USING BIVALVES IN AN ALTERNATIVE TESTING METHOD OF FRESHWATER POLLUTION WITH HEAVY METALS

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Abstract

In order to test an alternative method on freshwater pollution with heavy metals, individuals of *Unio crassus* were exposed in cages in polluted reaches of the Someş River. Their time-related bioaccumulation was registered and compared with control samples.

Keywords: biomonitoring, bioaccumulation, pollution ecology

Introduction

The heavy metal content of the natural waters and of the sediments reflects the geochemical particularities of the examined place; their quantities usually do not exceed the tolerable values for the organisms. Due to human influences, the concentration of heavy metals may increase in the water, as well as in the sediment. The aquatic organisms accumulate these elements along the trophic chain. Molluscs are particularly well known as bioaccumulators of some of these metals (Fuller, 1974; Burky, 1983; Lakatos *et al.* 1990), taking them either directly from the environment, or indirectly through the food. The metals are stored in the soft parts of the body, as well as in the valves. It is known that the unionids molluscs are great plankton consumers and it was experimentally demonstrated that unicellular algae are able to retain during 14 days 78 - 98 % of the heavy metal content (in positive relation with the concentration) of the culture media (Nagy-Tóth, F. and Adriana Barna, 1982). Due to these qualities of the unionid molluscs, many authors suggest their use as bioindicators in this sense and recommend in a particular way the use of gills as indicator organs for the heavy metal bioaccumulation (Salánki *et al.* 1991).

Many studies demonstrate the sub-lethal and lethal toxic effects of these xenobiotics in different organisms, the modification of their metabolism (Nagy-Tóth, 1981), as well as the appearance of certain malformations (Szító, 1994) or other modifications in the cells of different organs, or even the modifications of the nervous system (Serfőző, 1993).

The indicator value of the aquatic organisms is more obvious in the case of the temporary and punctiform pollutions, in which neither the water nor the sediments contain an excessive quantity of pollutant, but the organisms still bear the sign of modifications produced by them (Moore - Ramamoorthy, 1984, ap. Dévai, 1993).

The Unionidae molluscs accumulate with a high intensity heavy metals, especially in gills. Because of their relative low mobility, these organisms are very good for testing the pollution degree of rivers with xenobiotics.

The catastrophic accidental pollution with cyanides and heavy metals caused by the Aurul industrial unit, from Bozânta Mare, determined a drastic effect on the aquatic communities from the Someş and Lăpuş rivers. Investigating the consequences during the years of 2000 - 2002 we noticed a serious load of heavy metals content in sediments. Afterwards the bioaccumulation was also researched, by using those organisms that are able to survive in lower reaches of the Someş River, namely fish and vascular plants. The latter showed high levels of heavy metals, but this could be due to sediments and biotecton settled on their organs, that are hard to be removed during the chemical analyses. Regarding the experiments with fish, in the year 2000 the metals' contents in the specimens captured in the exposed river sector were lower than those registered in individuals from the upper reaches. This proves that the fish that once lived in the polluted river sector died out, and were replaced after the environmental recovery, with other individuals belonging to different species, coming from upstream the river and its tributaries. These are the reasons why we decided to use bivalves as an alternative method of biomonitoring, but in the lower sector of the river this group is absent at present. Therefore individuals of *Unio crassus* Philipsson, 1788 had to be brought from the Lăpuş River Defile and afterwards from the Someş River Defile from Ţicău, which still shelter abundant populations of naiads, and exposed in underwater cages in the Someş River.

Materials and method

In order to accomplish this experiment, on 18 October 2001 we collected manually 60 specimens from the Lăpuş Defile (Ohaba de Pădure sampling station). From these, 10 specimens were used as control samples (determining their heavy metal content), the other ones were exposed in the Someş River at Merişor, downstream the discharge of the Lăpuş River. These were held in plastic cages, and were removed for analyses in groups of 10 individuals after 7 days (on 25.10.2001), 21 days (on 08.11.2001) and 147 days (on 14.03.2002). After 08.11.2001 a very cold period followed and the Someş River froze, so we were unable to sample other individuals until the spring. The heavy metal content of muscles and gills were determined.

Results and discussion

The results of the gills' analyses demonstrate a high bioaccumulation rate of copper and lead, in the first 7 days and, in a smaller degree, after 21 days. At this time the temperature of the water was higher, 7-8 ^{0}C. After this date, when the temperature of the water has fallen close to 0 ^{0}C, the mussels started to "hibernate" and catabolyze their own substances, so the heavy metal content decreased as well **(Tab. 1, Fig. 1, 2)** until the spring.

Table 1. Heavy metal content of mussels in 2001

Sample			**Cu**	**Pb**
Mussels	**Sampling site**	**Date**	**mg/kg**	**mg/kg**
Unio crassus/muscle – control	Lăpuş - Defile	18.10.2001.	14	1
Unio crassus/gills- control	Lăpuş - Defile	18.10.2001.	144	14
U. crassus/gills	Someş - Merişor	25.10.2001.	259	19
U. crassus/muscle	Someş - Merişor	25.10.2001.	10	<1
U. crassus/gills	Someş - Merişor	08.11.2001.	171	27
U. crassus/muscle	Someş - Merişor	08.11.2001.	5	<1
U. crassus/gills	Someş - Merişor	14.03.2002.	77	13
U. crassus/muscle	Someş - Merişor	14.03.2002.	8	<1

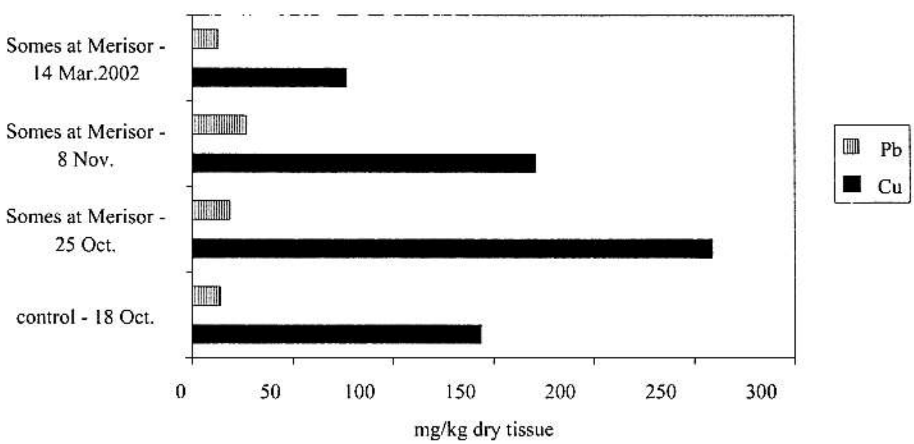

Fig. 1. The dynamics of heavy metal bioaccumulation in gills

In a very sharp contrast, the analyses of muscles illustrates another pattern, namely that all samples, despite the period, showed lower contents of heavy metals than the control. Led is continuously decreasing, while the copper registered an increased value in spring 2002, compared to the fall of 2001. These peculiarities suggested that the gills are much sensitive in heavy metals monitoring than muscles.

This first experience proved that the method is applicable only in the warm seasons, during which the bivalves are active. During the summer of 2002 the study was repeated in a similar manner but, finding out that the controls already have a certain amount of heavy metals, because of the residual mining waters discharged from the upper sectors, we used individuals from the Ţicău Defile, the Someş reach upstream the confluence with the Lăpuş tributary. The results are not available yet, but during the summer in only 9 weeks 60 % of these bivalves died, and the others were seriously weakened, having a pale colour of the tissues, as compared to the control samples.

Is worth mentioning that after the first 7 days the Sr content of the gills has increased. According to Coote & Trompetter (1995) one of the possible reasons of this increase should be the effect of stress.

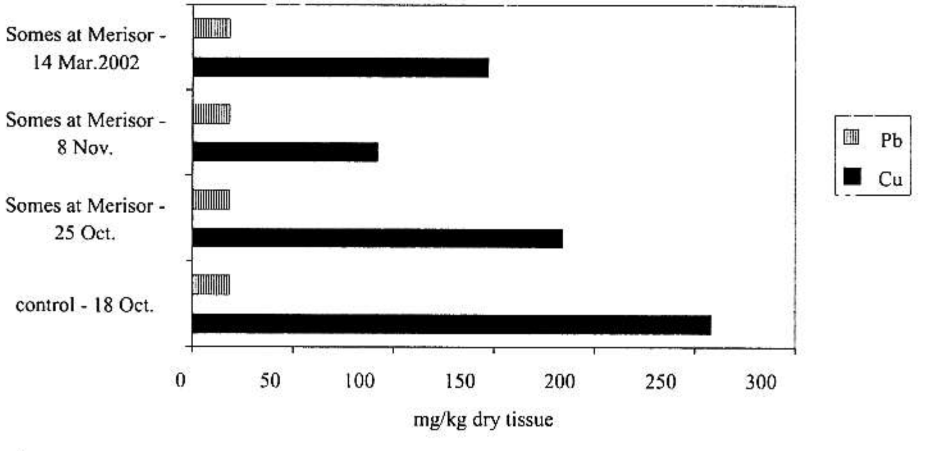

Fig. 2. The dynamic of heavy metal bioaccumulation in muscle

Acknowledgement

The study was supported by the Inco Copernicus Project ICA2-1999-10065.

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