DISTRIBUTION OF THE COMMUNITIES OF EPHEMEROPTERA, PLECOPTERA AND TRICHOPTERA IN THE BASIN OF THE SASAR RIVER

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Abstract. Life of zoobenthic communities that populate the watercourses is influenced by the mode of setting up of the substrate, slope, flowing speed and water flow as well as by the anthropogenic influence.

Ephemeroptera, and Plecoptera and also Trichoptera (EPT) are the main biomarkers in the evaluation of the health condition of the aquatic ecosystems. The new river classification methodologies in quality classes have been tested and mostly harmonized at European level.

This paper followed the distribution mode of EPT in the Sasar river basin and evidencing their biomarker quality.

Keywords: Normalized Global Biologic Index, EPT, monitoring biologic methods

INTRODUCTION

In the last years it has been proved that the analysis of the structures of plant and animal communities of the watercourses reflect with much more fidelity their ecologic condition.

The hydrographic basin of the Sasar River covers a surface of 311 km^2, being situated in the Baia Mare depression, and it is surrounded by the basins of the rivers: Săpânța to the North, Iza to the East and Lăpuș to the South-West [2].

As for the use of the land within the Sasar River basin, 73.18% of it is occupied by forest land, and only 18.75% by farming land. The inhabited area represents only 8.07%, comprising the urbane centers (Baia Mare, Baia Sprie) and the rural centers (Chiuzbaia, Tăuții de Sus, Satu Nou de Sus, Ferneziu and Blidari).

Most of the watercourses of the Sasar River basin are located on hilly and highland areas, the lithologic substrate being made up of pebbles and sand. The average annual rainfall is 500-700 mm, the average temperature of water varies within the interval of 8-10 ^{0}C.

During 2006, from the point of view of the physical-chemical properties, the analyzed watercourses of the Sasar River basin (**Fig. 1**) had been included within the I-II quality class for the regimen of oxygen and nutrients. Outstanding problems had been recorded for the markers: zinc, cadmium and manganese and lead for the Sasar and Firiza rivers, down river of the industrial areas of Baia Sprie, Baia Mare and Ferneziu.

MATERIALS AND METHODS

Stations located upriver and downriver of the urbane centers Baia Sprie and Baia Mare were chosen for the Sasar River, which determine a massive anthropic pollution (the station upriver of Baia Sprie–2, the station downriver of Baia Sprie-4, the station upriver of Baia Mare-9, the station downriver of Baia Mare-10).

The most important tributaries of the Sasar River were biologically assessed: Valea Limpedea-3, Valea Morii-5, Valea Gordanului-6, Valea Firiza-8. The reason was to determine their ecological condition, taking into account their location in areas affected by pollution or exposed to incidental pollution.

Two witness unpolluted stations were identified: the station Valea Mărițiii-1, and the station upriver of Blidari-7.

Ten stations were wholly explored, their location being shown in **Fig. 1**.

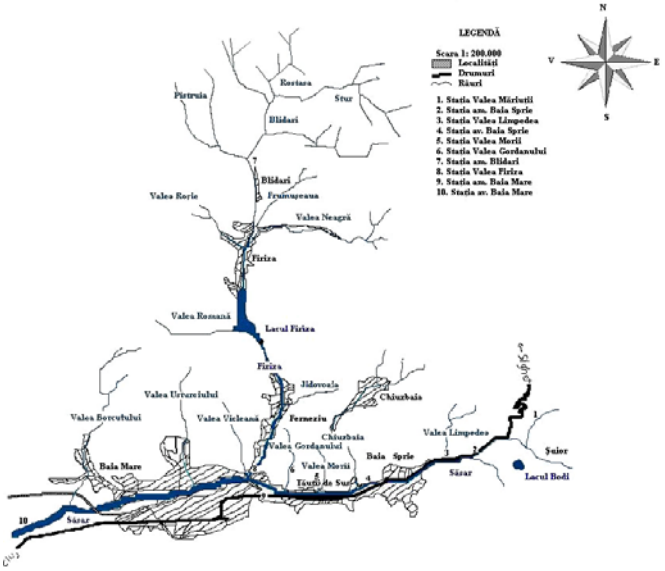

Figure 1. The location of the sampling stations in the hydrographic basin of the Sasar River.

The stations had been monitored and sampled for 4 years (2003-2006) according to the NGBI method (Normalized Global Biologic Index) [13].

The statistic data processing was made using the standard statistic methods (ANOVA, regression analysis) using the SPSS application (Statistical Package for the Social Science) [4].

RESULTS AND DISCUSSIONS

The zoobenthos gradient analysis along a watercourse demonstrates a gradual change of the faunistic communities towards downriver. These discontinuities correspond to the passage from the thermal conditions that characterize Rhithral and Potamal [11].

The distribution of macroinvertebrates is influenced by the environmental factors: altitude, water temperature, luminosity, dissolved oxygen, incline, water flowing speed, flow, contribution of organic material, water chemistry, etc. [6, 11].

Water pollution is highly important for the distribution of the benthic communities. Thus, the decrease of dissolved oxygen and the toxic impact of inorganic nature from the industry determine the deterioration of all taxons, especially those of the EPT communities [1, 3, 5].

A reduced number of taxons are summoned at the level of the superior watercourse due to the substrate erosion and instability. According to the same studies, the diversity of benthic invertebrate is high in the piemontan areas and in the hilly areas, due to the reduced erosion processes [7].

So, starting with the station downriver of Baia Sprie and up to the station upriver of Baia Mare, a segment in which the Sasar River is positioned in the middle course, according to these findings it would have been recorded a high diversity of benthic macroinvertebrates comparatively to the Valea Mariutii station and upriver of Baia Sprie, but this condition is not observed regarding the urbane conglomerations where the river flows.

Accordingly, the diversity of the studied zoobenthic communities is affected for most of the tributaries of the Sasar River, although the sampling stations are located at favorable altitudes for the emergence of most of the benthic groups, the explanation being the influence of the industrial pollution, the noxious waste being directed by the air draught towards the hilly areas, where the sources of the studied tributaries are located. Only the Valea Limpedea stream is characterized by a higher diversity, being positioned in an area which is less exposed to the anthropic influences.

The structure of the zoobenthic communities is compromised around the Valea Firiza station, considering the geographic location of the river in an area stressed by an intense anthropic pressure.

We have to mention that the structure of the benthic communities is also influenced by a series of abiotic nature events [8].

The decrease in the water flows due to the prolonged drought, this situation being found at the stations of Valea Morii and Valea Gordanului in 2003 and 2004, or flooding caused by torrential rains and snow melting, as it was the case in 2006 for most of the stations, are phenomenon which could also influence the distribution of the zoobenthic communities.

Of course, the consequences generated by the natural background of the area that comprises great polymetallic accumulations cannot be ignored either. Thus, a series of elements as: Mn, Fe, Cu, Zn and Pb were identified in the ground and in the watercourses.

Unfortunately, a scientific analysis of the natural background of the Baia Mare basin has not been done so far, although there are numerous preoccupations towards this direction [9].

A number of 20 species of Ephemeroptera, 9 species of Plecoptera and 27 species of Trichoptera were found and identified for the Sasar River, following the systematic study, carried out during the period 2003-2006 (**Table 1**).

The diversity of benthic fauna is reduced for the Sasar River, as there were identified 10 species of Ephemeroptera, 5 species of Plecoptera and 13 species of Trichoptera in the source area (the Valea Mariutii station). 9 species of Ephemeroptera, 3 species of Plecoptera and 7 species of Trichoptera were identified at a distance of 8 km downriver. Due to the important environmental changes, there is not any taxon belonging to the category of the benthic groups which are sensitive and very sensitive to the pollution phenomenon at 10 km from the source (the station downriver of Baia Sprie). Tolerant forms of Bäetidae (Ephemeroptera) appeared in the last two years of sampling 2005-2006.

The composition and abundance of taxons moderately differ relative to the specific structure of the unchanged natural conditions, for the stations of Valea Limpedea, Valea Morii and Valea Gordanului.

Finally, concerning Firiza, a good structuring of the EPT communities is found in the source area (the station upriver of Blidari) (10 species of Ephemeroptera, 6 species of Plecoptera and 3 species of Trichoptera). After about 20 km (the Firiza station), the water quality deteriorates due to the intense anthropic pressure, so the structure of the studied zoobenthic communities is totally compromised.

Table 1. The EPT Distribution in the Sasar River Basin

SPECIES	Station	Average	Standard Deviation	Occurrence Number	SPECIES	Station	Average	Standard Deviation	Occurrence Number
Paraleptophlebia sp	vlimp	4		1	*Rhyacophila (Hyperhyacophila) fasciata* Hagen	vmorii	8	,	1
	amblid	1	,	1		vgord	2	,	1
	Total	**2,5**	**2,12**	**2**		**Total**	**5**	**4,24**	**2**
Habroleptoides sp.	amblid	1	**,**	**1**	*Rhyacophila hirticornis* McLachlan	vlimp	4	,	1
	Total	**1**	**,**	**1**		**Total**	**4**	**,**	**1**
Leptophlebia sp.	amblid	1	,	1	*Rhyacophila nubila* Zetterstedt	vlimp	1	,	1
	Total	**1**	**,**	**1**		vmar	1	,	1
Ephemera danica Muller	vlimp	2		1		**Total**	**1**	**,00**	**2**
	vmar	9	,	1	*Rhyacophila polonica* McLachlan	vmar	5	,	1
	ambs	4	,	1		**Total**	**5**	**,**	**1**
	vmorii	3	,	1	*Ryacophila (Hyperhyacophila) torrentium* Pictet	vmar	1	,	1
	Total	**4**	**3,11**	**4**		**Total**	**1**	**,**	**1**
Ephemerella ignita Poda	vlimp	12	,	1	*Ryacophila tristis* Pictet	vlimp	2	,	1
	amblid	2	,	1		vmar	2	,	1
	ambs	8	,	1		**Total**	**2**	**,00**	**2**
	Total	**7,33**	**5,03**	**3**	*Ryacophila vulgaris* Pictet	ambs	5	,	1
Ephemerella sp	avbs	5	,	1		**Total**	**5**	**,**	**1**
	Total	**5**	**,**	**1**	*Ryacophila sp..*	vlimp	4	,	1
Caenis sp	vgord	4	,	1		**Total**	**4**	**,**	**1**
	Total	**4**	**,**	**1**	*Glossosoma boltoni* Curtis	vlimp	3	,	1
Ecdyonurus dispar Curtis	vmar	2	,	1		amblid	2	,	1
	vmorii	6	,	1		ambs	1	,	1
	vgord	4	,	1		**Total**	**2**	**1,00**	**3**
	Total	**4**	**2,00**	**3**	*Glossosoma intermedium* Klapalek	vmar	1	,	1
Ecdyonurus insignis Eaton	amblid	1	,	1		**Total**	**1**	**,**	**1**
	vmar	2	,	1	*Polycentropus flavomaculatus* Curti	vmorii	1	,	1
	vmorii	1	,	1		**Total**	**1**	**,**	**1**
	Total	**1,33**	**,58**	**3**	*Chimarra marginata* Linnaeus	vmorii	6	,	1
Ecdyonurus venosus Fabricius	vlimp	6	,	1		**Total**	**6**	**,**	**1**
	vmorii	1,	,	1	*Chimarra sp.*	vlimp	1	,	1
	Total	**3,5**	**3,54**	**2**		**Total**	**1**	**,**	**1**
Ecdyonurus sp	vlimp	2	,	1	*Philopotamus montanus* Donova	vmar	4	,	1
	vmar	2	,	1		vmorii	5	,	1
	ambs	4	,	1		vgord	1	,	1
	vgord	2	,	1		**Total**	**3,3**	**2,08**	**3**
	Total	**2,5**	**1,00**	**4**	*Cheumatopsyche lepida* Pictet	vlimp	6	,	1
Epeorus sylvicola Pictet	vlimp	4	,	1		ambs	12	,	1
	amblid	6	,	1		vmorii	2	,	1
	vmar	3	,	1		**Total**	**6,6**	**5,03**	**3**
	Total	**4,33**	**1,53**	**3**	*Hydropsyche angustipenis* Curtis	vlimp	1	,	1
Rhithrogena semicolorata Curtis	vmar	2	,	1		vmar	4	,	1
	ambs	6	,	1		**Total**	**2,5**	**2,12**	**2**
	vmorii	1	,	1	*Hydropsyche fulvipes* Curtis	vmar	10	,	1
	vgord	2	,	1		vgord	4	,	1
	Total	**2,7**	**2,22**	**4**		**Total**	**7**	**4,24**	**2**
Rhithrogena sp.	amblid	2	,	1	*Hydropsyche pellucidula* Curts	vlimp	21	,	1
	vmar	1	,	1		vmar	20	,	1
	ambs	1	,	1		ambs	3	,	1
	Total	**1,3**	**,58**	**3**		vmorii	24	,	1
Heptagenia sulphurea Muller	vmar	9	,	1		vgord	22	,	1
	ambs	4	,	1		**Total**	**18**	**8,51**	**5**
	vgord	10	,	1	*Hydropsyche sp.*	amblid	1	,	1
	Total	**7,67**	**3,21**	**3**		ambs	4	,	1
Heptagenia sp.	amblid	1	,	1		vgord	3	,	1
	Total	**1**	**,**	**1**		**Total**	**2,6**	**1,53**	**3**
Bäetis alpinus Pictet	vlimp	2	,	1	*Diplectrona felix* McLachlan	vmar	7	,	1
	amblid	4	,	1		vmorii	2	,	1
	vmar	6	,	1		**Total**	**4,5**	**3,54**	**2**
	ambs	2	,	1	*Diplectrona sp.*	vlimp	1	,	1
	Total	**3,5**	**1,91**	**4**		ambs	1	,	1
Bäetis rhodani Pictet	vlimp	14	,	1		**Total**	**1**	**,00**	**2**
	vmar	17	,	1	*Apatania miliebris* McLachlan	vmar	3	,	1
	ambs	55	,	1		**Total**	**3**	**,**	**1**
	vmorii	4	,	1	*Halesus radiatus* Curtis	vlimp	1	,	1
	avbs	36	,	1		vmar	1	,	1
	vgord	9	,	1		**Total**	**1**	**,00**	**2**
	vfir	2	,	1	*Potamophylax nigricornis* Pictet	vlimp	7	,	1
	ambm	26	,	1		**Total**	**7**	**,**	**1**
	avbm	3	,	1	*Potamophylax cingulatus* Stephens	ambs	1	,	1
	Total	**18,44**	**17,78**	**9**		**Total**	**1**	**,**	**1**

Bäetis vernus Curtis	ambs	4	,	1	*Goera pilosa* Fabricius	amblid	1	,	1
	avbs	2	,	1		**Total**	**1**	**,**	**1**
	Total	**3**	**1,41**	**2**	*Sericostoma sp.*	vmar	3	,	1
Brachyptera seticornis Klapalek	vmar	2	,	1		**Total**	**3**	**,**	**1**
	ambs	4	,	1					
	Total	**3**	**1,41**	**2**	**TOTAL**	**vlimp**	**4,88**	**5,04**	**24**
Brachyptera sp	vmar	2	,	1		**amblid**	**2,17**	**1,69**	**18**
	Total	**2**	**,**	**1**		**vmar**	**5,46**	**5,83**	**28**
Leuctra sp	vlimp	1	,	1		**ambs**	**6,47**	**12,07**	**19**
	amblid	2	,	1		**vmorii**	**5,64**	**6,52**	**14**
	Total	**1,5**	**,71**	**2**		**avbs**	**14,33**	**18,82**	**3**
Nemoura cinerea Reitzus	vmar	3	,	1		**vgord**	**5,42**	**5,93**	**12**
	Total	**3**	**,**	**1**		**vfir**	**2,00**	**,**	**1**
Protonemura intricata Ris	vlimp	6	,	1		**ambm**	**26,00**	**,**	**1**
	amblid	1	,	1		**avbm**	**3,00**	**,**	**1**
	vmar	8	,	1					
	ambs	3	,	1					
	Total	**4,5**	**3,11**	**4**					
Perla marginata Panzer	vlimp	11	,	1					
	amblid	6	,	1					
	vmar	23	,	1					
	ambs	1	,	1					
	vmorii	15	,	1					
	Total	**11,2**	**8,44**	**5**					
Perla sp.	amblid	2	,	1					
	Total	**2**	**,**	**1**					
Perlodes intricatus Pictet	amblid	4	,	1					
	Total	**4**	**,**	**1**					
Chloroperla tripunctata Scopoli	vlimp	1	,	1					
	amblid	1	,	1					
	Total	**1**	**,00**	**2**					

Analyzing the composition of the zoobenthic communities of the analyzed stations we remarked that Ephemeroptera appears in all the 10 stations, Trichoptera appears in 6 stations and Plecoptera appears in 5 stations.

Table 2. The Frequency of the Communities of Ephemeroptera, Plecoptera and Trichoptera in the Sasar River Basin

TAXONS	FREQUENCY		ABSENCE	
	Number of stations	%	Number of stations	%
EPHEMEROPTERA	10	100	0	0
TRICHOPTERA	6	60	4	40
PLECOPTERA	5	50	5	50

The species belonging to the EPT communities which fulfill the highest frequencies for the Sasar River basin are: *Bäetis rhodani* (90%), Perla marginata (50%), *Cheumatopsyche lepida* (50%), *Hydropsyche pellucidula* (50%), *Ephemera danica* (40%), *Ecdyonurus sp*. (40%), *Rhithrogena semicolorata* (40%), *Bäetis alpinus* (40%) and *Protonemura intricata* (40%).

Following the dynamic of the zoobentic communities studied during the period 2003-2006, a general tendency of restoration and diversification was found, probably due to the decreasing of pollution.

The identification of the predictors that influence the distribution of the benthic macroinvertebrate studied per stations was followed. Thus, the hierarchic multiple regressions were used [4].

Table 3. The identification of the predictors that influence the distribution of the species in the stations that suffered the impact of the mining activity

Model	Nonstandardized Coefficients		Nonstandardized Coefficients	t	sig.
	B	Standard Deviation	Beta		
(Constant)	-20,820	3,933		-5,294	,119
CBO_5	-2,687	,634	-,909	-4,239	,147
Cu	-126,282	17,028	-4,786	-7,416	,085
Fe	-,291	1,005	-,034	-,290	,821
Mn	7,512	1,181	2,558	6,359	,099
N	-,831	,311	-,311	-2,670	,228
Pb	334,000	44,409	4,677	7,521	,084
Zn	-12,752	2,437	-1,747	-5,233	,120
Ph	4,468	,687	1,336	6,502	,097

Observing the data presented above it can be noted that for the stations that have suffered the mining impact (upriver of Baia Sprie, downriver of Baia Sprie, upriver of Firiza confluence, upriver and downriver of Baia Mare), these are the negative predictors of the distribution of the studied communities, ordered: Cu (B= -126.28), Zn (B= -12.75), CBO5 (B= -2.69), nitrates (B= -0.83) and Fe (B= -0.29); and the positive predictors are: Pb (B= 334), Mn (B= 7.51) şi pH-ul (B= 4.47).

Table 4. Identification of the predictors that influence the distribution of the species in the stations out of influence of the mining activity

Model	Nonstandardized Coefficients		Nonstandardized Coefficients	t	sig.
	B	Standard Deviation	Beta		
(Constant)	6,417	11,109		,578	,572
CBO_5	,125	,690	,036	,180	,859
Ph	-2,192	1,141	-,434	-1,921	,073
G	-,311	,400	-,190	-,777	,449
N	1,835	,796	,470	3,306	,035
OD	1,185	,580	,587	2,042	,050
T	,327	,157	,616	2,081	,050

For the stations which are out of the influence of the mining activity (Valea Mărițiii, Valea Limpedea, Valea Morii, Valea Gordanului, upriver of Blidari) the negative predictors of the distribution of the studied communities are: pH (B= -2.19) and hardness (B=-31); and the positive predictors are, in the decreasing order of their influence: nitrates (B= 1.83), oxygen (B= 1.18), temperature (B= 0.33) and CBO_5 (B= 0.12).

CONCLUSIONS

- The investigated area is mostly included in the industrial perimeter of Baia Mare.
- Following the systematic study carried out during the period of 2003-2006, a number of 20 species of Ephemeroptera, 9 species of Plecoptera and 27 species of Trichoptera had been sampled and identified.
- The maximum number of the species which belong to the EPT communities were recorded for the Valea Mariutii station (28), followed by the Valea Limpedea station (24). A reduced diversity of the EPT communities was found in the stations located downriver of the urbane centers of Baia Sprie and Baia Mare (the station downriver of Baia Sprie, the Valea Firiza station, upriver and downriver of Baia Mare).
- In the case of the Sasar River basin, a natural sectoring of the communities of Ephemeroptera, Plecoptera and Trichoptera, is not be found as the influence of the anthropic impact is important, determining the readjusting of the spatial distribution of lots of species.
- These are the factors that restrict the distribution of the EPT communities for the stations which are influenced by the mining impact: Pb, Mn and pH; and for the stations located outside the area of the mining impact: nitrates, quantity of dissolved oxygen and temperature.

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