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Stream section types of the Danube River in Serbia according to the distribution of macroinvertebrates

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Abstract: The aim of this study was to use the data on the distribution of aquatic macroinvertebrates obtained from 14 sites within a 413 km long stretch of the Danube River in Serbia to show the relevance of the bordering zone between the Middle and Lower Danube. A total of 68 macroinvertebrate taxa were observed. Molluscs were the major component with regard to species richness and relative abundance. *Lithoglyphus naticoides* (C. Pfeiffer, 1828) was the most abundant species and *Unio tumidus* (Retzius, 1788) was the most frequent species. Product-moment correlation coefficients or Pearson *r* coefficient was used to analyse the relation between the sites based on macroinvertebrate distribution. The data obtained by product-moment correlation served as input for cluster analyses. According to a cluster analyses Danube River in Serbia could be separated in the free-flowing sector, the stretch with a backwater effect and the area of the Iron Gate.

Key words: aquatic macroinvertebrates; bioindication; Danube River; Iron Gate; river section types

Introduction

As proposed by the Water Framework Directive (WFD 2000), a proper typology which is based on the principal natural characteristics of water types, is an important tool that serves as the basis for effective water management and for monitoring the ecological status. The grouping of similar rivers is a prerequisite for following the river-type specific approach of the WFD. Thus, the identification of river types, as relatively homogeneous hydrological and geological systems, implies the existence of linked biological communities.

The classification of biological and ecological systems with the aim of organizing information in order to further develop management principles and practices, has a long history. Attempts to classify the lakes in Europe (Thienemann 1928; Naumann 1932), based mostly on experience in the typology of lakes in North America (Stanković 1951), were initiated in the first half of 20th century. The lake typology system proposed by Naumann (1932) was widely accepted by the scientific community at the time. However, there was no general agreement as to the classification of running waters (Illies & Botosaneanu 1963). Running water classification was extensively discussed after the 1960s (e.g., Stanković 1962; Illies & Botosaneanu 1963; Vannote et al. 1980; Horne & Goldman 1994; Allan 1995). In principle, two approaches could be distinguished: spatial (which takes into consideration the large scale character of a particular area, e.g., the ecoregions (Illies 1978), bioregions (Moog et al. 2001) and hydroecoregions (Wasson et al. 2002, etc.), and longitudinal (which considers the longitudinal changes along the watercourse, a concept proposed by Vannote et al. (1980). Until the WFD came into force, most attempts to classify running water focused on conceptual and regional approaches to stream classification rather than on general approaches, and thus remained applicable to narrow spatial areas.

The theoretical framework proposed by the WFD is comprised of both the spatial and longitudinal approaches to river classification. The concept offered by the WFD in regard to typology is complex. On one hand it requires the classification of water according to its functional entities, as characterized by the array of common features that could be described by biological traits. On the other hand, the system needs to be simple enough to be applicable to effective management, which also includes monitoring. Water typology, according to the WFD principles, implies a certain simplification of the relations in Nature, thus making it important to determine and standardise the level of this generalization.

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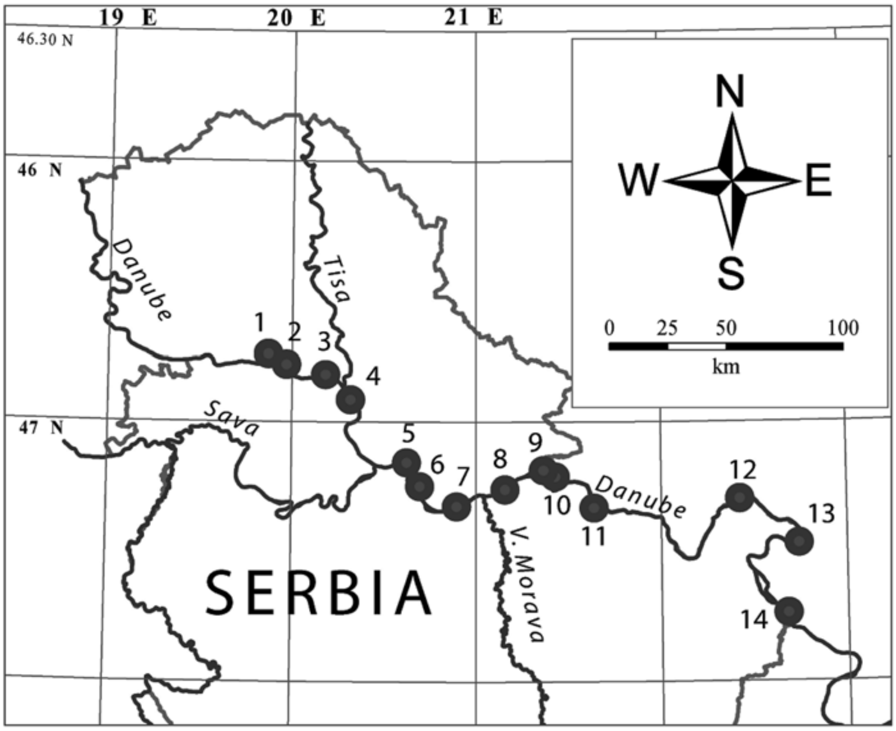

Fig. 1. Map showing the sampling sites along the investigated part of the Danube River.

The situation regarding the typology of large lowland rivers is also a complex issue. In an attempt to classify the typological units of the Danube River spatial typology fails because large rivers exhibit a self-contained development. Along the longitudinal gradient, a large river absorbs a catchment's characteristics that result in a mixture of different influences (Robert et. al. 2003).

The peculiarity of the typology of large lowland rivers was underlined in German typology. German stream typology has distinguished between small and mid-sized rivers in great detail (15 and 11 types have been defined for both size classes, respectively), whereas only seven and two types have been defined for large and very large rivers, respectively (Pottgiesser & Sommerhäuser 2004).

The Danube river basin can be divided into three broad sections, with the impressive delta representing a separate and unique system. The Upper Basin extends from the source in Germany, to the mouth of the Morava River, upstream of Bratislava (the so-called Porta Hungarica). The Middle Basin is the largest and is comprised of the part from the mouth of the Morava River to the Iron Gate dams in Serbia and Romania. The Lower Basin extends from the Iron Gate to the entrance of the delta, downstream of the confluence of the Prut River. The Danube Delta is shared by Romania and Ukraine.

Several studies have dealt with the sectioning of the Danube (Lászlóffy 1965; Literáthy et al. 2002; Robert et al. 2003; Moog et al. 2008; Vogel et al. 2002). Lászlóffy (1965) suggested sectioning the Danube River into four sectors – Upper, Middle, Lower and the Danube Delta; Literáthy et al. (2002) defined nine geo-morphological reaches, while Moog et al. (2008) divided the Danube into ten section types.

Regarding the sectioning of the Serbian stretch, Paunovic et al. (2007) indicated that three sectors of the Danube river could be distinguished – the upper (Pannonian), the Iron Gate sector and a sector represented by sites located at the entrance to the Iron Gate sector. A similar conclusion was subsequently presented by Paunović et al. (2010). According to the authors, the distribution pattern of aquatic macroinvertebrates supports differences between the Pannonian and Iron Gate sections of the Danube.

Furthermore, Paunovic et al. (2005) have presented evidence that the sector upstream from the Iron Gate (rkm 1083–1071) i.e. the stretch situated at the entrance to the Iron Gate (Djerdap) Gorge can be considered as the border zone between two Danube types – the Pannonian Plain Danube and the Iron Gate Danube. The authors pointed out that the sector is under the influence of both the downstream sector (Lower Danube) and the upstream zone (Middle Danube), as revealed by the faunistic composition of macroinvertebrates.

Study area

Until the end of the 19th century, the Danube was a generally undisturbed system with a preserved lateral connectivity along its large floodplain areas. The river was characterized by its natural dynamics, huge natural purification capacity and constant changes of its course. Since then, the anthropogenic impact (mostly flood protection, agriculture, energy production and navigation activities) has destroyed

Table 1. Sampling sites along the investigated part of the Danube River.

Mark	Site name	River km
1	Upstream Novi Sad	1262
2	Downstream Novi Sad	1252
3	Upstream Tisa confluence (Stari Slankamen)	1216
4	Downstream Tisa/Upstream Sava (Belegis)	1200
5	Upstream Pancevo/Downstream Sava	1159
6	Downstream Pancevo	1151
7	Upstream Velika Morava confluence	1107
8	Downstream Velika Morava confluence	1097
9	Stara Palanka – Ram	1077
10	Banatska Palanka – Bazias	1071
11	Irongate reservoir (Golubac/Koronin)	1040
12	Irongate reservoir (Tekija/Orsova)	955
13	Vrbica/Simijan,	926
14	Upstream Timok confluence (Radujevac)	849

over 80% of the Danube's wetlands, floodplains and floodplain forests.

The Danube River Basin covers an area of about 801,000 km^2 and it is shared by 19 countries in Central and South-Eastern Europe (Germany, Austria, Switzerland, Italy, Poland, the Czech Republic, Slovenia, Slovakia, Hungary, Croatia, Serbia, Romania, Bosnia and Herzegovina, Macedonia, Albania, Montenegro, Moldova, Bulgaria, and Ukraine), with more than 83 million people inhabiting the area (Sommerwerk et al. 2009).

The investigated reach of the Danube extends over a distance of 588 km, covering the middle and a part of the lower 220 km long waterway. The major part of this sector (358 km) belongs to the Pannonian basin. In this section the Danube is a typical lowland river with a slope of 0.05–0.04 per thousand.

The Serbian reach of the Danube has been extensively examined since the early sixties, (a review of the investigations is presented in Paunovic et al. 2007). The sector is under the influence of organic pollution and hydromorphological alteration. One of the most important problems that affect the nature of the Danube is river regulation and damming. In the Serbian part, due to dam construction (rkm 943) near Sip, a large reservoir, Iron Gate (Djerdap) was formed. Reservoir stretches 100 km in length, extending from the dam to Golubac (Iron Gate). After the damming of the Danube, the flow rate has slowed down upstream to Slankamen (1215 rkm).

Material and methods

Macroinvertebrate samples were collected during the Aqua-Terra Danube Survey (ADS – an investigation supported by the EU FP6 Project AquaTerra, Contract N°505428) on the River Danube between Klosterneuburg (Austria, 1942 rkm) and Vidin-Calafat (Bulgaria-Romania, 795 rkm), between 19 August and 04 September, 2004 (Csányi & Paunovic 2006). The material used in this work comprised data obtained from 14 sites within the sector flowing through Serbia (Table 1; Fig. 1). A 413 km long stretch of the Danube was examined (1262–849 rkm).

Material was collected with a benthological dredge (mesh size 1000 µm) and hand net (mesh size 1000 µm), using the Kick and Sweep technique. The fauna attached to stone surfaces was collected with tweezers and, if necessary, scraped with a brush. The sampling approach provided semi-quantitative data since the same sampling procedure was used at each sampling station.

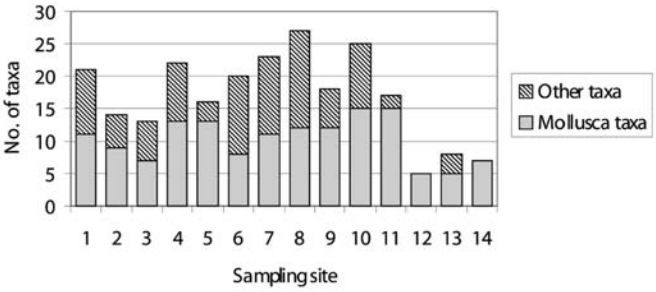

Fig. 2. Total and taxonomic richness of Mollusca at the sampling sites.

The samples were preserved in 70% ethanol. Sorting and identification of the material (when possible to the species level) was performed in the laboratory.

The frequency of each taxa was calculated as the percentage of the taxa in all collected samples (F = No. of sites where the particular taxa was found/total No. of sites). The PCoA was used to analyse the relation between the sites based on macroinvertebrate distribution. "Flora" (Karadžić 1998) was used for statistical processing of the data.

Results

The main faunistic features of the Danube recorded during the ADS in the sector between Klosterneuburg (Austria, 1942 rkm) and Vidin-Calafat (Bulgaria-Romania, 795 rkm) have been presented by Csányi & Paunovic (2006). During the ADS, a total of 89 taxa were detected within the investigated section. With regard to species richness, Molluscs were found to be the dominant group in the macroinvertebrate community (35 taxa).

The present work is focused on the Serbian part of the river in order to underline the peculiarity of different stretches within the sector. The composition of the macroinvertebrate community along the Serbian stretch is presented in Table 2. A total of 68 macroinvertebrate taxa were observed within the 14 sampling sites along the Serbian stretch. Molluscs were found to be the principal component of the community in regard to species richness (Fig. 2) and relative abundance (Fig. 3). Gastropoda were represented with 16 species, while 10 species of Bivalvia were recorded. A total of 18 taxa of Annelida (Oligochaeta 10, Hirudinea 7 and Polychaeta 1) and 17 species of aquatic insects were identified. Chironomidae (Diptera) were found to be the most important component within the insects in regard to species richness, with seven recorded taxa. *Lithoglyphus naticoides* (C. Pfeiffer, 1828) was the most abundant species and its frequency of occurrence was $F = 0.78$. *Unio tumidus* Retzius, 1788 was the most frequent species ($F = 0.93$), followed by *Dreissena polymorpha* (Pallas, 1771) ($F = 0.86$). *Corbicula fluminea* (Müller, 1774) was also frequent along the examined

Table 2. Composition of benthic fauna of the Serbian part of the Danube.

Taxa name	Sampling site													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
MOLLUSCA														
Theodoxus danubialis (C. Pfeiffer, 1828)									2	3	22			6
Theodoxus fluviatilis (L., 1758)	18	34	90	39	12	19	22	2	98	7	45		7	2
Viviparus acerosus (L., 1758)			4	4	4									
Viviparus viviparus (L., 1758)								8		5	4			
Lithoglyphus naticoides (C. Pfeiffer, 1828)	940	420	526	233	495		54	100	17	1	80	12		
Microcolpia daudebartii acicularis (Ferussac, 1821)				27					57	17	44			17
Esperiana esperi (Ferrusac, 1823)	31			6					14	18	174			5
Holandriana holandrii (C. Pfeiffer, 1828)									1					13
Bithynia tentaculata (L., 1758)		1		8					4		5			
Valvata naticina (Menke, 1845)	2		2		69	3					31	7		
Valvata piscinalis (Müller, 1774)									1		5			
Lymnaea auricularia (L., 1758)										2	1			
Lymnaea peregra var. *ovata* (Draparnaud, 1805)					1		1	12		5	1		1	
Lymnaea stagnalis (L., 1758)		1					1	1		1				
Physella acuta Draparnaud, 1805					1	1	1	6		2			3	
Planorbarius corneus (L., 1758)										1				
Unio pictorum (L., 1759)	1			4	2			3			1		1	7
Unio tumidus Retzius, 1788	2	3		40	30	6	23	38	11	52	8	2	3	3
Anodonta anatina (L., 1758)	1			4	10	1	1	5		3	1	1		
Anodonta cygnea (L., 1758)								1						
Sinanodonta woodiana (Lea, 1834)		2		3	18	6	13	14	46	45				
Pseudanodonta complanata Rossmassler, 1835	1													
Dreissena polymorpha (Pallas, 1771)	15	18	21	10	8	6	17	2	80	3	24	6		
Pisidium amnicum (Muller, 1774)					5		4							
Sphaerium rivicola (Lamarck, 1799)	3	12	1	23	18	1								
Corbicula fluminea (Müller, 1774)	10	9	20	11			2		8			23	30	21
POLYCHAETA														
Hypania invalida (Grube, 1860)	2													
OLIGOCHAETA														
Branchiura sowerbyi Beddard, 1892						4	2	1						
Criodrilus lacuum Hoffmeister, 1845	2	1												
Isochaetides michaelseni (Lastockin, 1937)	1													
Limnodrilus claparedeianus Ratzel, 1868	1					3	5	2					1	
Limnodrilus hoffmeisteri Claparede, 1862						2	4						2	
Limnodrilus profundicola (Verrill,1871)						2		3						
Limnodrilus sp.	1					3	3							
Limnodrilus udekemianus Claparede, 1862						3	1	1						
Psammoryctides albicola (Michaelsen, 1901)						2	1							
Tubificidae Gen. sp.				3		1								
HIRUDINEA														
Glossiphonia complanata (L., 1758)	4			2					1					
Alboglossiphonia heteroclita (L., 1761)								2		1				
Alboglossiphonia hyalina (O.F. Müller, 1774)								1						
Piscicola geometra (L., 1761)								1						
Dina punctata Johansson, 1927			1											
Erpobdella octoculata (L., 1758)	10	1							2					
Helobdella stagnalis (L., 1758)	1	1						1						
CRUSTACEA														
Limnomysis benedeni Czerniavsky, 1882					1		1	2	3	205	1			
Corophium curvispinum (Sars,1895)			4	10										
Dikerogammarus haemobaphes (Eichwald, 1841)										1				
Dikerogammarus villosus (Sowinsky, 1894)			9	2	3	1			1	39				
Obesogammarus obesus (Sars, 1894)		1		3						4				
Astacus leptodactylus Eschscholz, 1823				1										
EPHEMEROPTERA														
Cloeon dipterum (L., 1761)								15		15			12	
ODONATA														
Calopteryx splendens (Harris, 1780)				1			1							
Stylurus flavipes (Charpentier, 1825)	5	2	2											
Erythromma najas (Hansemann, 1823)						3								
Ishnura elegans pontica Schmidt, 1939						9		5		2				
HEMIPTERA														
Gerris sp.										1				
Ilyocoris cimicoides (L., 1758)						2		1		5				
Sigara sp.								70	1					
TRICHOPTERA														
Hydropsyche bulgaromanorum Malicky, 1977			8	10										
Neureclipsis bimaculata (L., 1758)				2										

Table 2. (continued)

Taxa name	Sampling site													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
DIPTERA														
Chironomidae Gen. sp.										2				
Chironomus plumosus (L.,1758)	2		1		1			2			5			
Cricotopus intersectus (Staeger, 1839)							1							
Cryptochironomus sp.								1						
Demicryptochironomus vulneratus (Zetterstedt, 1838)							7							
Parachironomus arcuatus Goetghebuer, 1919							1							
Procladius sp.							34	3						

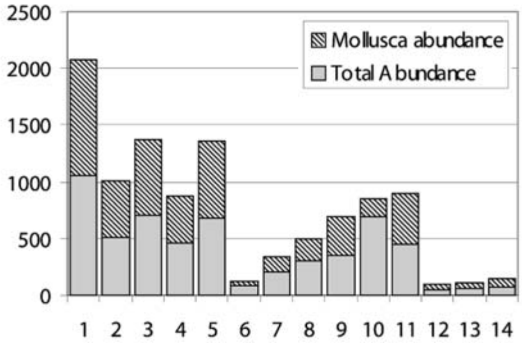

Fig. 3. Total relative abundance and relative abundance of Mollusca along the examined stretch.

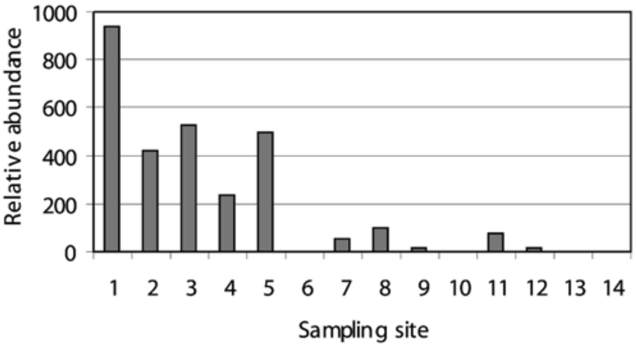

Fig. 5. Abundance of *Lithoglyphus naticoides* (C. Pfeiffer, 1828) along the examined stretch.

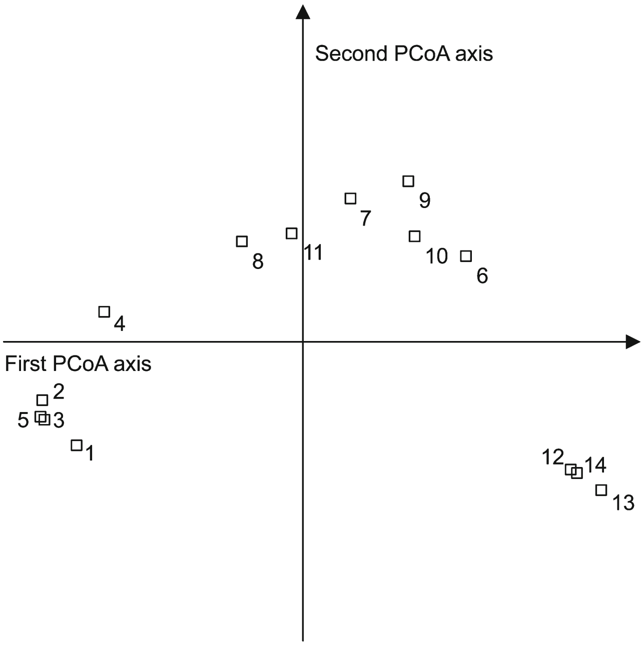

Fig. 4. The results of PCoA based on the abundance of taxa at the sampling sites.

stretch ($F = 0.64$). Other recorded species were found less frequently.

Based on the data on the relative abundance at the sampling sites, PCoA was performed. The results of PCoA are presented in Fig. 4. According to the resulting graph (Fig. 4), three sectors can be defined: (1) sites 1–5, the free-flowing section, (2) the Iron Gate reservoirs I and II section, sites 12 and 13 together with site 14, situated downstream of the second dam, (3) sections with a strong back water effect.

This result is a consequence of the shift in the benthic community, illustrated in Figs 2 and 3. A decline of species richness and abundance was observed in the Iron Gate sector (sites 12 and 13) as well as at the site situated downstream of the dam (14) when compared to the upstream sites. The relative abundance of the benthic community was highest in the “free-flowing section” (sites 1–5) upstream of Belgrade.

The change in the total benthocoenosis could be effectively followed by the analysis of the shift in the principal component – Mollusca (Figs 2, 3). The distribution of particular mollusc taxa, selected according to their participation in the abundance in the total community, is presented in Figs 5–7. *L. naticoides* (Fig. 5) and *Theodoxus fluviatilis* (L., 1758) (Fig. 6) were particularly abundant in the free-flowing section (sites 1–5), while *Theodoxus danubialis* (C. Pfeiffer, 1828) (Fig. 6) was recorded only in the lower stretch (sites 9, 10, 11 and 14). *Sphaerium rivicola* (Lamarck, 1799) was recorded exclusively within the “free-flowing section” (Fig. 7, sites 1, 2, 4 and 5). Furthermore, *Sinanodonta woodiana* (Lea, 1834) was not observed in the Iron Gate sector (Fig. 7). *Holandriana holandrii* (C. Pfeiffer, 1828) was found with a higher relative abundance only at site 14 (Table 2).

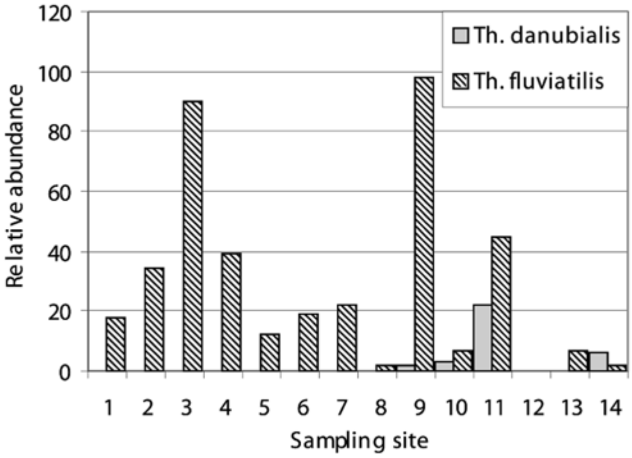

Fig. 6. Abundance of *Theodoxus fluviatilis* (L., 1758) and *Theodoxus danubialis* (C. Pfeiffer, 1828) along the examined stretch.

Discussion

Of the 89 species that were recorded along the entire stretch during the 2004 Danube Survey (Csányi & Paunovic 2006), 68 species were detected in the Serbian sector. The considerable decline in number of species per site was observed in the Iron Gate reservoirs I and II. A similar situation was observed in the upper sector, in the area of the Gabcikovo Reservoir (Csányi & Paunovic 2006). This result indicates that hydromorphological changes cause the deterioration of the status of the river in the Iron Gate stretch, where the lowest taxa richness was recorded.

The lower number of taxa detected during the present study in comparison to the 2001 Danube survey (when Paunovic et al. 2007 reported 74 macroinvertebrate taxa), could be due to the lower number of sampling sites within the same stretch.

A similar community structure, with respect to the dominant macroinvertebrate groups, but with a larger proportion of some taxa, was also observed in the Hungarian (Nosek 2000; Oertel 2000) and Slovakian stretch of the Danube (Elexová 1998; Šporka & Nagy 1998). The Hungarian stretch is characterized by the domination of *Dikerogammarus villosus* (Sowinsky, 1894), *Corophium curvispinum* (Sars, 1895), and *L. naticoides* (Nosek 2000; Oertel 2000). According to Elexová (1998) and Šporka & Nagy (1998), Oligochaeta and Chironomidae (Diptera) were dominant in the side arm of the Slovakian stretch. The same groups were found to be dominant in the Hungarian sector in the Ráckevei (Soroksári) Danube arm. This situation is the result of the difference between the sectors, but also due to the sampling methodology that was applied in our study. As we used a benthological dredge and a FBA hand net with a mesh size of 1000 μm, smaller animals, mostly belonging to Oligochaeta and Chironomidae, could have been missed. Nosek (2000) and Oertel (2000) described a community, based on a 500 μm mesh size EU ISO-7828 type net (in addition, they applied qualitative and/or semiquantitative concurrent sampling methods: kicking and sweeping, and in some cases collection with a triangular shaped dredge and by hand) that could have contributed to a larger proportion of small-sized individuals in their samples.

Considering the differences between the Slovak and Serbian stretch of the Danube, the higher taxa richness of Ephemeroptera and Trichoptera that was reported by Elexová (1998) could be expected. Differences in the dominant sediment types between the Slovakian and Serbian stretches could be the main reason for the observed differences. The Slovakian sector is distinguished by a higher proportion of habitats with gravel, boulders and stones (Elexová 1998), while the Serbian part (Paunovic et al. 2007) is predominantly characterized

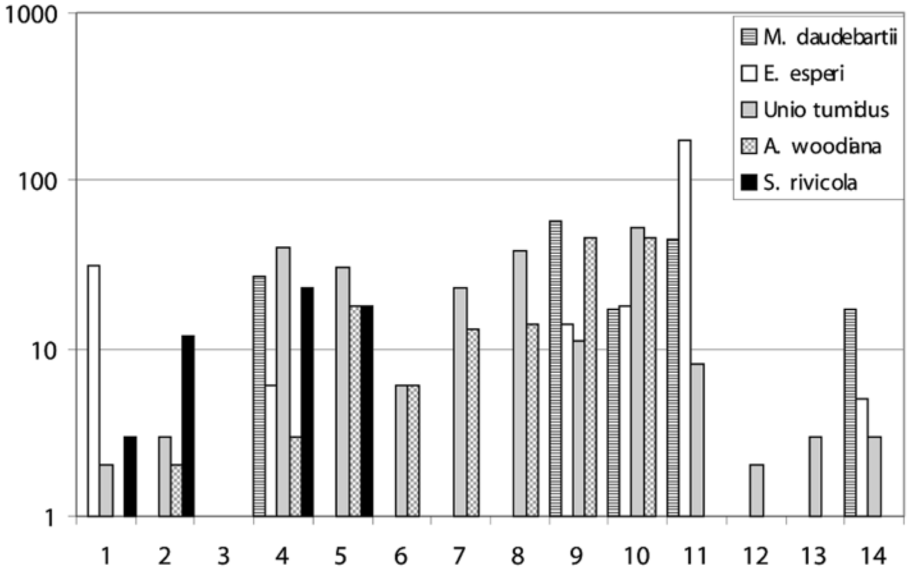

Fig. 7. Abundance of five selected mollusc taxa along the examined stretch.

by fine sediment particles (sand and mud) on the river bed.

In general, the community structure that was observed along the Serbian stretch was expected considering the watercourse type. In potamon-type rivers in Serbia, molluscs and oligochaetes are typically the most diverse and abundant groups, together with Chironomidae (Paunovic et al. 2007).

According to the presented results, three different sections could be distinguished within the investigated Serbian stretch: (1) the Iron Gate sector which covers the stretch distinguished by a back-water effect and part of the river situated downstream of the Iron Gate dam; (2) the part from Belgrade to the Iron Gate and the free-flowing stretch upstream of Belgrade. The results are similar to previous works on Danube River sectioning (Litheráty et al. 2002; Robert et. al. 2003; Vogel et al. 2002). All of the authors agree that the Iron Gate is the border between distinct Danube types i.e. between the Middle and Lower Danube. Based on the data describing the qualitative composition of the macroinvertebrate fauna, Paunovic et al. (2007) also divided the Serbian stretch into three sectors. These are the upper (Pannonian) sector, the Iron Gate sector and the entrance sector to the Iron Gate stretch. During the 2001 study (Paunovic et al. 2007), a similar distribution pattern was observed along the Serbian sector of the Danube River, i.e. a higher density of *L. naticoides* and *D. villosus* in the upper stretch, while *T. danubialis*, *Esperiana esperi* (Ferrusac, 1823), *Valvata naticina* (Menke, 1845) and *Bithynia tentaculata* (L., 1758) were more abundant in the Iron Gate sector. These results also demonstrate the differences between the upper (Pannonian) sector and the Iron Gate sector. According to the results of the 2001 study (Paunovic et al. 2007), the species that were equally represented in the Serbian sector [*Tubifex tubifex* Muller, 1774, *Limnodrilus hoffmeisteri* Claparede, 1862, *Limnodrilus claparedeanus* Ratzel, 1868, *Limnodrilus udekemianus* Claparede, 1862, *Limnodrilus profundicola* (Verrill, 1871) and *D. polymorpha*], were found to be ubiquitous, and their distribution was less dependent on changes in the environment.

According to the presented results, the sectioning of the Serbian stretch of the Danube into three distinct sectors represents an effective approach to define the monitoring and management entities.

The upper (Pannonian) sector (from Belgrade, 1071 rkm up to the Hungarian border) is similar to the Lower Hungarian stretch (Robert et al. 2003; Paunovic et al. 2005) and these sectors are classified as the same Danube type, referred to as the Pannonian Plain Danube (Robert et al. 2003). A general similarity was confirmed when comparing the macroinvertebrate community in the Hungarian (Nosek 2000; Oertel 2000) and Serbian stretches (the present study, as well as those of Paunovic et al. 2007, 2010).

In comparison to the upper stretch, the Iron Gate sector is different with regard to hydro-morphological conditions. The natural differences between the sectors that are situated upstream and downstream 1071 rkm of the watercourse are illustrated by the fact that this point has been identified as the border between the general Danube sectors (Pannonian Plain Danube and Iron Gate Danube), as well as the boundary between Middle and Lower Danube (Robert et al. 2003).

According to previous studies (Paunovic et al. 2005), the stretch situated in the area of the entrance into the Iron Gate sector was found to be specific in regard to the macroinvertebrate community and could be considered as a transitional zone between the Middle and Lower Danube. This is an area of considerable diversity of macroinvertebrates in comparison to the upper (Jakovcev 1987, 1988; Djukic & Karaman 1994), as well as downstream stretches (Djukic & Karaman 1994; Simic et al. 1997; Simic & Simic 2004). The greater species richness of the transitional zone is mostly supported by its considerable habitat diversity in comparison to other sections, and is illustrated by the fact that Paunovic et al. (2005) reported 84 aquatic macroinvertebrate taxa in a short stretch of the river section (between 1083 rkm and 1076 rkm).

Proper sectioning or typology is a basic precondition for the establishment of an effective system of status assessment according to the WFD. Defining typology and designing a system of status assessment is generally a very complex process. It is particularly involved when large lowland rivers are assessed, partly because of their transboundary character. The system should be harmonised between countries through the process of intercalibration (Birk et al. 2009). Therefore, further work aimed at defining a type-specific system for the assessment of the ecological status in Serbia, should take into consideration the general similarity of the fauna in the Hungarian, Slovakian and Serbian stretches, as well as the fine shifts within communities which point to differences between stretches,.

Conclusion

We conclude that the free-flowing sector, the stretch with a backwater effect and the area of the Iron Gate can be separated according to their macroinvertebrate communities. The results reveal differences between the Lower and Middle Danube, and point out the peculiarity of the stretches that are under the influence of the Iron Gate dams. The findings support a typology of the Danube that is based on selected abiotic parameters. According to the presented Danube typology, the Iron Gate area separates the Middle and Lower Danube.

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