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Preliminary aspects regarding the use of some invertebrate bioindicator species in the ecological study of an aquatic lotic ecosystem

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Abstract. Using invertebrate bioindicator species is one of the most important methodologies for evaluating the quality of the environment. The paper presents some data about monitoring studies, made during 1985-2008, with reference to some invertebrate bioindicator species, in the Someș River within the Cluj-Napoca city's limits. A number of 16 systematic categories were highlighted. The results presented in this paper are the preliminary data for a wider study referring to the evolution of this aquatic ecosystem's quality. On the other hand, the data show, for the studied period, a progressive increase of the level of the ecosystem's aggression and pollution.
Key Words: invertebrate bioindicators, environment quality, monitoring, aquatic ecosystem.

Tartalom. A környezet minőségének felmérésére az egyik legfontosabb módszer a gerinctelen bioindikátorok külömböző fajainak használata. Ez a dolgozat, olyan megfigyelések adatait mutatja be, amelyek 1985-2008 voltak végrehajtva, Kolozsvár környékén és amelyek bizonyos gerinctelen bioindikátorokra vonatkoznak, melyeket a Szamos folyóban azonosítottak. 16 szisztematikus csoport volt kitüntetve. A dolgozat eredményei, egy átfogóbb tanulmány előzetes adatai, amely e vizi ökoszisztéma minőségének változására vonatkozik. Ugyanakkor, az adatok kimutatják, hogy az illető periódusban, az ökoszisztéma szennyezési szintje fokozatosan nőtt.
Kulcsszavak: gerinctelen bioindikátorok, környezet minőség, megfigyelés, vizi ökoszisztéma

Rezumat. Folosirea speciilor bioindicatoare de nevertebrate reprezintă una dintre cele mai importante metodologii pentru evaluarea calității mediului. Această lucrare prezinta datele unor studii de monitorizare, realizate în perioada 1985-2008, cu referință la unele specii bioindicatoare de nevetebrate identificate în râul Someș, în zona orașului Cluj-Napoca. Un număr de 16 categorii sistematice au fost evidenţiate. Rezultatele din lucrare sunt date preliminare ale unui studiu mai cuprinzător referitor la evoluţia calităţii acestui ecosistem acvatic. Pe de altă parte, datele evidenţiază pentru intervalul studiat, o creştere progresivă a nivelului de agresare şi poluare a ecosistemului.
Cuvinte cheie: Nevertebrate bioindicatoare, calitatea mediului, monitorizare, ecosistem acvatic.

Introduction. Bioindicators represent a field of study in high current in applied ecology, with implications in the knowledge and protection of the biotic environments including the biocenosis. The bioindicator species represent an accurate reflection of the habitats' and biota's condition, the result of a long process of co-evolution. A set of intra- and inter-specific relations, but also relations between the organism and the environment, were established within a concept accepted today – the epharmony (Wilmanns 1999).

The importance of the concept of environmental quality is due to the fact that "being aware of the state of the environment enables finding and implementing solutions and ecological rehabilitation technologies of the environment" (Miller 2006). Today the ecological studies are of great importance from a practical point of view also, standing at the base of establishing modern methodologies that include the antropic factor in the knowledge and protection of the environment (Wearing 1988; Tschernyshev 1995; Wilmanns 1999; Stan 2007).

Monitoring ecosystems on a long period, using appropriate methodologies is of particular importance for a correct assessment of the quality of the biota's populations in an ecosystem, having direct implications in the ecological restoration activity (Stan 2005).

This paper includes the results of studies conducted during 1985-2008, regarding the presence and the evolution of the level of some invertebrate bioindicator species, in the Someșul Mic aquatic ecosystem, within Cluj-Napoca area.

Material and Method

The sampling process. Within this stage of the research the particularities of the Someș river have been considered, adapting the sampling techniques and equipment to the morphology of the watercourse and to the composition of the habitats. Making a correct sampling is particularly important in order to obtain the results which will best reflect the reality on the field. This is why, all the details regarding the sampling were analyzed and considered.

The samples were drawn from five sampling points on the Someș River, representing the three sections of an lotic aquatic ecosystem (the upper, middle and lower section), as follows: I – Someşul Rece village; II – Gilău – Luna de Sus village; III – Grigorescu – Sala Sporturilor neighborhood; IV – Mărăşti – Industrial Area neighborhood; V – Someşeni – Sânnicoară neighborhood (see Fig.1).

The sampling was realized in the period April-June and September-October. The monitoring had a monthly frequency. Samples were drawn during the years of: 1985, 1994, 2000, 2005 and 2008.

The sampling method. An experimental plot of around 100 m^2 was taken in each sampling point and the stratified random sampling method was applied but also other complementary techniques (Chiriac 2005). A water sample of 500 cm^3, consisting of 15-20 sub samples collected by random sampling, was drawn from each sampling point.

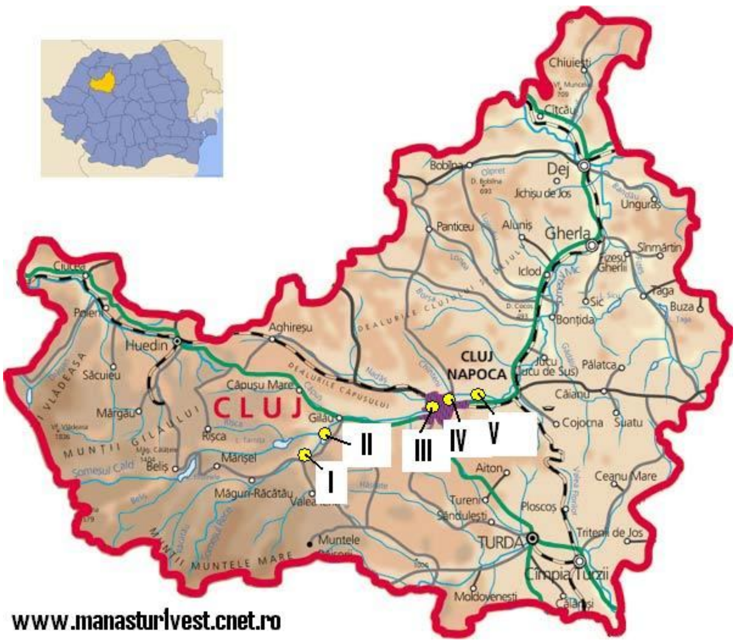

Figure 1. Map representing the location of the sampling points from Someșul Mic aquatic ecosystem in Cluj-Napoca area (1985-2008).

The biological material was sorted, determined, quantitatively evaluated and statistically processed (see Jarvis et al 1998, but also Krebs 1999).

Results and Discussion. The processing of the biological material revealed the presence of 16 systematic categories, typical to the aquatic ecosystem studied (Table 1).

The variation in the number of the individuals shows different levels of water contamination given the relation of interdependence between different species of organisms and their environment.

Comparing the samples drawn from the five sampling points, representing the three sections (the upper, middle and lower section) it was found that, during the years of the study, there was a gradual rise in the levels of pollution of the water of Someș River within Cluj-Napoca urban ecosystem and the adjacent area, reaching a maximum after it passes the city. Comparing the results obtained over the years (1985-2008), it was found that there was a continuous growth in the levels of water pollution for Someș River, up until the present.

Although the level of pollution, for the year 2008, has increased, fact proven also by the saprobe method (Gagyi-Palffy et al, unpubl. data), the studies have shown the lowest number of individuals (overall) of all the studied years. This can be correlated with the diversification of the pollutants, as well as with the powerful qualitative and quantitative modification of the water's chemistry (Gagyi-Palffy et al 2009).

Table 1

The systematic categories of aquatic invertebrates, known as bioindicators, identified in Cluj-Napoca lotic aquatic ecosystem, during the sampling period (1985, 1994, 2000, 2005 and 2008)

*Symbol**	*Invertebrate species common in fast moving waters***	*Invertebrate species common in slow moving waters***
1	Diptera – Brachicera larvae (e.g. *Simulium* sp.) (CW)	
2	Trichoptera larvae (small sized species) (CW)	
3	Plecoptera larvae (e.g. *Perla* sp.) (CW)	
4	Diptera-Nematocera larvae (e.g. *Tipula* sp.) (CW)	
5		Odonata larvae (e.g. *Libelulla* sp.) (CW)
6		Homoptera-Hydrocoridae larvae (e.g. *Corixa* sp., *Notonecta glauca* etc) (P; CW)
7		Neuroptera larvae (e.g. *Sialis lutea*) (CW)
8		Ephemeroptera larvae (*Ephemera vulgata*) (CW)
9		Diptera – Brachicera larvae (e.g. *Simulium* sp. - CW; *Chironomus* sp. - P)
10		Trichoptera larvae (*Pyrgamea grandis* etc) (CW)
11		Lamelibranhiata (*Sphaerium; Anodonta* sp.) (CW)
12		Coleoptera – Dytiscidae larvae and nymphs (CW)
13		Platyhelmyntha - Turbellariata (*Planaria* sp.) (CW)
14		a) Crustacea (*Asellus*–P)
15		b) Crustacea (*Gammarus*–CW); Cladocera (*Daphnia, Bosmina*) ; Copepoda (*Cyclops*)
16		Nematoda ; Annelida (Oligochaeta-Lumbricidae (*Tubifex sp* and related tubificidae) (P);

* - the figures correspond to the notation from Table 2;
** - CW = clean and relatively clean waters; P = polluted waters

Based on the total number of individuals for all the systematic categories considered for each of the five sampling points, the data revealed a high dominance of the systematic categories 2, 10, 14, 16. Two are representative for the clean waters upstream and two for the polluted waters downstream (Table 2).

Table 2

The abundance of individuals from 16 systematic categories found in five sampling points of Someșul Mic aquatic ecosystem within Cluj-Napoca area, during 1985-2008.

*The systematic category**	*Total number of individuals/sampling point***					*Total*
	I	II	III	IV	V	
1	38	16	7	2	1	64
2	180	128	30	9	57	404
3	7	2	0	0	5	14
4	23	21	1	2	22	70
5	0	8	23	0	32	63
6	0	0	2	2	14	18
7	0	0	0	0	2	2
8	0	0	2	0	0	2
9	0	4	14	8	43	69
10	0	34	38	6	107	185
11	1	1	0	0	10	12
12	1	3	3	4	32	43
13	0	7	1	10	2	20
14	0	22	16	34	94	166
15	3	41	18	7	45	84
16	0	17	15	143	237	412

* - the significance of the figures indicating the systematic categories is given in Table 1;
** - the location of the sampling points is given in Figure 1.

For the 1985-2004 period, the progressive increase in the level of water contamination was biologically demonstrated by the growth in the number of the individuals of some systematic categories known as bioindicators for clean and polluted waters (including the genus *Asellus* – Crustacea). Correlated with this increase, it was found that there was a progressive reduction in the number of individuals for clean water indicator species, among which some Diptera larvae (ex. *Simulium sp.*) (Fig.1).

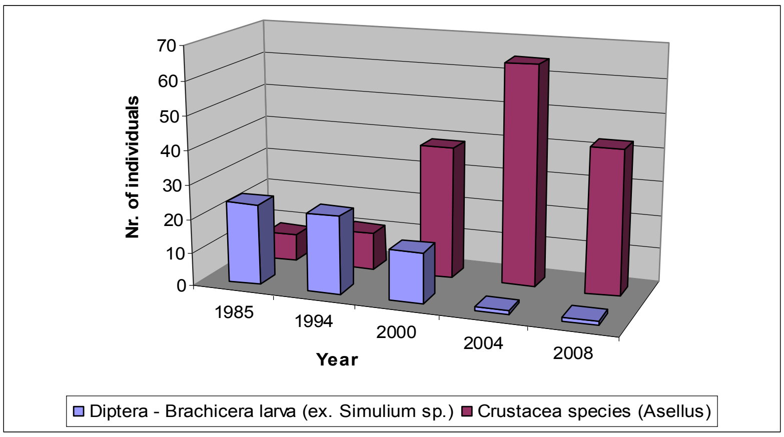

Figure 2. The evolution of *Simulium* sp. (Diptera) and *Asellus* sp. (Crustacea) populations' level in Someşul Mic river, within Cluj-Napoca urban ecosystem and the adjacent areas (1985-2008).

A common group of species for degradated, contaminated or polluted waters is the wide group of Tubificidae (Annelida: Oligocheta, with the best known *Tubifex tubifex*). Its population has grown gradually, especially in the period 2000-2004 (Fig.3), but the interesting thing is that this species' population was also significantly lower in 2008 compared with 2004 (t-test, P = 0.05, n = 64).

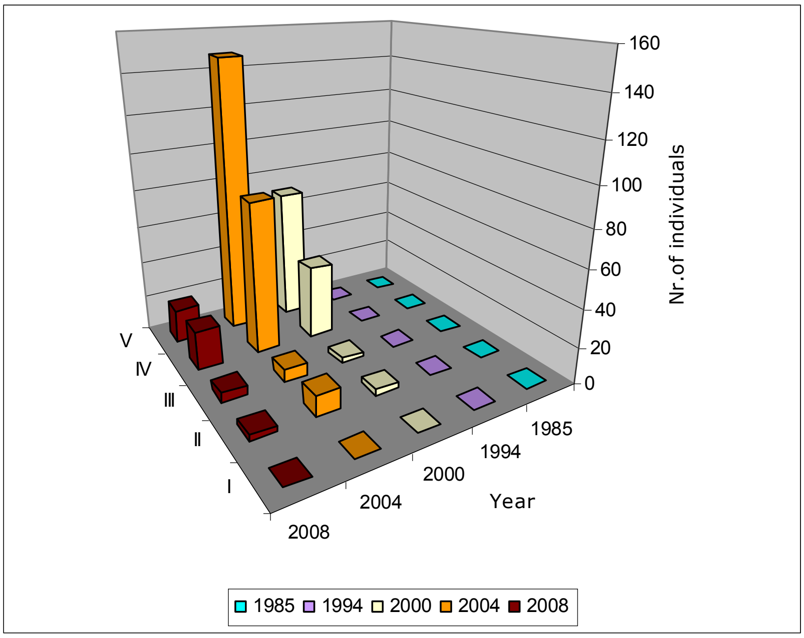

Figure 3. The evolution of tubificid (Annelida) populations in Someşul Mic river, within Cluj-Napoca urban ecosystem and the adjacent areas (1985-2008).

Another aspect that points out the poly-saprobe nature of the aquatic environment was the decrease of the populations of *Gammarus pulex,* a bioindicator for clean and relatively clean waters (Fig.4).

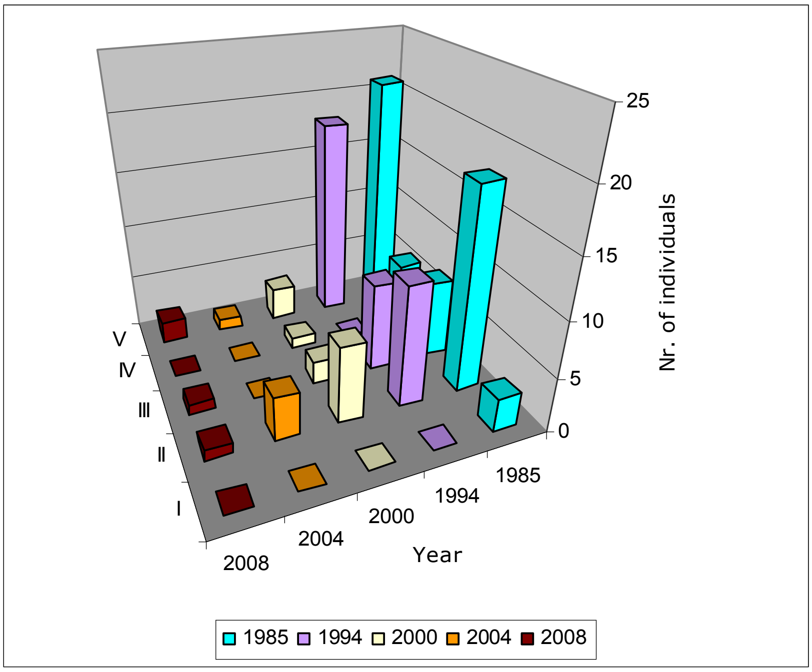

Figure 3. The evolution of the *Gammarus pulex* (Crustacea) populations in Someşul Mic river, within Cluj-Napoca urban ecosystem and the adjacent areas (1985-2008).

Considering the overall number of individuals for some invertebrate species, throughout the period of the study, it was revealed that there was, in time, an almost complete decrease of the number of individuals belonging to the genus *Gammarus*, a clean water bioindicator. Related to this, there was an increase in the number of individuals for the genus *Asellus* and also a strong increase for *Tubifex tubifex* (Fig.5) but only downstream of Cluj-Napoca. The powerful decrease in the number of it's individuals, recorded in 2008, will be clarified after conducting more complex analysis related to the chemistry of the water.

The recent increase in the level of pollution of Someşului Mic river was also proved by other studies that have included the water section downstream of Cluj-Napoca, in the forth quality class (poly-saprobe waters, with a very high level of contamination) (Someș-Tisa Water Branch).

The aquatic ecosystem is much more complex that the terrestrial ecosystem and the atmosphere, due to the fact that the aquatic organisms have a much stronger interdependence with their environment. As a result, the aquatic organisms are more exposed to poisoning. Most of the aquatic habitats, and especially those with a free flow, an adequate geology and an appropriate quality of water, sustain different communities of macroinvertebrates with a balanced distribution of the species and the number of individuals. The macroinvertebrate communities react to the changes in the quality of the habitat by adapting their structure. The responses of the benthonic organisms to the disturbances of the environment are useful in assessing the influence of anthropogenic activities on surface watercourses (Chiriac 2005).

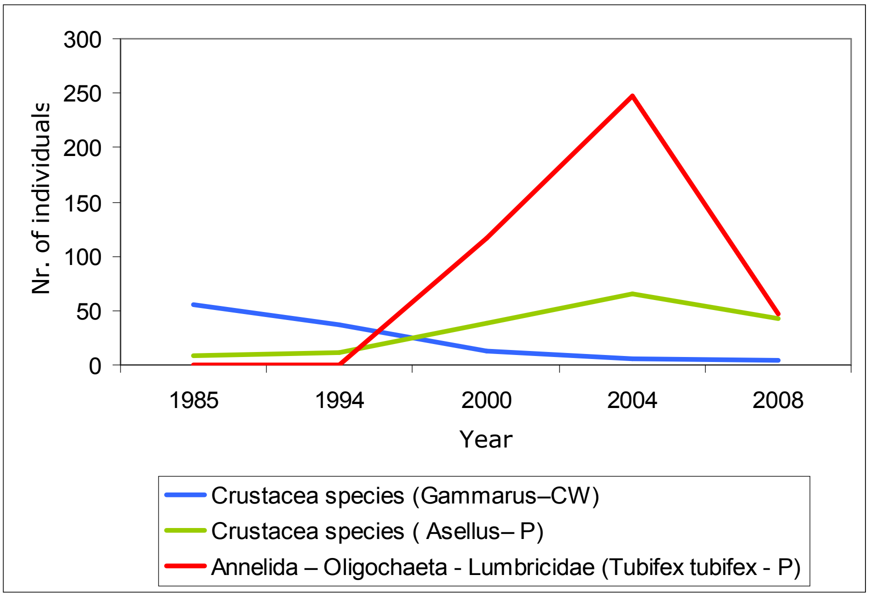

Figure 4. The dynamic of some relevant systematic categories (CW, MP, P) in the five sampling points.

The advantages of using benthonic macroinvertebrates in assessing the quality of rivers are given by their abundant presence in all types of rivers and river-side habitats, by their natural diversity, their capacity to indicate the quality of the water, their fast reaction to stress factors, the relative simplicity of the sampling and determination, a less frequent sampling required (the organisms have longer average life periods), as well as the heterogeneous sampling of different evolutional taxa that have different reactions to the specific changes in the quality of the water (see also Chiriac 2005).

Conclusions. A number of 16 systematic categories were highlighted with reference to some invertebrate bioindicator species. The results show, for the studied period (1985-2008), a progressive increase of the level of the ecosystem's aggression and pollution.

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