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Editors
Radoje V. Pantovic
Zoran S. Marković

EcoIst '15

Hotel "PUTNIK", Kopaonik, SERBIA
17-20 June 2015

UNIVERSITY OF BELGRADE
TECHNICAL FACULTY BOR

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WATER QUALITY ASSESSMENT BASED ON MACROINVERTEBRATES – SMALL HILLY STREAMS IN THE CARPATHIAN-BALKAN REGION OF EASTERN SERBIA

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ABSTRACT

In this paper the status assessment of small hilly streams in the Carpathian-Balkan region (Eastern Serbia) is given based on aquatic macroinvertebrates. The research was conducted in April, June, and September 2013 at nine sampling sites on seven streams. During the investigation 85 macroinvertebrate taxa from 11 taxa groups were recorded. Diptera (32.06 %) and Ephemeroptera (28.47 %) were dominant groups. Following indices were used for the status assessment: total number of taxa, Saprobic Index, Diversity index H', BMWP and ASPT, number of sensitive taxa and EPT. The results indicate low degree of organic pollution in analyzed streams.

Key words: Macroinvertebrates, Water Quality, Streams, Eastern Serbia.

INTRODUCTION

Macroinvertebrates are an important component of stream and river systems and have an effect on structure and function of freshwater ecosystems (1). For the assessment of aquatic ecosystems status, benthic macroinvertebrates are the most frequently used biological indicators (2). Macroinvertebrates are found in all aquatic habitats and are (noted as) more sensitive to changes in water quality in comparison to other Biological Quality Elements (BQE). They are less mobile, have relatively long periods of development in the aquatic environment and they are easily collected (3). Thus, macroinvertebrate communities should reveal harmful changes that have occurred in the aquatic environment during any stage of their development (4). Due to their sensitivity Ephemeroptera, Plecoptera and Trichoptera are the most commonly used taxa as bioindicators among macroinvertebrates, and their indices are appropriate for evaluation of the streams ecological status (5, 6).

Study area is situated in Eastern Serbia (the Carpathian-Balkan region), towards the border of the Wallachian-Pontic basin. Rivers Bigar, Jagnjilo, Valja Saka, Tisnica, Crna Reka, Valja Streži, and Vrkaluca belong to the Danube River Basin (catchments of

rivers Mlava and Pek) and are located in the hilly-mountain part of Eastern Serbia. Larger settlements in the region are Žagubica, Bor and Majdanpek. Broad-leaved forests and transitional woodland/shrub surround the investigated rivers which lie on limestone. Neighboring agricultural land is scattered as small agricultural lots, according to the CORINE Land Cover Database for Serbia (7). The biggest permanent stream is the Jagnjilo River. Valja Saka stream springs below Čoće at 860 m a.s.l. (8) and joins the Bigar River to form the Jagnjilo River, which further flows to the north. The Lipa River confluence into the Jagnjilo River and forms the Veliki Pek River in Jasikovo village (8). The Crna Reka River is a small watercourse that often dries out. It is a right tributary of the Tisnica River, which originates at Kučajske Mountain, flows to the north near the eastern slope of Beljanica Mountain. The Tisnica River is a right tributary of the Mlava River (8). The Mlava River rises from Žagubičko spring after which it immediately receives the Tisnica.

The aim of this study is to determine the water quality in small hilly streams in the Carpathian-Balkan region (Eastern Serbia) based on the macroinvertebrate community as the main biological component.

MATERIAL AND METHODS

Samples were collected during April, June, and September 2013 from the nine localities on rivers in the study area: Bigar (lower stretch), Valja streži, Jagnjilo at two sampling sites (Jagnjilo upper stretch and Jagnjilo lower stretch), Tisnica at two sampling sites (Tisnica lower stretch and Tisnica upstream of the Crna Reka confluence), Crna Reka (lower stretch), Vrkaluca and Valja Saka (Figure 1).

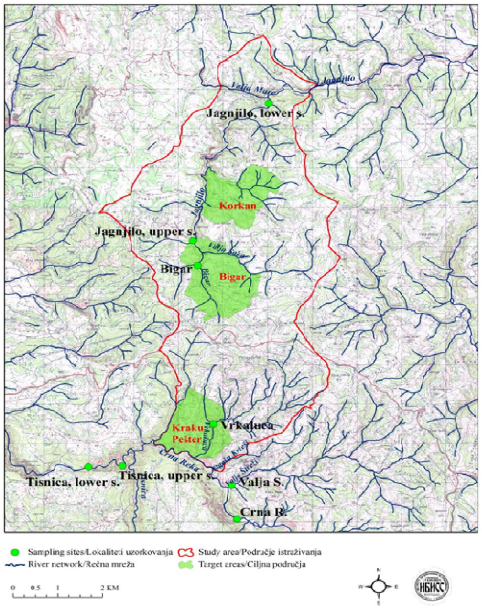

Figure 1. Aquatic macroinvertebrates sampling locations

RESULTS AND DISCUSSION

In total 85 macroinvertebrate taxa from 11 taxa groups were recorded within the study area. The qualitative composition of macroinvertebrate assemblages is presented in Table 1.

Table 1. List of identified taxa of aquatic macroinvertebrate assemblages

Turbellaria
Dugesia gonocephala (Dugès, 1830)
Dugesia sp.*

Oligochaeta
Enchytraeidae
Eiseniella tetraedra (Savigny, 1826)
Henlea ventriculosa (d'Udekem, 1854)
Limnodrilus hoffmeisteri Claparede, 1862
Mesenchytraeus sp.
Nais bretscheri Michaelsen, 1899 *
Nais elinguis Muller, 1774 *
Nais sp.
Stylodrilus heringianus Claparède, 1862
Rhyacodrilus falciformis Bretscher, 1901

Gastropoda
Bythinia tentaculata (Linnaeus, 1758)

Bivalvia
Pisidium sp.

Crustacea
Gammarus balcanicus Schäferna, 1922
Austropotamobius torrentium (Schrank, 1803)

Odonata
Cordulegaster boltoni (Donovan, 1807)

Ephemeroptera
Ephemera sp.
Baetis alpinus (Pictet, 1843)
Baetis rhodani Pictet, 1843
Baetis vernus Curtis, 1834
Baetis sp.
Ephemera danica Müller, 1764
Ecdyonurus helveticus Eaton, 1885
Ecdyonurus sp.
Liponeura sp.

Trichoptera
Allogamus auricollis (Pictet, 1834)*
Ceraclea sp.
Oecismus monedula (Hagen, 1859)
Glososoma boltoni Curtis, 1834
Halesus digitatus (Schrank, 1781)
Hydropsyche fulvipes (Curtis, 1834)
Hydropsyche pellucidula (Curtis, 1834)
Hydropsyche sp.
Hydroptila sp.
Leptoceridae
Limnephilus sp.
Polycentropus flavomaculatus
(Pictet, 1834)
Philopotamus montanus (Donovan, 1813)
Potamophylax cingulatus
(Stephens, 1837)
Sericostoma sp.
Rhyacophila fasciata Hagen, 1859
Rhyacophila obliterata McLachlan, 1863
Rhyacophila tristis Pictet, 1834
Rhyacophila sp.
Silo nigricornis (Pictet, 1834)
Drusus monticola McLachlan, 1876
Coleoptera
Agabus arcticus (Paykull, 1798)*
Ryolus sp.
Normandia nitens (Müller, 1817)
Dryops gracilis (Karsch, 1881)
Elmis sp.
Oulimnius troglodytes (Gyllenhal, 1827)
Limnius volckmari (Panzer, 1793)
Halipus confinis Stephens, 1828*
Hydraena gracilis Germar, 1824
Elodes marginata (Fabricius, 1798)
Elmis aenea (Müller, 1806)
Colymbete ssp.

Diptera
Tipula sp.
Tabanus sp.

Heptageniidae
Epeorus sylvicola (Pictet, 1865)
Ephemerella mucronata (Bengtsson, 1909)
Ephemerella ignita (Poda, 1761)
Ephemerella sp.
Rhytrogena sp.
Rhytrogena semicolorata group
Paraleptophlaebia submarginata (Stephens 1835)

Plecoptera
Brachyptera risi (Morton, 1896)
Leuctra sp.
Isoperla grammatica (Poda, 1761)
Nemoura cinerea (Retzius, 1783)
Nemoura sp.
Perla bipunctata Pictet, 1833
Perla sp.
Protonemura montana Kimmins, 1941

Psychoda cinerea Banks, 1894
Antocha sp.
Atherix ibis (Fabricius, 1789)
Clinocera sp.
Eleophila sp.
Ibisia marginata (Fabricius, 1781)
Gnophomyia sp.
Hexatoma sp.
Oxycera pardalina Meigen, 1822
Ceratopogonidae
Simulidae
Chironomidae
Pericoma sp.
Tonnoiriella pulchra (Eaton, 1893)

Megaloptera
Sialis lutaria (Linnaeus, 1758)

The number of recorded taxa per locality varied between 16 (Tisnica, upstream of the Crna reka confluence) and 37 (Valja Streži). A considerable taxa richness was recorded for locality Vrkaluca (27 taxa), Bigar (24) followed by Jagnjilo lower stretch (22) and Crna reka lower stretch (20), while a smaller number of species was recorded for the rest of the sampling sites. Analysis of the macroinvertebrates fauna indicated that, the main components of the community in relation to relative abundance were Diptera (32.06 %) and Ephemeroptera (28.47 %).

According to the ecological classification of the taxa, 18.73% of the identified species belong to the xenosaprobic and oligosaprobic group (14). Species that are tolerant to moderate organic loading (beta-mesosaprobic) were represented by 15%, while only 3.28% of the taxa could be characterized as alpha-mesosaprobic. No species adapted to high organic loading (polysaprobic) were recorded.

The majority of recorded species (46.82%) were typical for rhithral. A lower proportion of the taxa belong to those of the potamal type (14.32%) and only 7.53% to crenal type, according to Moog (14) and AQEM (13).

In regard to flow preference, the recorded community was dominated by rheophilous taxa (27.37%) and indifferent taxa (27.33%). Rheobionts and rheo-limnophilous taxa were represented with 15.48% and 10.21%, respectively. A low number of species (<0.2%) were characterized as limnophilous and limno-rheophilous, while 19.35% of the taxa could not be classified in regard to current preference.

Lithophylous taxa that prefer coarse gravel, stones and boulders (grain size > 2 cm) were dominant, representing 25.20% of the macroinvertebrate assemblages. The phytophylous taxa had also a significant presence of 19.42%, as well as the species that prefer fine-to-medium-sized gravel (pelal, psammal and argilal) – 18.37%. A smaller number of taxa (0.92%) prefer particulate organic matter such as woody debris, while for the remaining taxa there is not enough data on microhabitat preference (13).

The values of SI indices varied per sampling location from 1.28 to 1.65, indicating high status (I class) for all investigated streams (Table 2). BMWP Scores for rivers in the Study area ranged from 59 to 142. The highest ASPT score was recorded for the stream Vrkaluca (7.23) − corresponding to high status (I class), low ASPT value means low level of organic pollution and good to high ecological status; on the contrary, high value of ASPT means higher level of organic pollution and moderate to bad ecological status. ASPT Scores from other investigated streams have been slightly lower, indicating good water quality (II class) (15) (Table 2).

Table 2. Assessment of ecological status based on macroinvertebrate metrics. SI - Saprobic Index (Zelinka & Marvan 1961), H' - Shannon Diversity Index; Sites: 1 – Bigar, 2 – Valja Streži, 3 – Tisnica lower stretch, 4 – Tisnica- upstream of the confluence with Crna reka, 5 – Jagnjilo-lower stretch, 6 – Jagnjilo-upper stretch, 7 – Crna reka-lower stretch, 8 – Vrkaluca, 9 – Valja Saka

Metric/Sites	1	2	3	4	5	6	7	8	9
SI	1.65 (I)	1.30 (I)	1.47 (I)	1.45 (I)	1.28 (I)	1.42 (I)	1.52 (I)	1.31 (I)	1.39 (I)
BMWP	112 (I)	142 (I)	82 (IV)	59 (III)	87 (IV)	116 (I)	105 (I)	123 (I)	80 (IV)
ASPT	6.59 (II)	6.76 (II)	6.31 (II)	5.90 (II)	6.21 (II)	6.44 (II)	7 (II)	7.23 (I)	6.15 (II)
H'	0.78 (IV)	0.86 (IV)	0.85 (IV)	0.81 (IV)	0.82 (IV)	0.87 (IV)	0.89 (IV)	0.91 (IV)	0.35 (V)
EPT	14 (III)	25 (I)	11 (III)	8 (IV)	11 (III)	16 (II)	12 (III)	17 (II)	9 (IV)
Sensitive taxa	6 (I)	11 (I)	5 (II)	6 (I)	6 (I)	10 (I)	8 (I)	12 (I)	1 (V)

The values of EPT Index are shown in Table 2. The higher values of EPT index are associated with non-impacted or slightly impacted streams, while decline of index indicates increasing of environmental stress. The number of EPT taxa per locality varied in range from 8 to 25. The EPT index is a useful tool for status assessment in rivers with hard bottom substrates. The index clearly reflects the quality of the aquatic environment (16).

Status assessment according to the number of sensitive taxa revealed good status (I class) for most localities except Tisnica, lower stretch (II class) and Valja Saka (V class).

Values of diversity index H' (11) ranged from 0.35 to 0.91, indicating bad status (IV class) for most localities and poor status (V class) for locality Valja Saka. The overall status of rivers in the study area could be assessed as high to good. Parameters that are based on number of taxa (BMWP score, EPT and diversity index) indicate moderate and poor status, but mostly due to unfavorable hydrological conditions at the time of the sampling - high water level and current in the Spring sampling period and extremely low water level and drought during other investigated periods of the year.

Based on used community indices, the general conclusion is that the degree of organic pollution of streams from this study is low. This is also confirmed by the taxa

richness - characteristic number of species for small streams of hilly-mountainous regions of ecoregion 5 and 6 (17) and community structure - appearance of taxa characteristic for small streams of hilly-mountainous regions of ecoregion 5 and 6 (17). Evenness of the community is high, more precisely, there is absence of the phenomenon that one, or only a few species, overtake absolute domination within the community.

Our study proved that the use of selected macroinvertebrates and their communities in ecological status assessment of determined river types is an effective approach for estimating and monitoring aquatic ecosystem health.

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