An Assessment of Aquatic Macroinvertebrates Diversity and Ecological Preferences in Some Smaller Watercourses from Srem (Vojvodina, Serbia)

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Abstract

A total of 80 aquatic macroinvertebrates taxa were recorded at six localities situated on the smaller watercourses in the province of Srem (Vojvodina, Serbia). The sampling was performed in November of 2015. Diptera were found to be the most important part of the recorded communities, both in terms of taxa richness and abundance/percentage participation. The greatest number of taxa was found at the site upstream of the City of Inđija with 41 taxa, while the lowest (only one taxon) was recorded at the downstream Inđija locality. High median values of diversity metrics used indicate the presence of taxa rich and diverse aquatic macroinvertebrate communities . Pelophilous and phytophilous, potamal and rhithral taxa were the dominant component of a community in relation to their microhabitats and habitat preferences, respectively. A very low diversity found at localities downstream of larger settlements (Inđija and Ruma) points to pronounced negative anthropogenic impacts on these small capacity components of the hydrological network in this lowland part of Serbia.

Keywords: aquatic macroinvertebrates, diversity indices, habitat preferences, streams, Pannonian Plain.

Introduction

The Pannonian Plain as the central part of the Danube basin is well known as a region with some of the largest European rivers, such as the Danube, Sava, Tisa and Drava Rivers and many smaller, man-made watercourses (canals) such as the Danube-Tisa-Danube (DTD) canal-network. In Serbia the Pannonian Plain occupies the northern part of the country (Province of Vojvodina). The south-eastern part of Vojvodina, bordered by the Danube (on the North and the East) and the Sava River (on the South), is called Srem. Srem is a particularly interesting region, from a biogeographic perspective, due to the presence of one of the Pannonian Island Mountains – Fruška Gora (with the oldest national park in Serbia - NP Fruška Gora), which occupies its northern part (Habijan-Mikeš, 2007). Numerous small watercourses (streams) arise on this mountain and create a unique hydrological network in this Pannonian province (more details are provided in Živić et al, (2002) and Cvetić & Sabovljević (2005)). Although traditionally considered a border between ecoregions 5 (Dinaric western Balkans) and 11 (Hungarian lowlands) (Illies, 1978), based on new data, this region (Srem) belongs to Ecoregion 11 (Paunović et al, 2012).

Being one of the more densely populated regions in Serbia and with large areas of agricultural lands, it is not surprising that watercourses in this region are under heavy anthropogenic influences. Agricultural runoff, irrigation and drainage, communal and industrial waste waters can be singled out as some of the main threats to these smaller aquatic habitats. (Živić et al, 2002).

Aquatic macronvertebrates, of which the majority would be considered as benthic organisms, are an important component of aquatic diversity (e.g. Covich et al, 1999). In the Panonnian part of Serbia, aquatic macroinvertebrate communities are well studied only in large rivers, such as the Danube, the Sava and Tisa River (e.g. Liška et al, 2015), while to date, knowledge regarding their communities in smaller watercourses in this region is rather scarce. Živić et al. (2000; 2002) conducted an investigation of the Kudoški stream watershed in the central part of Srem., As part of a regular yearly investigation of

surface waters performed by the Institute for Public Health, Belgrade, the lower courses of a few canals (the Progarska Jarčina, Galovica, Karaš, Vizelj and PKB canals, among others) are monitored in the southern part of Vojvodina, in the Belgrade Region (Marković et al, 2014).

Aiming to draw more attention to small Panonnian watercourses in Serbia, as rather undervalued and neglected habitats for aquatic macroinvertebrates, here we present data regarding the diversity of this important component of aquatic fauna in some of these smaller Pannonian streams in the province of Srem (Vojvodina).

Material and Methods

The samples were taken in November of 2015 at three watercourses (six sampling sites in total) (figure 1, table). AQEM protocol (AQEM, 2002; Hering et al, 2005) was applied and semi-quantitative sampling was performed by using a standard benthological hand net (25x25 cm, 500 µm mesh size). Samples were preserved using 60 - 80% ethanol solution and further processed in the laboratory. Identification to the lowest taxonomic level (preferably species level) for the main taxonomic groups was done by using appropriate taxonomic keys in the laboratory for hydroecology and water protection of the Institute for Biological Research „Siniša Stanković“ in Belgrade.

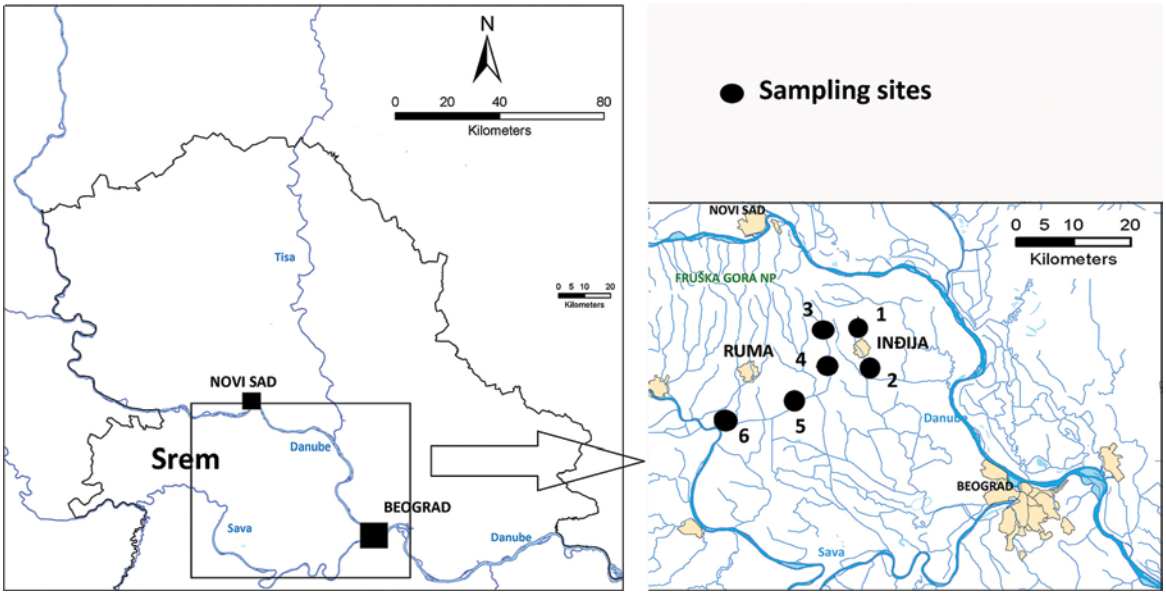

Figure 1: Sampling localities

Table 1: Sampling localities – main data

Watercourse	Sampling Site	Code	N coordinates	E coordinates
Inđijski potok Stream	Inđija upstream	1	45° 3'59.96"	20° 3'40.62"
Inđijski potok Stream	Inđija downstream	2	44°59'44.83"	20° 7'16.87"
Šelevrenac	Maradik downstream	3	45° 4'0.28"	19°59'55.06"
Šelevrenac	Ljukovo	4	45° 1'37.61"	20° 1'5.40"
Jarčina	Dobrinci upstream	5	44°57'26.11"	19°56'18.79"
Kudoški canal	Jarak	6	44°54'54.52"	19°44'37.95"

In order to assess the diversity and ecology of the investigated communities a commonly used Shannon's diversity index (H; Shannon & Weaver, 1949), habitats/zonation and microhabitats preferences of taxa were calculated by AQEM software (AQEM, 2002). A Flora statistical package (Karadzic et al, 1998; Karadzic, 2013) was used to perform multivariate analysis. Raw data (matrix consisting of 80 taxa and 6 localities) were used as input for cluster analysis (CLA). Generalized Euclidean distances and the Noy-Meir method were used in order to classify the investigated sampling localities.

Results and Discussion

A total of 80 aquatic macroinvertebrate taxa were identified. Diptera were found to be the most dominant of the recorded communities, both in terms of taxa richness and abundances/percentage participation. Diptera were also the only taxon found at all the investigated localities.

The greatest number of taxa was found at the site upstream of City of Inđija (Inđijski potok Stream, Sampling Site 1) with 41 taxa, while the lowest (only one taxon) was recorded at the downstream Inđija locality (Inđijski potok Stream, Sampling Site 2) (Figure 2). The upstream Inđija sampling site was

the only site where Diptera were not the most taxa rich group (Figure 2). Coleoptera, besides being the most diverse taxon at Sampling Site 1, were also found to be diverse at Sampling Site 5 (Jarčina, upstream Dobrici) (Figure 2). However, it should be noted that due to the specifity of aquatic Coleoptera, whose representatives, unlike the majority of others aquatic insects, with a wholly aquatic life cycle (where the larval and adult phase can significantly differ in ecology), for the purpose of our ecological analysis, the adult and larval aquatic beetles were treated as separate taxa (different codes in the AQEM database), resulting in an increase in diversity for this group (compared to the other analyzed groups).

Regarding relative abundance of taxa (presented as a percentage participation of the main taxonomic groups per sampling site; Figure 3), it can be noted that Diptera, besides Sampling Site 2 (where they were the only taxon found), were particularly abundant at Sampling Site 5 (upstream Dobrinci) with 70% of the total community. Oligochaeta were dominant groups, in terms of abundance, at sampling sites 3 (Šelevrenac, downstream Maradik) and 6 (Kudoški Canal, Jarak).

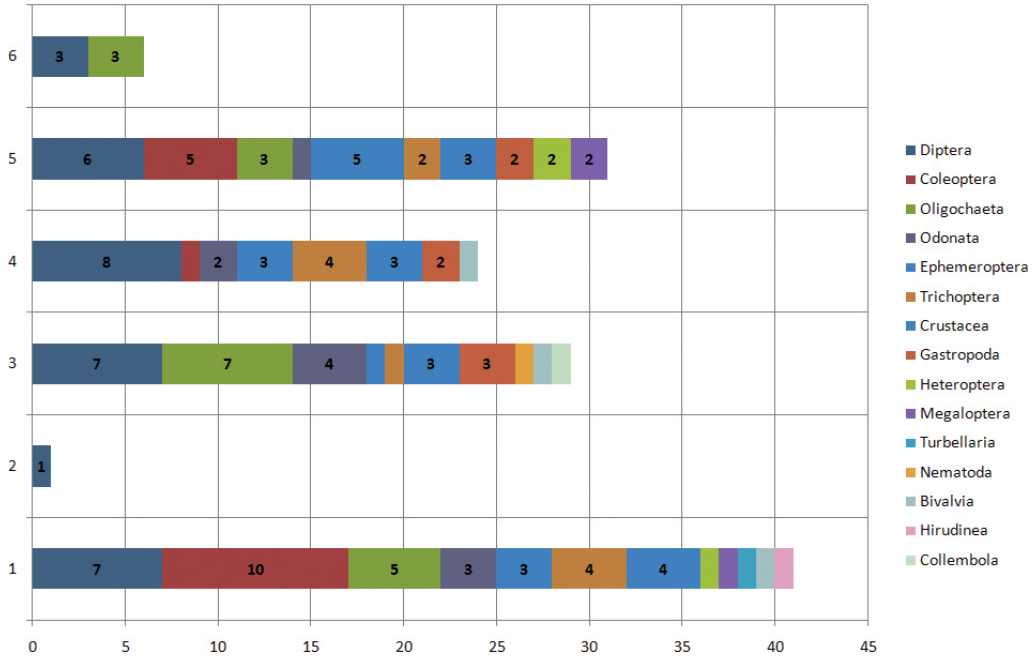

Figure 2: Diversity, presented as a number of taxa, of the main aquatic macroinvertebrate groups along the investigated smaller watercourses in Srem. Sampling localities are coded as in Table.

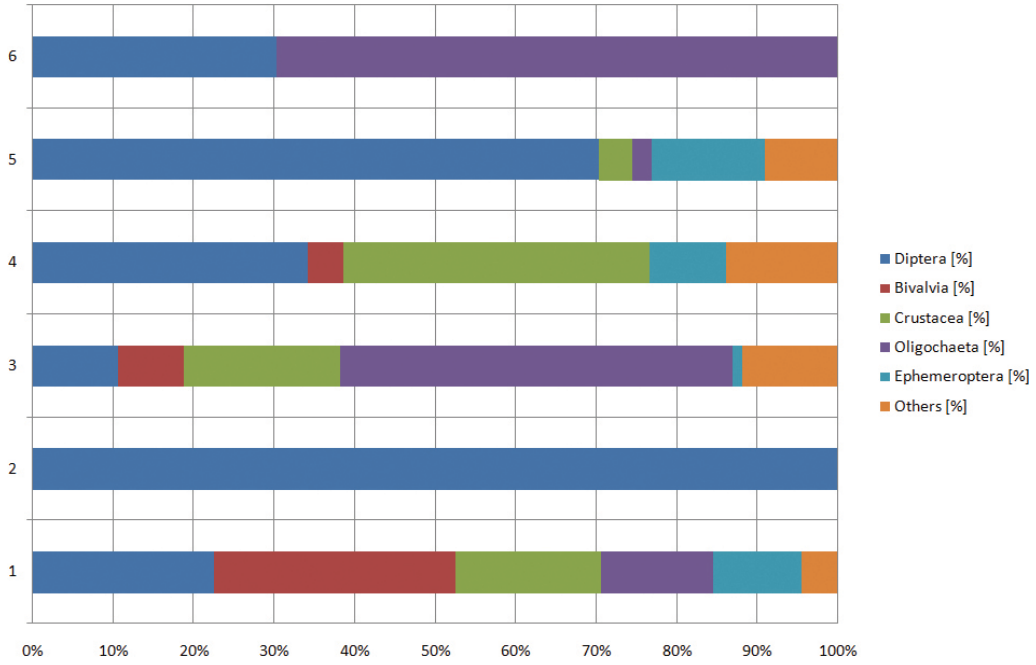

Figure 3: Percentage participation of the main aquatic macroinvertebrate groups along the investigated smaller watercourses in Srem. Sampling localities are coded as in Table.

The calculated values of the H-diversity index ranged from 1.65 (locality 6 - Jarak) to 2.86 (Locality 3 - Maradik downstream, Šelevrenac). It should be mentioned that for one locality (Inđija downstream) the H-index could not be calculated (only one taxon was found). The median value of the diversity index used was high (2.17) and could indicate the presence of diverse communities along the investigated watercourses.

In regards to microhabitat preferences (Figure 4), pelophilous and phytophilous taxa were dominant in terms of abundance/percent participation with a total share in a community of 30.7% and 20.3%, respectively. Pelophilous taxa were dominant at sites 2 (Inđijski potok Stream, downstream Inđija) and 6 (Kudoški Canal, Jarak), while phytophilous taxa were dominant members of communities at sites 4 (Šelevrenac, Ljukovo) and 5 (Jarčina, Dobrinci upstream). Representatives of Diptera (Chironomidae) and Oligochaeta (Tubificidae) should be mentioned as the main pelophilous taxa found in this investigation.

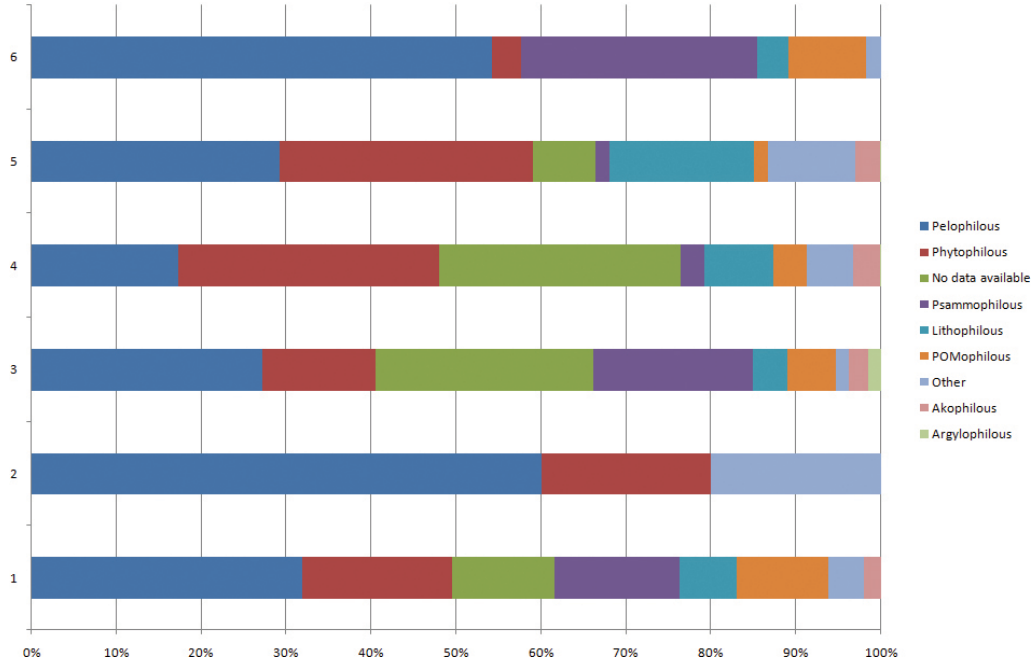

Figure 4: Microhabitat preferences of the main aquatic macroinvertebrates groups along the investigated smaller watercourses in Srem. Sampling localities are coded as in Table.

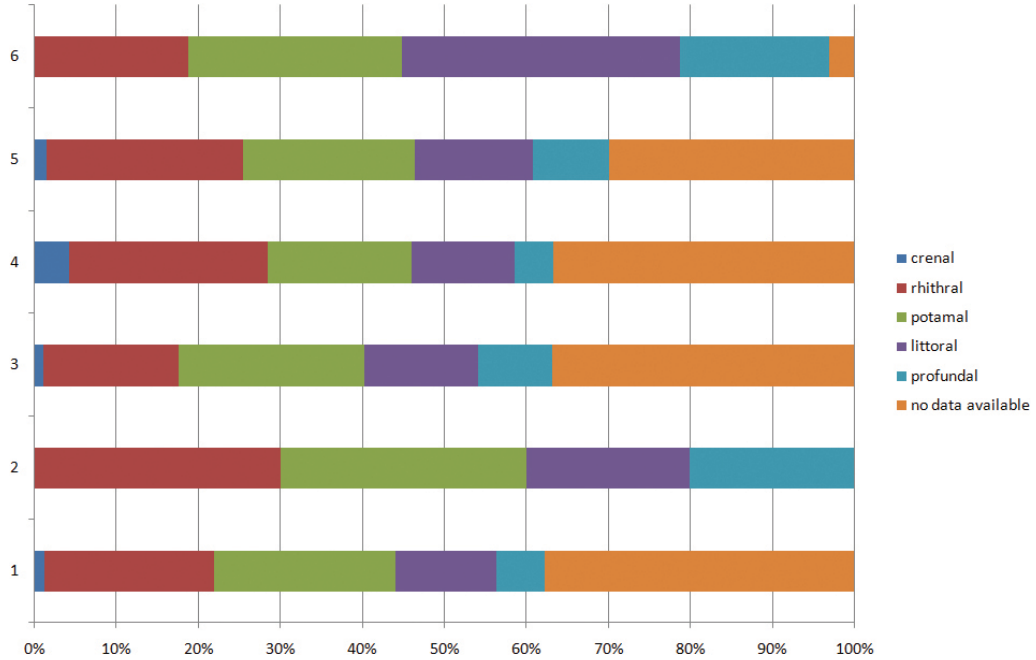

Figure 5: Zonation preferences of the main aquatic macroinvertebrate groups along the investigated smaller watercourses in Srem. Sampling localities are coded as in Table.

Regarding zonation, as a taxa preferences for main habitats along the longitudinal river profile, potamal and rhithral components were found to be the dominant taxa groups, with 21.7% and 21.4% in total community, respectively. It should be noted that habitat preference could not be assessed for 35.3% of the taxa. Potamal and rhithral taxa were dominant components at the majority of the investigated localities, except for Locality 6 (Kudoški Canal, Jarak) were littoral taxa were the most abundant part of the recorded community (Figure 5).

Based on the macroinvertebrate communities found, investigated localities were analyzed/ clustered in order to better visualize similarities in the community structure and composition. From Figure 6 it is obvious that Locality 1 (Inđijski potok Stream, Inđija upstream) significantly differs from all the other investigated localities. This locality, characterized by the highest taxa richnesss, is situated in a small valley in the vicinity of Fruška Gora mountain, in an area with the lowest negative anthropogenic pressure (compared to other investigated localities, which are either downstream from larger settlments /sites 2 and 6) or downstream from fisheries/acumulation (Site 3) or situated in areas with intensive agriculture (sites 4 and 5).

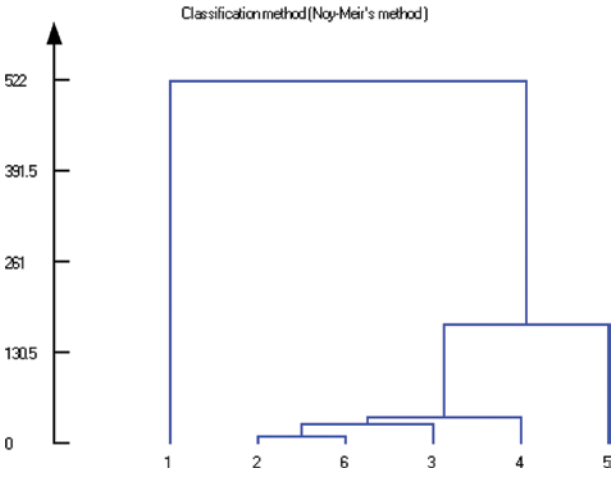

Figure 6: Cluster Analysis Diagram (CLA; Noy-Meir method) of the investigated localities/communities at the investigated smaller watercourses in Srem. Generalized Euclidean distances were calculated for an input matrix consisting of 80 taxa (as the number of specimens recorded per site) and 6 localities.

Considering other aquatic macroinvertebrate investigations in this region (Živić et al, 2000; 2002) it could be noted that a higher overall diversity was recorded in our investigation. So, a total of 80 taxa recorded and 26 taxa per locality (as a median value), could be compared to 38 taxa in total and 14 taxa as maximum value per locality, or median value of diversity index (H) (2.17), could be compared to a value of 1.14 as the maximun diversity index (H) value in other investigations. Such a difference in diversity among supposedly rather similar watercourses (and investigation/number of localities investigated, as well), could be partly explained by different taxonomic resolutions in the comparative investigations, as for Oligochaeta, which was found to be an example of one of the most abundant groups in our investigation, was identified to the species level, thus contributing more significantly to the overall diversity recorded. Additionally, the taxonomic resolution (obtained in our study) in the case of Coleoptera, with larval and adult phase being counted as a separate taxa (for ecological analyses purposes), also resulted in a somewhat higher number of taxa and greater diversity in our investigation. The presence of one particularly taxa rich community (Inđija upstream, 41 taxa from 12 groups recorded) should be underlined. A somewhat lower negative anthropogenic influence, compared to the other investigated sites, and the vicinity of Fruška Gora NP, could be a partial explanation for such great diversity recorded at this site.

Very low diversity was found (only representatives of pollution tolerant taxa from groups Oligochaeta and Diptera) at sites downstream of larger settlements (site 2 and 6, dowstream Inđija and Ruma, respectively) should be underlined, as it could point to the importance of communal and industrial wastewaters from these cities as the main factors of pollution which influence these smaller watercourses. A similar situation was found during the investigation of smaller watercourses in the Belgrade Region (Marković et al, 2014) pointing to the usage of smaller watercourses in the region as recipients for untreated communal and industrial wastewaters.

A high median value for the number of taxa and diversity indices could indicate the presence of taxa rich and diverse aquatic macroinvertebrate communities in the investigated watercourses, despite intensive negative anthropogenic pressures in this lowland region. The Pannonian Island Mountain Fruška Gora (and NP) situated in this region, could act as a diversity center and refugium for aquatic macroinvertebrates, particularly the more vagile insect components. A prolonged and more detailed study of this area is needed in order to better estimate aquatic macroinvertebrate communities present.

Acknowledgements

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