

The assessment of the bioindicator value of some rheophilic elements of the River Someş/Szamos¹ lotic system

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Abstract

The analysis of the benthic communities characteristic of the Someş lotic system according to the main taxa (Ephemeroptera, Plecoptera, Trichoptera and fishes) carried out at 27 sampling sites in 1992 and 1996.

The carrying capacity of the river was assessed and some lists of bioindicators specific for this catchment area were proposed.

Keywords: bioindicators, carrying capacity, Ephemeroptera, Plecoptera, Trichoptera and fishes

Introduction

There are two main points to be taken into account:

a. The necessity of permanent monitoring and management of the aquatic resources which must be sustained with a good scientific base. It means a relatively complete knowledge about the taxonomic composition, physico-chemical parameters, structure of the communities, the role of some populations in nutrient cycling.

b. The necessity of comparing the aquatic ecosystems in order to understand their evolution and to predict the environmental impact.

The river Someş is one of the most interesting flow in Romania. It is included within the western hydrographic systems (Gâstescu & coll., 1983).

In 1992 and 1996 two expeditions (Someş/Szamos Expedition) were organised by the Liga Pro Eurpa, Târgu Mureş (Romania) and TiszaKlub of Szolnok (Hungary) to complete researches on the river Someş, from its spring to its mouth.

The river Someş with a hydrographic basin of 15.217 km², is formed by the union of 3 main flows, namely of the Someşul Cald, Someşul Rece and Someşul Mare, located in different geological areas. It is interesting that the placing of the Someşul Cald and Someşul Rece within the phoenic winds zone of the Western Carpathians impart the following reduced values, although the discharge basin can be found at an altitude of 1000-1500 m (Ujvary, 1959). This thing provides steadiness to these two ecological systems and contributes to their diversity in species development.

¹ The first name is Romanian, and the second Hungarian

On the other hand, along the lower flow of the Someş, downstream the locality of Jibou, some parts with as pronounced slope can occur, generating the flow acceleration and providing life conditions for some rheophilic species. As a matter of fact, most length of the Someş resembles a submountain, fast flowing river, stirred by the bouldery substratum.

Material and methods

The faunistical analyses took place by a quantitative test (with a Surber benthometer) and a qualitative one (with a hand dredge). In some areas the sampling based on the stratified random criteria, i.e. different substratum types were selected.

The communities of benthic macroinvertebrates can reflect the main processes of the ecosystems taking into account the existing knowledge (taxonomy, ecology and zoogeography) about the main groups (Plecoptera, Ephemeroptera, Trichoptera and Diptera Chironomidae). We can use the data of dispersal of different groups in an aquatic basin and also we can predict the status of the community and of the system based upon the assessment of the community structure. The anthropogenic influence on lotic ecosystems increases: the energy flux changes by the modification of border vegetation, like the input of alloctonous organic materials and the recycling of nutrients, especially of nitrogen and phosphorus (Hildrew & Giller, 1995).

Results and Discussion

Carrying capacity of the Someş lotic system

Assessing the carrying capacity we must take into account the following criteria:

The activity of a minimum number of populations, which are more adapted to the environmental conditions.

The ecosystem can maintain its functionality based only on 2-3 species that sustain its structure. In some areas of the river Someş just Oligochaeta and some Diptera (Chironomidae) can survive in extreme conditions and they are able to preserve a simplified structure, sufficient for the system.

The special significance of the consumers which are able to use allochthonous trophic resources (some Coleoptera larvae, Trichoptera Limnephilidae, Plecoptera, Leuctridae and some Chironomidae)

The heterogeneity of substrata which induces the localisation of the benthic populations.

- coarse gravel, relatively uniform, with a fine layer of algae
- boulders rinsed by the water current very well, without detritus
- coarse sand without detritus
- coarse sand with detrital deposits with many mayfly larvae (*Siphonurus*)
- small deposits of mud with many oligochaets and midges.

In the Năsăud area (Someșul Mare) there are some braided sections, which permit the deposition of fine, muddy sediments, inducing the dominance of oligochaets (*Limnodrilus*). On the other hand, in sections with a high water velocity there are numerous Trichoptera (Hydropsychidae).

The riverine vegetation is a main factor for ecosystem and influences the carrying capacity in two ways: directly, as a source of organic fresh material available for macrodecomposers (shredders Crustacea Amphipoda and some Trichoptera) and microdecomposers indirectly, by the shading effect which favours the low temperatures of the water.

The riverine herbaceous vegetation rinsed by the water flow is a shelter for many species mostly in the flooding periods.

The actual distribution of the forests along the Someș reflects the main types of human impacts. The Someșul Mare is protected by mixed forests at the Sant-Rodna section and by deciduous ones at the Năsăud-Beclean section. The Someșul Cald and Someșul Rece flow through deciduous forests. The Someșul Mic and the Someș are more influenced by the deforestation phenomena, mainly in the lower zones.

Between 1910 and 1970 the human pressure was simply estimated by the population growth, correlated with the benthic diversity. In the sectors of the Someșul Mic the growing was significant, from 500-1000 individuals/m² up to 2000/m². In the sectors of the Someșul Cald and Someșul Rece the values did not change in time and the benthic communities are more diverse than the others one. In the Someș away from Jibou the density became double and this phenomenon, correlated with the industry development induced the decreasing of diversity.

The limits of the carrying capacity

The remarkable diversity in the upper reaches of the Someșul Cald, Someșul Rece and Someșul Mare indicates both favourable abiotic conditions and the complexity of trophic relations. Taking into account the limits of carrying capacity it was possible to appreciate the chances of recovering of the impacted areas.

In our opinion, the upper carrying capacity limit is sustained by the rheophilic species (Ephemeroptera, Plecoptera, Trichoptera, Diptera – Blephariceridae and Pisces-Salmonidae) which use many resources, both autochthonous and allochthonous ones. The medium limit is correlated with the real possibility of restoring the initial conditions because in the sectors of the Someșul Mare (Sant-Rodna-Năsăud) and the Someșul Mic (away from Cluj) the dominant populations of Hydropsychidae (Trichoptera) and Unionidae (Bivalvia) have a remarkable filtering capacity. The lower limit is induced by the wastes loaded in the water and is sustained by the populations of Chironomidae (Diptera), Oligochaeta, Bryozoa colonies and Hydropsychidae (Trichoptera). The decreasing below this limit can produce a drastic change in the system and a human intervention is necessary to sustain the biological recovering.

The populations of *Hydropsyche pellucidula* (Trichoptera, Hydropsychidae), *Plumatella repens* (Bryozoa) and the Unionidae (Bivalvia) determine the filtering capacity of the benthic communities and ensure specific conditions for settling of other

benthic groups. So, the aggregation of Hydropsychidae larvae on boulders or on argilla permit the forming of an association with Ephemeroptera larvae, many Chironomidae and Isopoda (Crustacea). It must be mentioned that the Hydropsychidae larvae are also dominant in the upper sections of the river, being sustained by loading particles. This situation determines some effects as:

- the covering of the boulders and other surfaces with a fine layer of algae, bacteria and moss
- the accumulation of a fine sediment between the elements of gravel
- the tendency of decreasing of rheophilic populations
- the dominance of filtering collectors
- the consolidation of the association.

The lowest limit is demonstrated by the dominance of Oligochaeta and Chironomidae populations (in the Someșul Mic, downstream Cluj) which can use a quantity of organic matter. In the sector Someșeni (Someșul Mic) this limit is accessible for bacterial populations only.

There are some points to be discussed in order to differentiate the sectors of the river depending on its carrying capacity:

Only the main water-course of the Someș is taken into account; the affluent (small creeks, springs) form a particular unit.

The species characteristic for the upper part of the river have the best bioindicator value.

The actually lotic systems are influenced by the human activity.

The chances of recovering for the impacted zones depend on the stability of affluent (they are reserves of biodiversity).

The bioindicators

The mayflies are considered to be significant in the water qualification but depending on the environmental deterioration their presence may be discussed in different sectors of the rivers. This must be considered with some criteria:

- the population size (isolated individuals are not significant)
- the pollution is not the only phenomenon determining the quality deterioration of the ecosystems
- the assessment of data must be made for a sufficiently long time

In our days the negative phenomena affecting the quality of waters are more and more important. In the Someș watershed there are dams, hydrotechnical buildings, impounds, mining, agriculture. The drought of the last 10 years (as a general phenomenon for Romania) reduced the outputs and contributed to the eutrophication processes resulting an excess of algae, moss and aquatic macrophytes (in the Someșul Mic and in the Someș downstream Jibou) and an increase in water temperatures in summer.

The algal-blooming, which is characteristic of the lentic ecosystems, has a correspondent in the lotic ones, namely the increasing of population size in Bryophyta, aquatic macrophytes (*Potamogeton* species) and Oligochaeta (e.g. *Limnodrilus hoffmeisteri*). These ones are characteristic of the sections Someșeni-Gherla and Dej-Jibou.

Taking into account the faunistical analysis we propose a checklist of species with bioindicator value for the Someş watershed:

Bioindicators of excellent quality	<i>Perla pallida</i>
Plecoptera:	<i>Isoperla grammatica</i>
<i>Brachyptera risi</i>	<i>Chloroperla tripunctata</i>
<i>Leuctra albida</i>	Ephemeroptera
<i>Leuctra rauscheri</i>	<i>Baetis lutheri</i>
<i>Leuctra quadrimaculata</i>	<i>Baetis rhodani</i>
<i>Amphinemura triangularis</i>	<i>Baetis scambus</i>
<i>Nemoura fulviceps</i>	<i>Rhithrogena semicolorata</i>
<i>Perla marginata</i>	<i>Ecdyonurus dispar</i>
<i>Siphonoperla neglecta</i>	<i>Ecdyonurus venosus</i>
Ephemeroptera:	<i>Ephemerella mesoleuca</i>
<i>Siphonurus lacustris</i>	<i>Ephemerella notata</i>
<i>Siphonurus aestivalis</i>	<i>Leptophlebia marginata</i>
<i>Ameletus inopinatus</i>	<i>Paraleptophlebia submarginata</i>
<i>Baetis alpinus</i>	<i>Ephemera danica</i>
<i>Baetis sinaicus</i>	Trichoptera:
<i>Baetis melanonyx</i>	<i>Rhyacophila oblitterata</i>
<i>Epeorul sylvicola</i>	<i>Neureclipsis bimaculata</i>
<i>Rhithrogena aurantiaca</i>	<i>Brachycentrus maculatum</i>
Trichoptera:	<i>Halesus digitatus</i>
<i>Rhyacophila fasciata</i>	<i>Goera pilosa</i>
<i>Rhyacophila polonica</i>	<i>Mystacides longicornis</i>
<i>Glossosoma boltoni</i>	<i>Sericostoma schneideri</i>
<i>Philopotamus montanus</i>	Bioindicators of good quality
<i>Wormaldia occipitalis</i>	Ephemeroptera:
<i>Drusus brunneus</i>	<i>Baetis vernus</i>
<i>Limnephilus griseus</i>	<i>Baetis fuscatus</i>
<i>Grammotaulius nigropunctatus</i>	<i>Centroptilum luteolum</i>
<i>Stenophylax permistus</i>	<i>Heptagenia lateralis</i>
<i>Beraea pullata</i>	<i>Ephemerella ignita</i>
Bioindicators o	<i>Caenis macrura</i>
very good quality	Trichoptera:
Plecoptera	<i>Hydropsyche pellucidula</i>
<i>Tanyopterix nebulosa</i>	Bioindicators of satisfactory quality
<i>Leuctra nigra</i>	Trichoptera:
<i>Leuctra hippopus</i>	<i>Hydropsyche pellucidula</i>
<i>Leuctra inermis</i>	Bioindicators of low quality
<i>Capnia bifrons</i>	Oligochaeta
<i>Nemoura cinerea</i>	Diptera Chironomidae
<i>Nemoura cambrica</i>	
<i>Nemurella pictetii</i>	
<i>Protonemura intricata</i>	

Table 1.

Taking into account the taxa used in this checklist (mainly Ephemeroptera, Plecoptera and Trichoptera) we can observe a clear differentiation of sectors (zones) in the rivers. The mayflies reveal the sustenance capacity of the system for the primary production of algal layer (bioderma) which is maintained at optimum values at least in some sectors.

The competition among the family Baetidae and Heptageniidae induces some changes in the relative abundance of *Baetis vernus*, *B. rhodani*, *Rhithrogena semicolorata*, *Caenis moesta*, *Ephemerella ignita*.

Some considerations about the relation between the ichthyofauna and the benthic macroinvertebrates

The analysis of the gut content of some fish populations revealed their capacity to control other populations (benthic macroinvertebrates).

Phoxinus phoxinus is abundant in the Someșul Cald, Someșul Rece and Someșul Mic but comparing them each other the significance of their populations is different. The specimen collected in the Someșul Cald (Ic Ponor) used many trophic resources: Chironomidae, Trichoptera (some of them with cases), imagoes of different insects and detritus in the following proportion:

insects larvae	36%
insects imagos	32%
detritus (vegetal origin)	32%

The specimen collected in the Someșul Rece (Blajoaia) consumed Trichoptera (with or without cases), Diptera, insects imagoes, snails (*Radix*) and coarse and fine detritus.

insects larvae	38%
insects imagos	24%
gasteropoda	5%
coarse detritus	18%
fine detritus	15%

In the specimen collected in the Someșul Mic (upstream Cluj) the gut content is dominated by detritus:

very fine detritus	86%
vegetal tissue	7%
chitinous fragments	7%

Here, the boulders and argilla are covered with a thick layer of algae and the population of *Phoxinus phoxinus* uses this resource mainly.

Alburnus alburnus shows the same diversity concerning the trophic resources.

The population from the Someș near Sălsig:

insects imagos	53%
coarse detritus (chitinous fragments and vegetal tissue)	19%
larvae and pupae of trichoptera (<i>Hydropsyche</i>)	14%
very fine detritus	14%

The population from the Someș, near Someș Odorhei:

chitinous fragments	39%
fine detritus	23%
very fine detritus	19%
vegetal tissue	19%

The population from the Someșul Mare near Beclean:

very fine detritus	85%
detritus and chitinous fragments	15%

The population from the Someșul Mare near Dej:

very fine detritus	42%
insects imagos	25%
vegetal tissue	8%

Leuciscus cephalus has more or less similar trophic preferences with that of *Alburnus alburnus*. In the specimen collected in the Someșul Cald the gut content is composed by

vegetal tissue	44%
very fine detritus	23%
chitinous fragments	23%
chitinous fragments and detritus	10%

Alburnoides bipunctatus, Someșul Mare near Beclean:

very fine detritus	78%
chitinous fragments	22%

In other species, the low number of collected examples could not permit such estimations. Only the fact must be emphasised that some individuals of *Gobio gobio* used fragments of Bryozoa colonies as a trophic resource.

Conclusions

The Someș can be characterised as a very complex lotic system both from the faunistical and functional point of view. The distribution of the rheophilic elements and the benthic communities reflects either the quality of the river or the state of the watershed. In this way it was possible to establish some characteristic zones:

Someșul Rece and Someșul Cald: very good water quality, high level of biodiversity and absence of human influence

Someșul Mare up to Năsăud: very good water quality and a little influence of the villages

Someșul Mare from Năsăud up to Dej: a good water quality but a significant human influence

Someșul Mic up to Cluj: good water quality, average impact

Someșul Mic downstream Cluj: low water quality, high impact

Someș up to Jibou: average water quality

Someș downstream Jibou: average or good water quality, different types of impact

References

Gâștescu, P., Diaconu, C., Pisota, I., Ujvary, I., Zavoianu, I. (1983): Apele. -In: Geografia României. -Edit. Acad. RSR, 293-387, București

Hildrew A.G. & Giller, P.S. (1995): Patchiness, species interactions and disturbance in the stream benthos.- In Giller, P.S. ; Hildrew, A.G. & Raffaelli, D.G. (eds.). Aquatic ecology: scale, pattern and process. Blackwell Science, 21-62.

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