Macroinvertebrates of the Natural Substrate of the Sava River – Preliminary Results

Momir Paunović[1], Jelena Tomović[1], Simona Kovačević[2], Katarina Zorić[1], Krešimir Žganec[3], Vladica Simić[2], Ana Atanacković[1], Vanja Marković[1], Margareta Kračun[1], Sandra Hudina[3], Jasna Lajtner[3], Sanja Gottstein[3] and Andreja Lucić[3]

[1] University of Belgrade, Institute for Biological Research "Sinisa Stankovic", 142 Despota Stefana Boulevard, Belgrade, Serbia, E-mail: mpaunovi@ibiss.bg.ac.rs

[2] University of Kragujevac, Faculty of Science, Institute for Biology and Ecology, Radoja Domanovića 12, Kragujevac, Serbia

[3] University of Zagreb, Faculty of Scence, Division of Biology, Rooseveltov trg 6, Zagreb, Croatia

Abstract

The objective of this study is to present the comparable data on macroinvertebrate communities from the natural bottom substrate along the middle and lower stretch of the Sava River. The study was carried out in September 2011 at eight sites of the sector between Zagreb - Martinska Ves and Belgrade – at the confluence into the Danube. The data presented could be used as baseline information for any future management of the main course of the Sava River.

Keywords: Aquatic macroinvertebrates, Sava River, community structure, species richness

Introduction

The Sava River is the second largest tributary of the Danube. The river basin is shared by four countries: Slovenia, Croatia, Bosnia and Herzegovina and Serbia. Despite its importance as a large transboundary river, macroinvertebrate communities of its main course have not been systematically studied recently. Up until this study, the most detailed research of macroinvertebrates of the Sava River was performed by Matoničkin et al. (1975). Since then, the macroinvertebrate community has been studied within limited stretches (e.g. in the Belgrade region). Published results concerning macroinvertebrates of the Sava River were related mostly to restricted stretches, annual investigation (Jakovcev 1988, 1989, 1991; Martinovic-Vitanovic et al., 1999; Paunovic, 2004; Paunovic et al., 2008) or specific research topics (e.g. non-indigenous taxa), thus offering limited data.

The aim of this paper is to present the preliminary results of investigating the macroinvertebrate community of the natural substrate along the middle and lower reach of the Sava River, in the sector between Zagreb (Martinska Ves) and Belgrade (confluence into the Danube). Existing data on macroinvertebrate fauna of the Sava River are lacking and insufficient to be effectively used for water management purposes, such as sectioning of the river (typology), water body delineation, defining ecological status class boundaries, design of water status screening system, harmonization of ecological status assessment methods. between the Sava countries, as well as improvement of large river sampling methodologies. The above mentioned activities are related to the implementation of the EU Water Framework Directive (WFD, 2000). Thus, this work offers a basis of comparable data for further consideration along a considerable stretch of this large river.

Study area

The Sava River Basin (SRB) covers an area of 95,719 km^2 and is situated in the southern part of the Danube Basin (Figure 1). Together with its tributaries, this 940 km long watercourse represents a mighty river system. The Sava begins in mountains of Slovenia and flows throughout the lowlands of Croatia, Bosnia and Herzegovina, and Serbia, and confluences the

Danube in Belgrade (river km 1171). According to average discharge (1,513 m^3/s at station Sremska Mitrovica, about 100 km from the confluence to the Danube – SRBA 2009), it is the largest tributary of the Danube. Further, by its catchment area, the Sava is the second largest sub-basin of the Danube after the Tisa River Basin. The Sava River Basin is shared by Bosnia and Herzegovina (40.0 % of the basin area), Croatia (26.0 %), Serbia (15.4 %), Slovenia (11.0 %), Montenegro (7.5 %), and Albania (0.1 %). About 8.8 million people live in the basin (Sava RBMP, 2011). More than 50 % of the Sava watercourse is navigable, from the mouth up to the Kupa confluence.

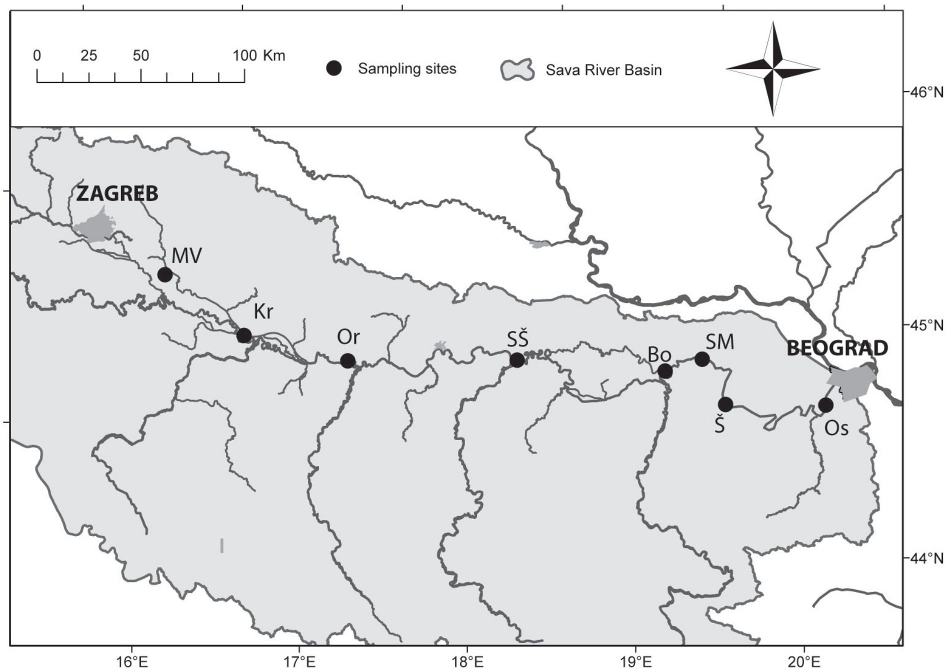

Figure 1: Sampling sites along the investigated stretch

The elevation of the Sava River Basin with a mean of 545 m a.s.l. ranges between 71 m.a.m.s.l. at the mouth of the Sava River in Belgrade (Serbia) and 2,864 m.a.m.s.l. (Triglav, Julian Alps in Slovenia).

The Sava River Basin is heterogeneous concerning overall environmental conditions. Due to its geographic position, diverse climate, petrographic and pedological variety, and orographic characteristics, it is one of the most complex regions in Europe concerning the distribution of plants and animals (Lopatin and Matvejev, 1995).

According to the register of areas important for biodiversity conservation, 165 sites along the Sava River were identified with total surface area of more than 18,226 km^2 (Sava RBMP, 2011). In lowland areas, agricultural activities and urban wastewater (nutrient and organic pollution) may contribute to the degradation of protected areas (PA). Pesticides and overuse of fertilizers in regions with intensive agriculture contributes to water pollution. Groundwater depletion, mostly due to the exploitation of river bed material (sand and gravel extraction), as well as changes in the water regime (e.g. flood control prevention of periodical flooding as a consequence of embankment and damming) the structure and functioning of floodplain wetlands depend on, can threaten water dependent PAs, especially lowland forests.

Material and methods

Macroinvertebrates sampling was performed during September 2011 at eight sampling sites on the stretch between 622 km and 17 km along the Sava River (Figure 1, Table 1).

Table 1: Sampling sites along the investigated stretch

Sampling site	Sampling site code	Dominant substrate type	Elevation	River kilometre
Martinska Ves	MV	gravel	99	622
Krapje	Kr	sand/ gravel	93	533
Orubica	Or	sand/ gravel	91	442
Slavonski Šamac	SŠ	sand	83	312
Next to the Bosut Confluence	Bo	sand	80	165
Sremska Mitrovica	SM	sand/silt	78	140
Šabac	Š	sand	76	105
Ostružnica	Os	sand/silt	72	17

Quantitative samples (n=10) were collected using hand nets (mesh size 500 μm) on the area of 0.0625 m^2, in a shallow bank region (up to the depth of 1.5 m). Substrate at the sampling site has not been changed by any form of channelization and thus corresponds to natural substrata along the assessed river reach. Samples were collected from all available types of substrate (mainly gravel, sand and mud), taking into consideration the relative contribution to each microhabitat and the number of samples collected from particular microhabitats within each reach corresponds to the relative contribution of this microhabitat to the substrate of assessed river reach (10% = 1 sample). Approximate length of assessed reach at each sampling site was 100 m of the shore region.

Asterics software Version 3.3.1. (AQEM, 2002) was applied for calculating classes of the species in regard to saprobic preference, current, substrate type, river zonation and feeding type composition while the autecological data are used from AQEM (2002).

To present the spatial distribution of the macroinvertebrate community, correspondence analysis (Pielou, 1984) was applied. “Statistica for Windows 5.1 (Edition ’97)” was used for statistical processing of the data.

Results

Based on the examined material, 80 macroinvertebrate species from 14 taxa groups were recorded in the Sava River, within the investigated sector (Table 2).

Table 2: The list of recorded macroinvertebrate taxa

Nematoda
Nematoda
Turbellaria
Dugesia tigrina (Girard, 1850)
Oligochaeta
Branchiura sowerbyi Beddard, 1892
Eiseniella tetraedra (Savigny, 1826)
Embolocephalus velutinus (Grube, 1879)
Isochaetides michaelseni Lastockin, 1936)
Limnodrilus claparedeanus Ratzel, 1868
Limnodrilus hoffmeisteri Claparede, 1862
Limnodrilus udekemianus Claparède, 1862
Nais sp.
Potamothrix hammoniensis (Michaelsen, 1901)
Propappus volki Michaelsen, 1916
Psammoryctides barbatus (Grube, 1861)
Stylaria lacustris (Linnaeus, 1767)
Stylodrilus heringianus Claparède, 1862
Tubifex tubifex Müller, 1774
Hirudinea
Erpobdella octoculata (Linnaeus, 1758)
Helobdella stagnalis (Linnaeus, 1758)
Piscicola geometra (Linnaeus, 1761)
Gastropoda
Bythinia tentaculata (Linnaeus, 1758)
Borysthenia naticina (Menke, 1845)
Esperiana acicularis (Ferussac, 1823)
Esperiana esperi (Ferussac, 1823)
Gyraulus laevis (Alder 1838)
Holandriana holandrii Pfeiffer, 1828
Lithoglyphus naticoides (Pfeiffer, 1828)
Physella acuta Draparnaud, 1805
Planorbis planorbis (Linnaeus 1758)
Radix auricularia (Linnaeus, 1758)
Theodoxus danubialis (C. Pfeiffer, 1828)
Theodoxus fluviatilis (Linnaeus, 1758)
Viviparus acerosus (Bourguignat, 1862)
Bivalvia
Corbicula fluminea O. F. Müller, 1774
Pisidium sp.
Sinanodonta woodiana (Lea, 1834)
Sphaerium rivicola (Lamarck, 1818)
Unio crassus Philipsson, 1788
Unio pictorum (Linnaeus, 1758)
Unio tumidus Philipsson, 1788
Crustacea
Asellus aquaticus (Linnaeus, 1758)
Corophium curvispinum Sars, 1895
Dikerogammarus haemobaphes (Eichwald, 1841)
Dikerogammarus vilosus (Sowinsky, 1894)
Odonata
Calopteryx splendens (Harris, 1782)
Cercion lindeni (Sélys, 1840)
Coenagrion mercuriale (Charpentier, 1840)
Gomphus vulgatissimus (Linaeus, 1758)
Pyrrhosoma nymphula (Sulzer, 1776)
Platycnemis pennipes (Pallas, 1771)
Ephemeroptera
Baetis fuscatus (Linnaeus, 1761)
Baetis lutheri Müller-Liebenau, 1967
Baetis vernus Curtis, 1834
Caenis luctuosa Burmeister, 1838
Cloeon dipterum (Linnaeus 1761)
Cloeon simile Eaton, 1870
Ephemerella sp.
Heptagenia sulphurea (Muller 1776)
Torleya major (Klapálek, 1905)
Trichoptera
Ceraclea sp.
Cyrnus trimaculatus (Curtis, 1834)
Ecnomus tenellus (Rambur, 1842)

Hydropsyche bulganomanorum (Malicky,. 1977)
Hydropsyche contubernalis McLachlan, 1865
Hydropsyche fulvipes (Curtis, 1834)
Hydroptila vectis Curtis, 1834
Polycentropodidae
Setodes punctatus (Fabricius, 1793)
Tinodes sp.
Coleoptera
Aphelocheirus aestivalis (Fabricius, 1794)
Dytiscidae
Hydrophilidae
Oulimnius tuberculatus (Müller, 1806)
Diptera
Ceratopogonidae
Chaoboridae
Chironomidae
Hexatoma sp.
Empididae
Simulidae
Hydracarina
Hydrachnidia Gen. sp.
Bryozoa
Plumatellidae

With 20 species (Gastropoda 13 and Bivalvia 7), molluscs were found to be the principal component of the macroinvertebrate community in regard to species richness. Annelida were also characterized by considerable taxa richness along the investigated stretch with 17 taxa (Oligochaeta – 14 and Hirudinea – 3). Among Insecta, the dominant group was Trichoptera (10 species), followed by Ephemeroptera (9), Diptera and Odonata (6 species of each group) and Coleoptera (4 species). Diversity of other taxa groups was lower: Crustacea (4), while groups Nematoda, Turbellaria, Hydracarina and Bryozoa were represented with only one species.

Keeping in mind that Chironomidae (Insecta: Diptera) were not identified to the species level, due to the complex identification process and a possibility to identify only fourth instars larvae with high level of confidence, the taxa richness is certainly higher.

The number of recorded taxa per locality (Figure 2) varied between 10 (Ostružnica and Krapje) and 37 (Orubica). A considerable taxa richness was detected for localities: Martinska Ves (34) and Šabac (29), as well.

Oscillations of the macroinvertebrates community in terms of abundance were recorded. The number of individuals per locality varied in the range of 107 (Ostružnica) to 2090 (Sava, next to the Bosut Confluence).

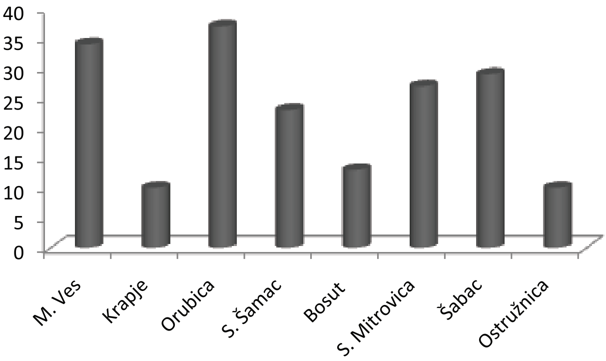

Figure 2: Number of recorded taxa per locality

Litoglyphus naticoides (Gastropoda) and *Limnodrilus hoffmeisteri* (Oligochaeta) were the most frequent and abundant species at all investigated localities.

Representatives of groups: Bryozoa (Plumatellidae), Turbellaria (*Dugesia tigrina*) and Hirudinea (*Helobdella stagnalis)* were detected in the upper part of the investigated stretch at only one locality (Orubica). Aquatic worm species *Propappus volki*, *Isochaetides michaelseni* were found exclusively at the Krapje locality. Findings of *Erpobdella octoculata* (Hirudinea) and representatives of Ephemeroptera (*Baetis lutheri*, *Baetis vernus, Baetis fuscatus, Baetis vernus* and *Caenis luctuosa*) were detected only at the Martinska Ves sampling sites, while presence of Mysidae (Crustacea) was registered only at the Šabac locality.

According to ecological classification of taxa with regard to saprobic valence of Moog (2002), 15.95% of identified species in the Sava River belong to the α-mesosaprobic group, while 27.4% of the taxa could be characterized as β- mesosaprobic. Species classified as sensitive to organic pollution (xeno-saprobic and oligo-saprobic) were represented by 3.37% of the total number of taxa. Only 14.94% of the recorded taxa were adapted to very high organic load (polysaprobic). For the rest of the species (38.35%) there is no data to classify them in regard to saprobic tolerance (AQEM 2002).

In regard to a preferred zone within the river continuum (longitudinal zonation), the greatest proportion of recorded species (57.5%) is characteristic for the lower river stretches (hypopotamal, epipotamal, metapotamal) – potamal species (AQEM, 2002). The rest of the taxa belong to the littoral (12.3%) and rhithral type (12.8%), while information about the preferred zone for remaining number of registered species is not available (9.3%). Thus, in regards to longitudinal zonation, potamophylous and taxa that are characteristic for littoral zones dominated along the whole investigated stretch (Figure 3).

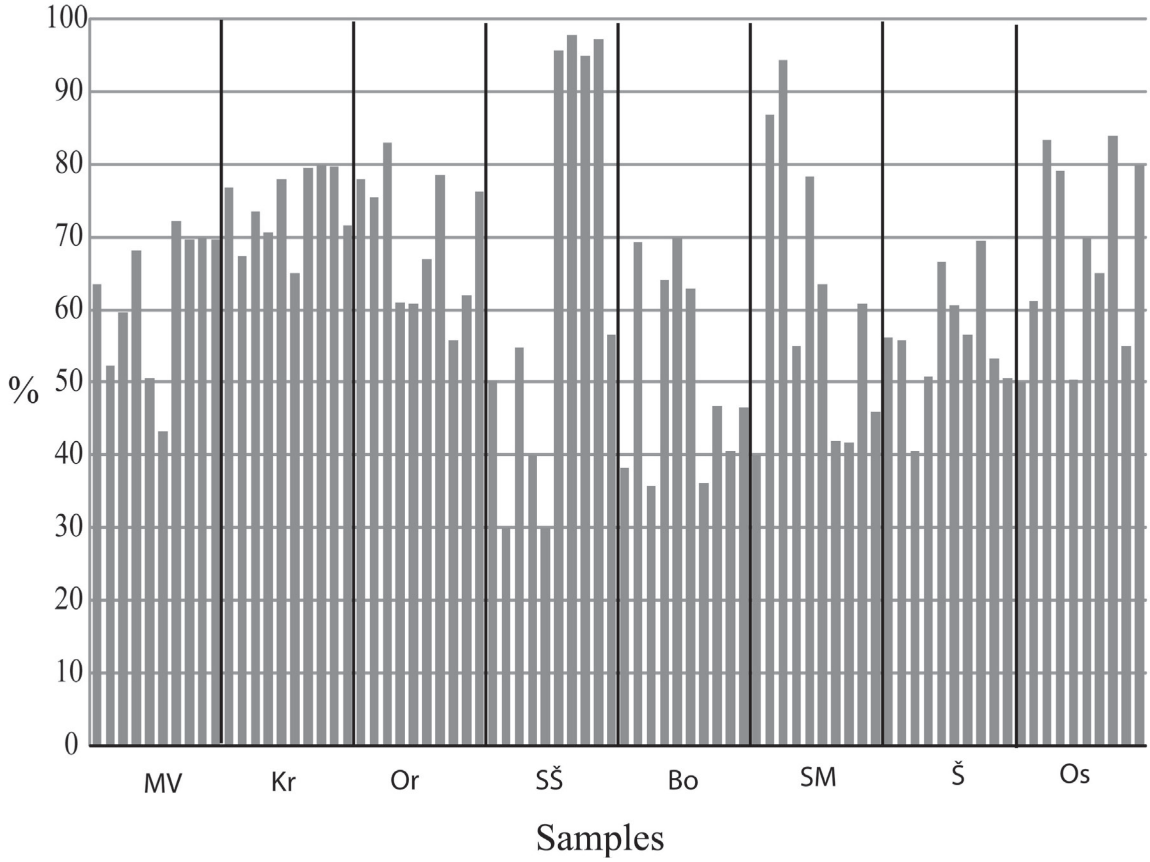

Figure 3: Distribution of potamophylous taxa in samples per sampling sites

The majority of the identified species (53.48%) are adapted to the bottom substrate types typical of large lowland rivers (substrate types pelal, psammal and argillal). The lithophilous taxa that prefer lager fraction of the substrate were represented with 7.51% while the taxa characterized as phytophilous participated with 2.95% of the total number of identified species. Preference for fine to medium-sized gravel is determined for 3.26% of identified taxa. The taxa characteristic for particulate organic matter (POM) substrate type participated with 2.9% in the total macroinvertebrate community. For the significant number of taxa (29.93%) there is not enough information about microhabitat preference (AQEM, 2002).

In regard to functional feeding types, the greatest part of recorded species (54.7%) could be characterized as gatherers/collectors. The active filter feeders were represented by 20.16% while the taxa classified as grazers and scrapers participated with 10% of the total bottom fauna. The species adapted to the other feeding types were represented with less than 2%.

In regard to current preference, a small number of species could be characterized as limnophilous and limno- to rheophilous taxa (Types LP and LR – 10.1%), i.e. taxa preferring standing waters. The recorded community is characterized by a domination of rheo- to limnophilous taxa (Type RL – 44.03% of the total number of recorded species). This type of species prefers slow-flowing streams and lentic zones. A smaller amount (9.31%) of species were indifferent to current conditions, while 32.4% of the taxa could not be classified with regard to current preference, due to a lack of relevant data (AQEM, 2002).

The domination of rheo- to limnophilous taxa indicates that, although the generally typical fauna for potamon-type (slow flowing) rivers has been identified (based on analyses of other authecological information), the higher current velocity influences the community composition.

Based on the analysis of the community pattern (correspondence analysis of the relative abundance of the taxa in samples – Figure 4), the regularity of the distribution along the watercourse was not recorded, which indicates that the investigated stretch belongs to the same general river type. Anyhow, the resulting Correspondence Analysis diagram (Figure 4) shows that samples from sampling sites Slavonski Šamac and Sava next to the Bosut Confluence demonstrate fewer mutual differences in comparison to the rest of the samples. The recorded community pattern is the consequence of multiple factors – the differences in substrate type (Table 1), microhabitat diversity, influence of stress factors etc.

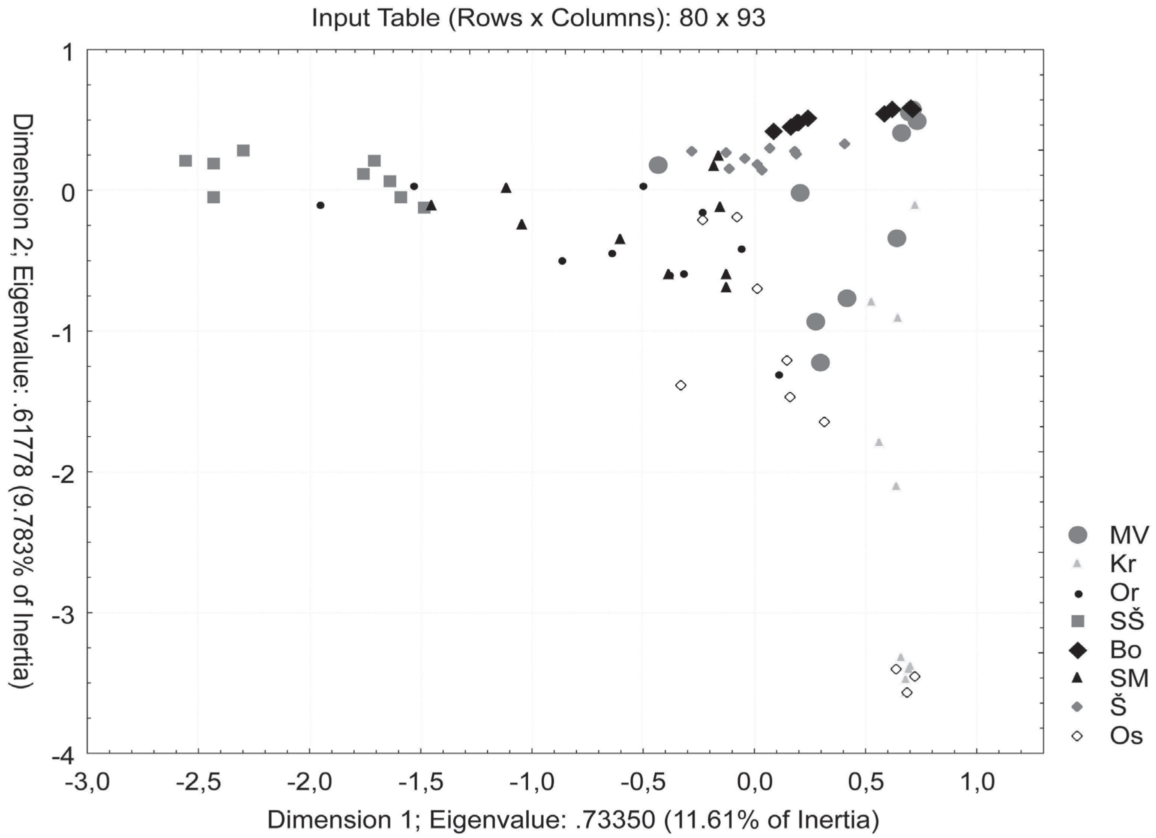

Figure 4: Correspondence analysis of relative abundance of taxa in samples per sampling sites

Discussion

The investigated section of the Sava River, despite anthropogenic impacts (organic pollution and impact of agricultural activity) has considerable habitat diversity resulting in macroinvertebrate fauna diversity.

In comparison to the previous research of the Sava River (Matoničkin et al., 1975, Paunović et al., 2004), a considerable number of species have been recorded during our study. According to Paunović et al. (2008) a total of 62 macroinvertebrate taxa were registered in the Serbian section of the Sava River. For comparison, during the AquaTerra Danube Survey (ADS) in the sector between Klosterneuburg (Austria, 1942 river km) and Vidin-Calafat (Bulgaria-Romania, 795 river km), 89 taxa are detected (Csányi and Paunovic, 2006) and molluscs were found to be the most dominant group within the macroinvertebrate community with regard to species richness (35 taxa).

The taxa richness of the investigated stretch of the Sava River is certainly higher, having in mind that representatives of the Chironomidae family were not determined up to the species and genus level, as well as taking into the consideration that this work comprises the analyses of macroinvertebrates of natural substrate types only. Further, for achieving adequate taxonomic knowledge about the bottom fauna of large rivers such the Sava along the investigated stretch, more detailed sampling is needed. The combination of near-shore, shallow region sampling (applied in this study), along with collecting material in deeper areas of the river (by dredging).

Based on the fauna recorded, the investigated stretch could be characterized as a potamon- type river. Among the recorded species, potamophylous and taxa characteristic for littoral areas, dominated at all sites. In terms of the number of species and relative abundance, molluscs and annelids were a dominant component of the community, which is characteristic for large lowland rivers in the region (Csányi and Paunović, 2006; Paunović et al., 2007, 2008; Sommerwerk et al., 2009).

There is an obvious need for further investigation of the Sava River in order to complete data on aquatic macroinvertebrates and to provide basis for accurate assessment of the river's environmental status. This work represents contribution to the basic knowledge on the aquatic fauna of this large river, as the basis for more effective future water resource management planning of the Sava River Basin.

Acknowledgements

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