bolyai
Department of Chemistry
Str Clinicilor 5-7.
3400 Cluj, Romania

Ilie Telcean
University Oradea
Oradea
Romania