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COMPOSITION OF THE MACROZOOBENTHOS IN SEMI-MOUNTAINOUS RIVER IN SOUTH-WESTERN BULGARIA

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SYNOPSIS

Senokoska River is a semi-mountainous river in south-western Bulgaria. The river is a left tributary of Struma River, but so far has not been a subject of investigation. The study represents the results from an investigation on the species composition of macrozoobenthos in the river. The research was performed at four sites along the river in the period 2009 – 2011. During the study a total of 113 macrozoobenthic taxa from 57 invertebrate families were found. Order Ephemeroptera is characterized with the highest number of taxa (24), followed by the orders Diptera (23), Plecoptera (22) and Trichoptera (13). Mayflies, stoneflies, caddisflies and true flies were established at all observed sites.

INTRODUCTION

Senokoska River is a left tributary of Struma River – one of the biggest rivers in Bulgaria. In spite of this, so far the small tributaries of the river have not been a subject of investigation. Senokoska River is a R5 type (River basins management plan in West Aegean Sea River Basin Directorate 2010-2015) – small semi-mountainous river in eco-region 7 (East Balkans). The river springs north-east of Bachishte peak (1771 m above sea level) and flows through north-western slopes of Pirin Mountains. The upper part of the river basin is located in the borders of Pirin National Park - included in the UNESCO World Heritage List. The river basin is characterized with a steep slope, mountain and high mountain relief. The geology of the river basin appears heterogeneous with metamorphous, magmatic and sedimentary rock formations with different ages.

The length of Senokoska River is about 8.80 km. The predominant substrate on the river bed is sand and gravel. The river is a permanent and is fed by rain and snow water. The benthic invertebrates include litoreophil, psamophil and phytoreophil species.

Two villages are situated in Senokoska River basin – Senokos and Mechkul, both with population of 100 people, most of them are seasonal inhabitants. Only extensive agriculture is practiced in the region. Senokoska River is in nearly pristine condition. No matter that the river is used as a source for drinking and irrigation water, the river flow is slightly affected.

Benthic macroinvertebrates play a major role in river ecosystems. Since there is no information on the composition of macrozoobenthic invertebrates in the Senokoska River, as well as in most of the small tributaries of the Struma River, the aim of the current study was to establish the composition of the macrozoobenthic communities in Senokoska River, a small semi-mountainous river in south-western Bulgaria.

MATERIAL AND METHODS

Macrozoobenthic samples were collected according to ISO 7828/1985 from four sites seasonally in summer and autumn of 2009, in spring, summer and autumn of 2010 and in spring and autumn of 2011 (Fig. 1). The researched area along the river is about 6.6 km, or approximately 75% of its length. All macrozoobenthic samples were fixed in 4% formaldehyde and after laboratory sorting by systematic groups are kept in 70% alcohol.

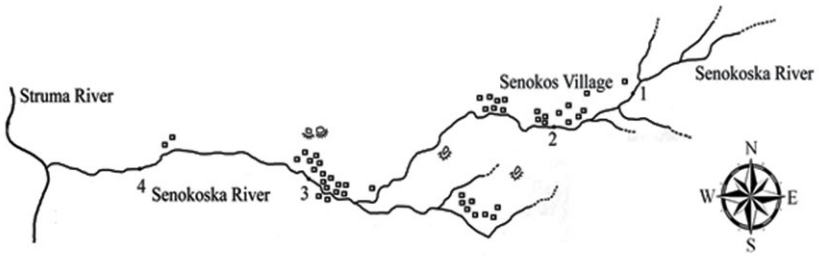

Figure 1: Scheme of sample sites along the Senokoska River.

Physical and chemical variables of the river were measured in situ. Temperature and oxygen were measured by WTW 3310 oxy-meter, pH and specific electrical conductivity (EC) – by HI 98129. The altitude of the sites was obtained by GPS Garmin- Etrex/Vista.

To calculate the average values of the environmental variables we used descriptive statistics. The correlation between the variables is proved by the

correlation coefficient of Pearson (r). The species similarity amongst the sampling sites was presented by cluster analysis. The statistical analysis was performed using Statistica 7.0-2004.

RESULTS AND DISCUSSION

Physical and chemical variables in Senokoska River follow a regular pattern (Table 1). The temperature values increase along the river, influenced by the weather, altitude and the shade of river bed. The river water is well oxygenated (9.3 – 9.7 mg/l) and the changes in the oxygen values are function of water temperature ($r = -0.63$, $n = 26$, $\alpha < 0.05$). The average values of pH at different sampling sites vary from 6.8 to 7.1. The electrical conductivity (EC) increases downstream.

Table 1: Altitude, average values and standard deviations of physicochemical variables in Senokoska River in 2009-2011.

Sampling sites	Altitude (meters above sea level)	T (^{0}C)	O_2 (mg/l)	pH	EC (µS/cm)
1	1024	9.2 (±2.8)	9.7 (±0.8)	7.1 (±0.4)	75 (±12)
2	972	10.7 (±2.4)	9.3 (±0.5)	6.8 (±0.4)	77.9 (±13.5)
3	714	11.2 (±3)	9.3 (±0.8)	6.9 (±0.5)	113 (±22)
4	649	11.9 (±3.6)	9.3 (±0.7)	6.9 (±0.7)	114 (±22)

During the study totally 113 macrozoobenthic taxa from 57 invertebrate families were found (Table 2). 23 taxa of them were reported in Struma River in 1956 – 1978, 1980 – 1984, 1999 – 2000 by Kovachev et al. (1979), Uzunov (1980), Islam et al. (1986) and Vidinova et al. (2006).

Order Ephemeroptera is characterized with the highest number of taxa (24), followed by the orders Diptera (23), Plecoptera (22) and Trichoptera (13). These orders are among the most numerous in the river, which corresponds to the findings of Ward (1986), Bispo & Oliveira (2007), Cole (2012) and Romero et al. (2013) stating that in semi-mountainous rivers those orders are characterized with high number of taxa.

The taxa richness is highest at site 1 where 83 taxa were registered for the studied period (Fig. 2). In all three years of investigation the most numerous is order Ephemeroptera (19.62% of the total number). The following taxa: *Gyraulus albus* Müller, 1774 (Gastropoda), *Eiseniella tetraedra* Savigny, 1826 (Oligochaeta),

Ecdyonurus helveticus Eaton, 1885 (Ephemeroptera), *Brachyptera risi* Morton, 1896, *Perlodes intricata* Pictet, 1842, *Perlodes* sp., *Perla* sp. (Plecoptera), *Brachytron* sp. (Odonata), Elmidae gen. sp. 1 (Coleoptera), *Polycentropus* sp., *Lepidostoma hirtum* Fabricius, 1775, *Brachycentrus* sp. (Trichoptera), *Blepharicera fasciata* (Diptera) and *Hydracarina* (Acari) were found only at site 1.

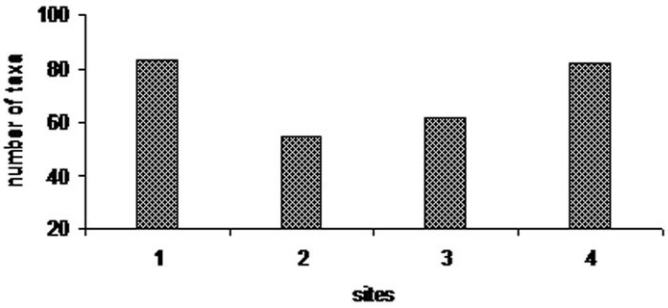

Figure 2: Number of taxa found in different sites along the Senokoska River in 2009-2011.

Site 2 is located between the series of waterfalls with river bed dominated by rocky substrate. The richness decreases to 55 taxa due to the reduction of potential habitats. At this site the most numerous is class Turbellaria (42.89% of the total number). The genera *Henlea* and *Mesenchytraeus* (Oligochaeta) and family Dolichopodidae (Diptera) were found only at site 2.

Along the river the richness increases with the increased habitat diversity and at site three 62 taxa were registered. Three species: *Ecdyonurus vitoshensis* Jacob & Braasch, 1984 (Ephemeroptera), *Simulium variegatum* Meigen, 1818, *Simulium ornatum* Meigen, 1818 (Diptera) were found only at this site. The most numerous order is Ephemeroptera (63.37% of the total number).

In the lower reaches of the river (site 4) the taxa richness increases to 82 taxa mostly due to the appearance of new taxa, not present at higher altitudes. The following taxa were recorded only at site 4: *Ancylus fluviatilis* Müller, 1774 (Gastropoda), Hirudinea gen. sp. (Hirudinea), *Caenis macrura* Stephens, 1835, *Centroptilum sp., C. luteolum* Müller, 1776, *Cloeon dipterum* Linnaeus, 1761, *Paraleptophlebia submarginata* Stephens, 1835, *Pseudocentroptilum pennulatum* Eaton, 1870 (Ephemeroptera), *Siphonoperla* sp. (Plecoptera), Lestidae gen. sp. (Odonata), *Nepa cinerea* Linnaeus, 1758 (Heteroptera), Chrysomelidae gen. sp., *Haliplus* sp., *Hydrous* sp., (Coleoptera), *Simulium monticola* Friedrichs, 1920, *S. spinosa* Doby et Deblock, 1957 (Diptera). At this site again the most numerous is order Ephemeroptera (50.46% of the total number).

During the study the relative abundance of orders Plecoptera and Trichoptera decease along the river. Order Diptera was characterized with the same tendency, except at site 4, where the true flies abundance increases. The relative abundance of order Ephemeroptera decreases at sites 2 and 4 and increases at site 3.

Table 2: Composition of macrozoobenthic communities along the Senokoska River in 2009 - 2011.

	sites			
	1	2	3	4
Turbellaria				
Dygesiidae				
Dugesia polychroa (Schmidt, 1861)	*	*	*	*
Planariidae				
Crenobia alpina (Dana, 1766)	*	*	*	*
Planaria torva (Müller, 1776)	*	*	*	*
Oligochaeta				
Lumbricidae				
Eiseniella tetraedra+ (Savigny, 1826)	*			
Henlea sp.		*		
Lumbricidae gen.sp. juv	*	*	*	*
Stylodrilus heringianus+ (Claparede, 1862)	*	*		
Mesenchytraeus sp.		*		
Hirudinea				
Hirudinea gen. sp.				*
Mollusca				
Gastropoda				
Ancylidae				
Ancylus fluviatilis+ (Müller, 1774)				*
Lymnaeidae				
Lymnaea stagnalis (Linnaeus, 1758)	*	*	*	*
Planorbidae				
Gyraulus albus (Müller, 1774)	*			
Crustacea				
Amphipoda				
Gammaridae				
Gammarus balcanicus+ (Schaferna, 1922)	*	*	*	*
Isopoda				
Asellidae				
Asellus aquaticus+ (Linnaeus, 1758)	*	*		
Insecta				
Ephemeroptera				
Baetidae				
Baetis alpinus+ (Pictet, 1845)	*	*	*	*
B. muticus+ (Linné, 1758)	*	*	*	*
B. rhodani+ (Pictet, 1843)	*	*	*	*
Centroptilum sp.				*
C. luteolum+ (Müller, 1776)				*
Cloeon dipterum+ (*Linnaeus*, 1761)				*
Pseudocentroptilum pennulatum (Eaton, 1870)				*
Caenidae				
Caenis macrura+ (Stephens, 1835)				*
Ephemerellidae				
Serratella ignita+ (Poda, 1761)	*			*
Ephemeridae				
Ephemera danica+ (Müller, 1764)	*	*	*	*
Heptageniidae				
Ecdyonurus sp. juv.	*	*	*	*
E. epeorides (Demoulin, 1955)	*	*	*	
E. helveticus (Eaton, 1885)	*			
E. sp. gr. *helveticus*	*	*	*	*
E. picteti+ (Meyer-Dur, 1864)	*		*	*
E. vitoshensis (Jacob & Braasch, 1984)			*	
Epeorus sp.	*	*	*	*
E. assimilis (Pictet, 1865)	*	*	*	*

Rhithrogena sp.	*	*	*	*
*Rh.*sp. gr. *hybrida*	*		*	*
Rh. sp. gr. *semicolorata*+	*	*	*	*
Rh. sp. gr. *sowai*	*		*	*
Leptophlebiidae				
Habroleptoides confusa+ (Sartori & Jacob, 1986)	*	*	*	*
Paraleptophlebia submarginata+ (Stephens, 1835)				*
Plecoptera				
Chloroperlidae				
Chloroperla sp.	*	*		
Siphonoperla sp.				*
Leuctridae				
Leuctra sp.	*	*		*
L. fusca fusca (Linnaeus, 1758)	*		*	*
L. inermis (Kempny, 1899)	*	*	*	*
L. pseudosignifera (Aubert, 1954)			*	*
Nemouridae				
Amphinemura sp.	*			*
Nemoura sp.	*	*	*	*
N. cinerea cinerea (Retzius, 1783)	*	*	*	
Protonemura intricata intricata (Ris, 1902)	*	*	*	*
P. montana (Kimmins, 1941)	*	*		*
P. praecox praecox (Morton, 1894)	*	*	*	*
Perlidae				
Perla sp.	*			
P. marginata+ (Panzer, 1799)	*	*	*	
Perlodidae				
Isoperla sp.	*	*	*	*
I. grammatica+ (Poda, 1761)	*		*	*
Perlodes sp.	*			

P. intricata (Pictet, 1842)	*			
Tanyopterygidae				
Brachyptera sp.	*		*	*
B. risi (Morton, 1896)	*			
B. seticornis (Klapálek, 1902)	*		*	
Taeniopteryx sp.	*	*	*	*
Odonata				
Aeshnidae				
Aeshna sp.			*	*
Brachytron sp.	*			
Gomphidae				
Gomphus sp.			*	*
Lestidae				
Lestidae gen. sp.				*
Heteroptera				
Gerridae				
Gerris sp.			*	*
Hydrometridae				
Hydrometra gracilenta (Horváth, 1899)	*			*
Nepidae				
Nepa cinerea+ (Linnaeus, 1758)				*
Notonectidae				
Notonecta sp.			*	*
Coleoptera				
Chrysomelidae				
Donacia sp.	*		*	
Chrysomelidae gen. sp.				*
Dytiscidae				
Agabus sp.	*	*		*
Elmidae				
Elmis sp.	*	*	*	*
Elmidae gen. sp. 1	*			
Optioservus sp.	*	*	*	*
Haliplidae				
Haliplus sp.				*
Hydrophilidae				
Hydrous sp.				*
Trichoptera				
Brachycentridae				

Brachycentrus sp.	*			
Glasosomatidae				
Glassossoma sp.	*		*	
Hydropsychidae				
Hydropsyche bulbifera+ (McLachlan, 1878)	*	*	*	*
H. incognita (Pitsch, 1993)	*	*	*	*
Lepidostomatidae				
Lepidostoma hirtum (Fabricius, 1775)	*			
Leptoceridae				
Leptoceridae gen. sp.	*	*		*
Limnephilidae				
Chaeteopteryx sp.	*	*	*	*
Odontoceridae				
Odontoceridae gen. sp.				*
Philopotamidae				
Philopotamus montanus (Donovan, 1813)	*	*	*	*
Polycentropidae				
Polycentropus sp.	*			
Rhyacophilidae				
Rhyacophyla nubila+ (Zetterstedt, 1840)	*	*	*	*
Rh. tristis (Pictet, 1834)	*	*	*	*
Sericostomatidae				
Sericostoma sp.	*	*	*	*
Diptera				
Atherixidae				
Atherix ibis (Fabricius, 1798)	*	*		*
A. marginata (Van der Goot, 1985)	*	*	*	*
Blephariceridae				
Blepharicera fasciata (Westwood, 1842)	*			
Ceratopogodinae				
Ceratopogodinae gen. sp.	*			*
Chironomidae				
Chironomidae gen. sp.	*	*	*	*
Dixidae				
Dixa sp.	*	*	*	*
Dolichopodidae				
Dolichopodidae gen. sp.		*		
Limonidae				
Antocha sp.	*		*	*
Limonium sp.	*	*		*
Limonidae gen. sp.	*		*	
Pediciidae				
Dicranota sp. 1	*	*	*	*
Dicranota sp. 2	*		*	
Simulidae				
Eusimulium sp.		*		*
E. latipes (Meigen, 1804)	*	*		*
Simulium ornatum (Meigen, 1818)			*	
S. (*Odagmia*) *monticola* (Friedrichs 1920)				*
S. (O.) spinosa+ (Doby et Deblock, 1957)				*
S. variegatum (Meigen, 1818)			*	
Simulidae gen.sp. juv.	*	*	*	*
Tabanidae				
Tabanus sp.		*		*
Tanypodinae				
Tanypodinae gen. sp.	*	*	*	*
Tipulidae				
Hexatoma sp.	*		*	*
Tipula sp.	*	*	*	*
Acari				
Hydracarina	*			

+ taxa found in Struma River in 1956-1978, 1980-1984, 1999-2000.

In Senokoska River among the dominate taxa were *Crenobia alpina* Dana, 1766, *Dugessia polychroa* Schmidt, 1861, *Planaria torva* Müller, 1776 (Turbellaria), *Gammarus balcanicus* Schaferna, 1922 (Amphipoda), *Baetis alpinus* Pictet, 1845, *B. rhodani* Pictet, 1843, *Ecdyonurus* sp. juv. (Ephemeroptera), *Elmis* sp., *Optioservus* sp. (Coleoptera), *Hydropsyche bulbifera* McLachlan, 1878, *H. incognita* Pitsch, 1993, *Rhyacophila nubila* Zetterstedt, 1840*, Rh. tristis* Pictet, 1834*,* (Trichoptera), *Atherix marginata* Van der Goot, 1985, Chironomidae, *Dicranota* sp.1, Simuliidae g. sp.juv*,* (Diptera).

The cluster analysis distinguished two groups of the examined river sites according to the similarity of their macrozoobenthic invertebrates' composition (Fig. 3).

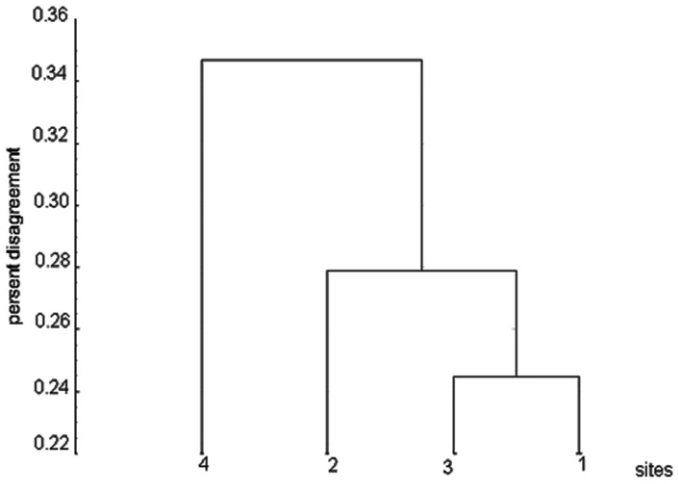

Figure 3:
Dendrogram of the similarity of the macrozoobenthic invertebrates' composition in the examined sites of Senokoska River in 2009-2011.

The first group includes the sites in the upper reaches of the river (714 – 1024 m above sea level). The most similar are sites 1 and 3. Although the species composition of site 2 is altered due to reduced habitat diversity, it is more closely related to sites 1 and 3. The low altitude site 4 (649 m above sea level) stands alone with faunistic similarity of 65% to the group of the high altitude sites.

CONCLUSIONS

The present study of the macrozoobenthic composition of Senokoska River established relatively high species richness. The river was studied for the first time. During the studied period totally 113 macrozoobenthic taxa (57 invertebrate families) were found, of them 90 taxa were reported for the first time in the region. Along the river there was observed a significant difference in the faunistic similarity between the upper and lower reaches of the river.

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