COMPOSITION AND STRUCTURE OF THE OLIGOCHAETA (ANNELIDA) IN BENTHIC ASSEMBLAGES OF THE DANUBE RIVER IN THE BELGRADE REGION DURING MAY AND OCTOBER OF 2004

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Abstract

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The present work discusses composition and structure of the Oligochaeta community of the Danube river in the Belgrade region, Serbia, as determined in investigation of the bottom fauna in May and October of 2004. The investigated region encompassed five locations along 66 km of the river's course. Sixteen species of Oligochaeta (12 genera; 3 families) were determined in the spring, while 12 species (8 genera; 2 families) were found in the autumn aspect of the assemblages. Aquatic worms made up the majority component of the bottom fauna in the investigated part of the river, both in regard to the number of species present in the fauna and with respect to their abundance. The following species were found most frequently at the investigated locations in May and October: *Limnodrilus hoffmeisteri* C l a p a r e d e , 1862; *L. claparedeanus* R a t z e l, 1868; *L. udekemianus* C l a p a r e d e, 1862; *L. profundicola* V e r r i l l, 1871; *Tubifex tubifex* M ü l l e r, 1774; *Psammoryctides albicola* M i c h a e l s e n, 1901; *Branchiura sowerbyi* B e d d a r d; and *Potamothrix hammoniensis* M i c h a e l s e n, 1901. In view of the fact that Belgrade is an important urban and industrial centre, the influence of organic pollution on the oligochaete and benthic communities as a whole was taken into consideration. The Sørensen's Quotient of Similarity was determined to compare benthic assemblages of the investigated locations.

Key words: Danube, Belgrade region, Serbia, benthic assemblages, Oligochaeta, species richness, spatial and temporal distribution, Sørensen's Quotient of Similarity, organic pollution

Introduction

The Danube is the second-longest river in Europe (with a length of 2,950 km) and the only European river that flows from the west to the east. It flows through nine countries and for centuries has served as the main trade route between nations. On the sector that passes through our country (588 km long), quality of the Danube's water neither deteriorates nor improves. Although it receives great quantities of waste water from large settlements and industrial installations on its banks, there is no worsening of water quality owing to the fact that the Danube is a large river with a great ability to absorb wastewaters and a considerable capacity for self-purification (Martinovic-Vitanovic, Kalafatic, 1995). In the Belgrade region Serbia, the river is constantly subjected to heavy loading with matter of mainly organic origin (Martinovic-Vitanovic et al., 1999a, b). According to the Regulations for Classification of waters of Inter-Republic Water Courses, International Water Courses, and Coastal Waters of Yugoslavia (1978) and Regulations for Categorization of Water Courses of Serbia (1968), the Danube's water can be characterized as mesosaprobic in terms of quality.

During the 20th century, especially during the last 30 years, investigators have devoted considerable attention to the Oligochaeta assemblages of the Danube and its tributaries (Hrabe, 1941; Uzunov, 1979, 1983; Petto, Humpesch, 1992; Sporka, 1998; Sporka, Nagy, 1998). Altogether, 82 species of oligochaetes have been identified in the Danube to date (Uzunov, 1988). Djukic and Karaman (1994) give a list of 24 species in the Danube and its larger tributaries. With 24 species in the Belgrade region, aquatic worms (Oligochaeta) are more numerous than any other recorded benthos group (Radovic, Stevanovic, 1998).

The distribution and abundance of oligochaetes in freshwaters depend upon numerous environmental factors, most important of which is the nature of the substrate, the others being temperature, flow rate, oxygen concentration and availability of nutrients (Jakovcev et al., 1995). Several authors have stressed the phenomenon of mass development of oligochaetes in polluted waters and their significance in processes of self-purification of watercourses (Dumnicka, 1978; Jakovcev et al., 1995).

The objectives of the present work were to establish similarities and dissimilarities in composition and structure of the benthic community along the investigated part of the Danube's course in May and October of 2004, determine the spatial distribution of oligochaete species, and ascertain the frequency of their occurrence. The influence of environmental factors (abiotic and anthropogenic) on the aquatic biota is considered, with primary stress on how they affect its oligochaete component.

Material and methods

The investigations was performed during periods of high (May, 2004) and low (October, 2004) water conditions.

In order to investigate composition of the Danube's bottom fauna (especially the group Oligochaeta) in the Belgrade region, five locations were selected along a stretch of the river measuring 66 km in length:
Location 1 – the settlement of Stari Banovci, at the entrance into the Belgrade region;

Location 2 – Zemun, near the city's core;
Location 3 – the settlement of Visnjica, on the periphery of Belgrade, downstream from the mouth of the Sava river and the city dump on the right bank (at this location, water quality is also affected by effluents nearly port and ship-yard and industrial installations);
Location 4 – the settlement of Vinca, near the water intake of Vinca Waterworks;
Location 5 – the settlement of Brestovik, at the exit from the Belgrade region (Fig. 1).

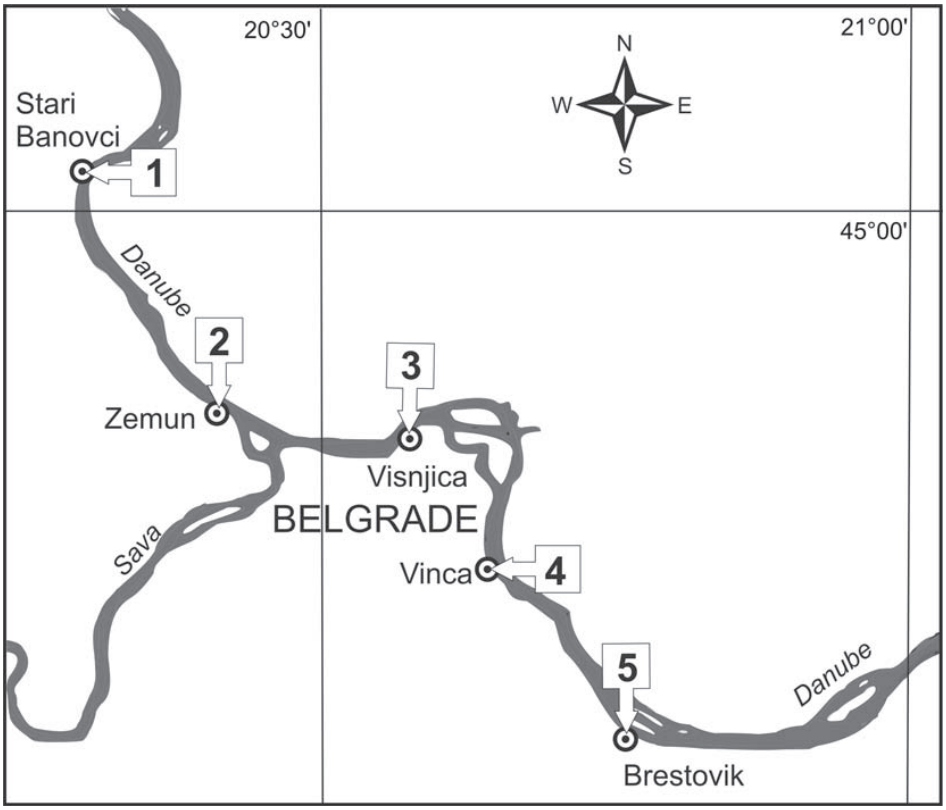

Fig. 1. Map of the Danube in the Belgrade region.

Samples were taken near the right bank of the Danube in May and October of 2004 at depths greater than 1 m, i.e. 1–4 m, when the water level was high and less than 2 m when it was low. Samples were gathered two times per year, most often one sample per site (10 in total) and sometimes one replica of each. Samples for analysis of benthic assemblages came from the riverbank mostly with different bottom facies (see Table 1).

Bottom fauna samples were taken using a Van Veen type of grab (with a grab area of 270 cm^2) at all locations except Visnjica, where a qualitative sample was taken in May. A sieve (mesh size 200 μm) was used to separate aquatic macroinvertebrates from the sediment. Samples were fixed with 4% formaldehyde. For isolation, sorting and identification of macrozoobenthic organisms, a stereomicroscope (Krüss; magnification 5–50x) and a binocular microscope (Krüss; magnification 10x10 and 10x40) were used. Identification of organisms was carried out to the species level (standing for Oligochaeta, Gastropoda, Bivalvia, Diptera – Chironomidae, Hirudinea, Amphipoda, Ephemeroptera, Odonata, Trichoptera, Polychaeta, Hydrozoa, and Decapoda) except for Nematoda, Coleoptera,

and Mysidacea, which were left at the group level. Taxonomic identification of Oligochaeta was conducted using appropriate keys (Brinkhurst, Jamieson, 1971; Timm, 1999).

The occurrence frequency of taxa (F) and Sørensen's Quotient of Similarity (QS) were calculated based on analysis of spatial distribution of the benthic species in cenoses.

The former was calculated as the representation, i.e. occurrence of a species per location [F = 0–1]:

$$F = m \cdot M^{-1},$$

where **m** is the number of locations at which the given species was found and **M** is the total number of locations.

Values of the Sørensen's Quotient of Similarity (QS) (1948) are represented in percent, indicating the similarity or dissimilarity between locations with respect to composition of the macrozoobenthic assemblages:

$$QS = 2\,c / a + b \cdot 100,$$

where **c** is the number of species held in common by two locations, **a** is the total number of species at one location, and **b** is the total number of species at the other location.

Results

The 10 samples analysed primarily came from the river bank mostly with finely granular types of substrates, all sampling sites being characterized by the presence of grey mud containing admixtures in amounts different at each location: shell remains at Stari Banovci and Zemun; clay with coarse detritus at Zemun; sand with coarse detritus at Visnjica; mud with coarse detritus at Vinca; and mud with vegetation at Vinca and Brestovik locations (Table 1).

The results of qualitative analysis of the benthic community of the Danube in Belgrade region are given in Table 2.

In the spring aspect of 2004, a total of 38 taxa from 10 faunistical groups were recorded during investigation of the Danube in the Belgrade region. The dominant group among them was Oligochaeta (16 species), accompanied by the insect group Diptera, i.e., the family Chironomidae (eight species), Gastropoda (four species), Amphipoda

T a b l e 1. Physical characteristics of the investigated locations.

Locations	Stari Banovci		Zemun		Visnjica		Vinca		Brestovik	
Month	May	October	May	October	May	October	May	October	May	October
Substrate	gray mud,shell remains	yellowish-gray mud	gray mud,shell remains, clay,coarse detritus	graymud	gray mud, sand,coarse detritus	gray mud	fine gray mud,Lemna sp., coarse detritus	gray mud	fine gray mud,detritus	gray mud, vegetation
Depth (m)	3	0.5	1	1	4	0.6	2	1.3	2	2
Distance (km)	1192		1171.5		1162		1144.5		1126	

Table 2. Qualitative composition of the macrozoobenthic assemblages of the Danube in the Belgrade region during May and October of 2004.

SPECIES	LOCATIONS									
	Stari Banovci		Zemun		Visnjica		Vinca		Brestovik	
	May	October	May	October	May	October	May	October	May	October
HYDROZOA										
Hydra sp.	+			+			+			
NEMATODA	+	+		+		+		+		+
POLYCHAETA										
Hypania invalida Grube, 1860	+					+				
OLIGOCHAETA										
Tubificidae										
Limnodrilus hoffmeisteri Claparede, 1862	+	+	+	+	+	+	+	+	+	+
L. claparedeanus Ratzel, 1868	+	+	+	+	+	+	+	+	+	+
L. udekemianus Claparede, 1862	+	+	+	+	+	+	+	+	+	+
L. profundicola Verrill, 1871	+	+	+	+	+		+		+	+
Tubifex tubifex Müller, 1774	+	+	+	+	+		+	+	+	
Potamothrix hammoniensis Michaelsen, 1901	+	+		+		+		+	+	+
Psammoryctides albicola Michaelsen, 1901	+	+	+	+	+	+	+		+	
P. barbatus Grube, 1861				+						
Isochaetides michaelseni Lastockin, 1937	+		+	+			+		+	+
Aulodrilus pluriseta Piguet, 1906	+									
Branchiura sowerbyi Beddard, 1892		+		+	+	+	+	+		+
Naididae										
Paranais frici Hrabe, 1941	+		+							
Nais communis Piguet, 1906	+									
N. elinguis Müller, 1773	+									
Ophidonais serpentina Müller, 1773	+									
Piguetiella blanci Piguet, 1906	+									
Stylaria lacustris Linnaeus, 1767										+
Dero obtusa Udekem, 1855				+						
Enchytraeidae										
Enchytraeus albidus Henle, 1837	+									
HIRUDINEA										
Erpobdella octoculata Linnaeus, 1758			+							
Piscicola geometra Linnaeus, 1761					+					+
Helobdella stagnalis Linnaeus, 1758				+						
GASTROPODA										
Lithoglyphus naticoides Pfeiffer, 1828	+		+	+						
Valvata naticina Menke, 1845	+			+						
V. piscinalis Müller, 1774				+						
V. cristata Müller, 1774				+						
Viviparus acerosus Bourguignat, 1862	+			+						
Theodoxus fluviatilis Linnaeus, 1758	+									+

Table 2. (Continued)

SPECIES	LOCATIONS									
	Stari Banovci		Zemun		Visnjica		Vinca		Brestovik	
	May	October	May	October	May	October	May	October	May	October
Acroloxus lacustris L i n n a e u s, 1758				+						
Bythinia tentaculata L i n n a e u s, 1758				+						
Physa acuta D r a p a r n a u d, 1805				+						
BIVALVIA										
Unio pictorum L i n n a e u s, 1758				+						
Dreissena polymorpha P a l l a s, 1771				+		+		+		
Anodonta cygnea L i n n a e u s, 1758								+		
A. anatina L i n n a e u s, 1758				+						
Sphaerium rivicola L a m a r c k, 1818								+		
Corbicula sp. iuv.				+		+				
AMPHIPODA										
Corophium curvispinum S a r s, 1895	+	+								
C. robustum S a r s, 1895	+									
Gammarus sp.	+	+		+	+	+		+		+
DECAPODA										
Astacus astacus L i n n a e u s, 1758					+					
MYSIDACEA			+							
ODONATA										
Platycnemis pennipes P a l l a s, 1771				+						
EPHEMEROPTERA										
Baetis sp.				+						
TRICHOPTERA										
Polycentropus flavomaculatus P i c t e t, 1834		+								
DIPTERA										
Chironomidae										
Chironomus plumosus L i n n a e u s, 1758								+		
Chironomus sp.								+		
Polypedilum convictum W a l k e r, 1856										+
P. scalaenum S c h r a n k, 1803	+									
P. nubeculosum M e i g e n, 1804					+					
P. pedestre M e i g e n, 1830							+			
Microspectra sp.	+									
Paratendipes sp.							+			
Cryptotendipes sp.					+					
Cryptochironomus sp.	+									
Cladopelma sp.					+					
Harnischia sp.										+
Dicrotendipes notatus M e i g e n, 1818				+						

Table 2. (Continued)

SPECIES	LOCATIONS									
	Stari Banovci		Zemun		Visnjica		Vinca		Brestovik	
	May	October	May	October	May	October	May	October	May	October
Einfeldia carbonaria Meigen, 1804								+		
Chironominae juv.	+						+			
Chironomidae pupae	+				+		+			
COLEOPTERA				+						
Total number of taxa per locality	28	12	11	31	13	11	11	14	8	14

(three species), and Hirudinea (two species), followed by other groups being much less diverse and frequent. It was unusual that we did not find representatives of the group Bivalvia, an important component of the bottom fauna of lowland rivers.

In the autumn aspect, a total of 13 faunistical groups and 44 taxa of macrozoobenthos were recorded. In this case, too, Oligochaeta were the dominant group, with 12 species. The indicated group was followed by Gastropoda (nine species), Bivalvia (six species), Chironomidae (six species), Hirudinea (two species), and Amphipoda (two species). Ephemeroptera, Odonata, Trichoptera, Hydrozoa, Polychaeta, Coleoptera, and Nematoda were represented each one by one taxa. Greater diversity of the insect component of the benthofauna is noticeable in this sampling period.

In the year 2004, 15 faunistical groups with 62 taxa were found in the macrozoobenthos of the Danube in Belgrade region.

The percentage representation of Oligochaeta and all other groups of bottom fauna at different locations on the Danube is given in Figs 2 and 3.

As the most significant and numerous component of the benthos of large lowland rivers, the oligochaete community was dominant in the Danube in Belgrade region during the spring and fall of 2004. Table 2 gives the results of detailed qualitative analysis of the oligochaete community.

The oligochaete fauna of the Danube in the Belgrade region was found to be characterized by the presence of 16 species belonging to 12 genera and three families (Tubificidae, Naididae, and Enchytraeidae), and 12 species belonging to eight genera and two families (Tubificidae and Naididae) during high and low water level period, respectively.

During research on the Oligochaeta community of the Danube in the Belgrade region, it was found that its composition is typical for large lowland rivers subject to organic pollution. In May, diversity of the oligochaete cenoses on the investigated sector of the Danube fluctuated from seven (Visnjica) to 15 (Stari Banovci) species. Oligochaetes were recorded at all of the investigated locations with participation in the benthofauna

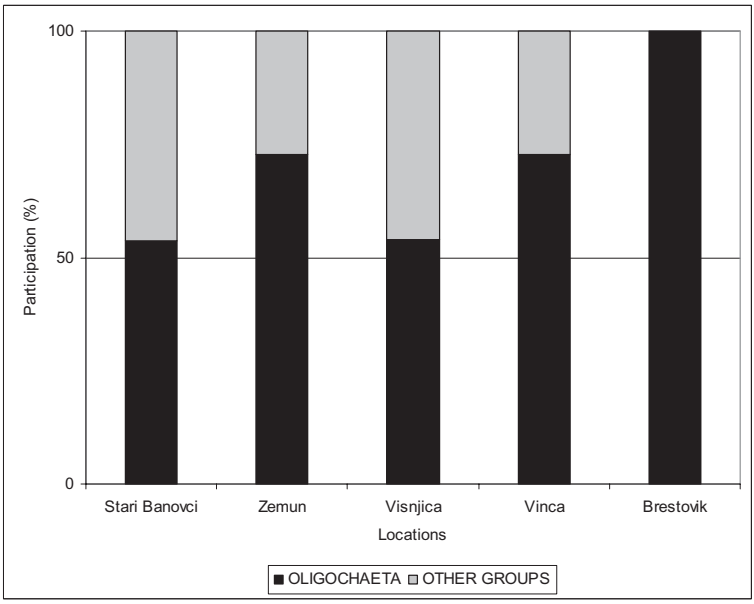

Fig. 2. Participation (%) of Oligochaeta and other groups of bottom fauna in the macrozoobenthic assemblages of the Danube in the Belgrade region during May of 2004.

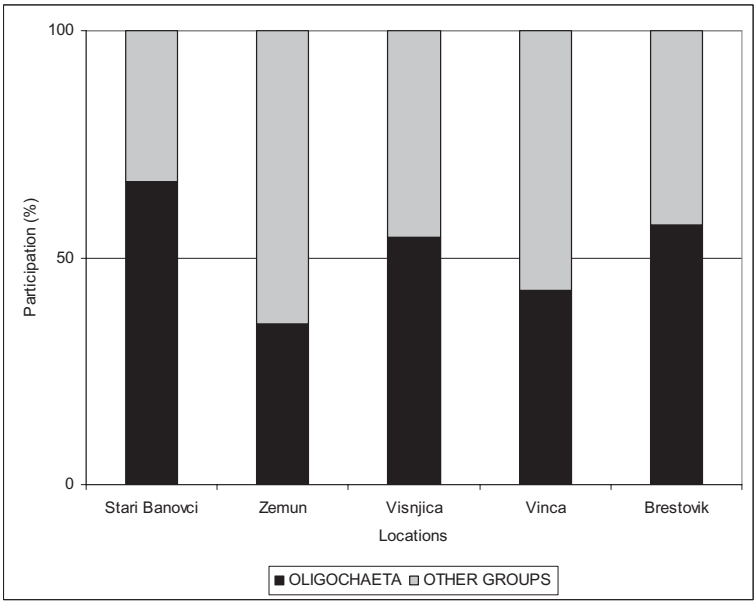

Fig. 3. Participation (%) of Oligochaeta and other groups of bottom fauna in the macrozoobenthic assemblages of the Danube in the Belgrade region during October of 2004.

ranging from 53.6% (Stari Banovci) to as much as 100% (Brestovik), where they were the only recorded benthos group. The following species from the family Tubificidae had the highest occurrence frequency at all of the investigated locations: *Limnodrilus hoffmeisteri*, *L. claparedeanus*, *L. udekemianus*, *L. profundicola*, *Tubifex tubifex*, and *Psammoryctides albicola* (F = 1); and *Isochaetides michaelseni* (F = 0.8). At Stari Banovci location, the majority of oligochaete species (9) belonged to the family Tubificidae (32.1%). Naididae were represented by five species four of them with a frequency of F = 0.2, while the species *Paranais frici* had a frequency of F = 0.4 (found also at location Zemun). Enchytraeidae were represented by only one species (F = 0.2). Representatives of these two families were present at the Stari Banovci location with participation in the bottom fauna of 17.8% and 3.6%, respectively.

In the fall of 2004, diversity of oligochaetes of the Danube in the Belgrade region ranged from six species (Visnjica, Vinca) to 11 species (Zemun). The major component at this time too was made up of members of the family Tubificidae (10 species). The participation of oligochaetes in the bottom fauna ranging from 35.5% (Zemun) to 66.7% (Stari Banovci). At all locations, the following species from the family Tubificidae were the most frequent: *Limnodrilus hoffmeisteri*, *L. claparedeanus*, *L. udekemianus*, *Branchiura sowerbyi*, and *Potamothrix hammoniensis* (F = 1). Only two representatives of the family Naididae were found at the Zemun (*Dero obtusa*) and Brestovik (*Stylaria lacustris*) locations, with the occurrence frequency of F = 0.2, both.

The Visnjica location yielded the smallest number of oligochaete species (six in October, seven in May), all of them belonging to the family Tubificidae (species of the genus Limnodrilus, which are tolerant of organic pollution). This location is characterized by the presence of intensive organic pollution originating from inadequately purified communal and industrial wastewaters.

The complex of environmental factors (abiotic and anthropogenic) is what dictates the composition, structure, and distribution of the Oligochaeta assemblages on the investigated sector of the watercourse.

The faunistical similarity of macrozoobenthic assemblages was determined according to Sørensen's Quotient of Similarity (1948) in order to compare all five investigated sampling locations of the Danube in Belgrade region. In May, the least similarity (29.3%) was found between the Stari Banovci and Visnjica locations, the greatest (73.7%) between the Zemun and Brestovik, and Vinca and Brestovik locations. In October, the least similarity (31.1%) was between the Zemun and Vinca, and Zemun and Brestovik locations, the greatest (52.2%) between the Stari Banovci and Visnjica locations. The values of the Sørensen's Quotient of Similarity (QS) at both times of the year 2004 are shown in Figs 4 and 5.

According to Sørensen's bottom fauna communities Quotient of Similarity (QS), in May, the majority of locations – 30% show a faunistical similarity between 40 and 50%. Two groups of localities (20% each) have similarity between 50 and 60%, and between 70 and 80%, respectively. A lesser number of localities show a similarity between 20 and 30%, 30 and 40%, and 60 and 70% (10% each). There are no locations with similarities less than 20% and greater than 80%. In October, the majority of locations (50%) have similarity

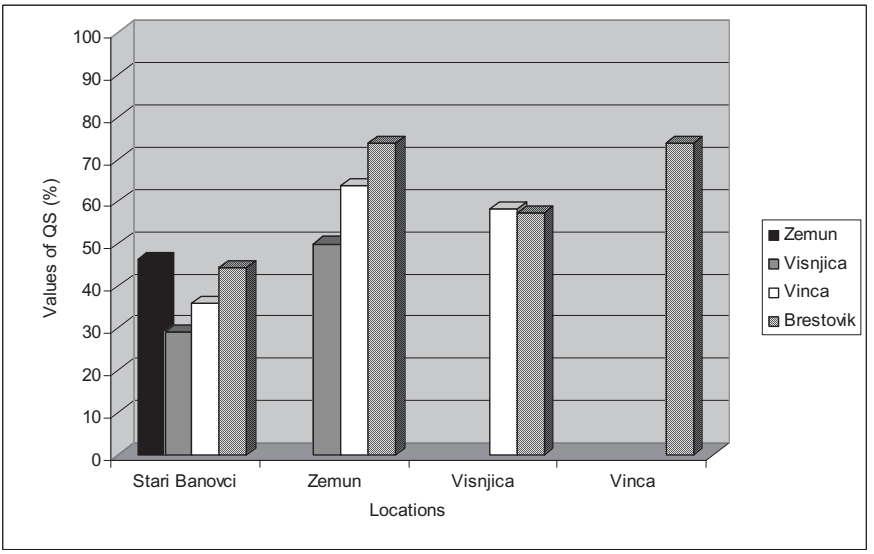

Fig. 4. Calculated values of the Sørensen's Quotient of Similarity (QS) along the investigated sector of the Danube in the Belgrade region during May of 2004.

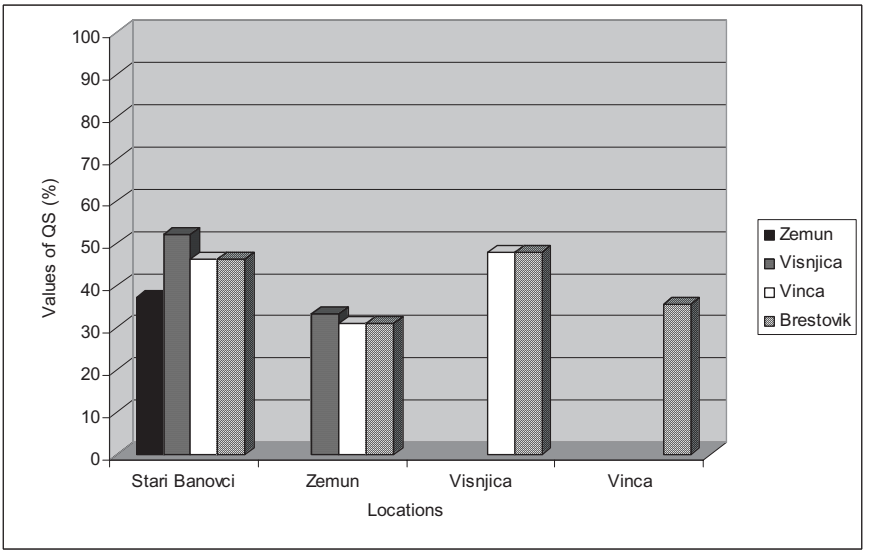

Fig. 5. Calculated values of the Sørensen's Quotient of Similarity (QS) along the investigated sector of the Danube in the Belgrade region during October of 2004.

between 30 and 40%, another 40% sites show similarity between 40 and 50%, and only 10% between 50 and 60%. There are no sampling sites with similarities less than 30% and greater than 60%.

In May, the least similarity determined according to Sørensen's Quotient of Similarity was between the Stari Banovci and all other investigated locations (29.3–46.1%) and between Visnjica and other locations (29.3–58.3%). According to the QS values, the Vinca, Brestovik and Zemun locations showed the similarity in the range from minimal 35.9–44.4–46.1% to maximal 73.7%, respectively. In October, the least similarity was between the Zemun and all other locations being in the narrow range from 31.1 to 37.2%. All other investigated locations showed somewhat greater similarity between each other, but with lower values of QS than those reported in May, in the range of 35.7–52.2%.

The majority of locations in Belgrade region in May and in October 2004, 60%, and 90%, have medium similarity values from 30 to 60% and from 30 to 50%, respectively. In May, only, the high QS values between 60–80% have 30% of investigated locations, as is the case with the little similarity between 20 and 30%, only – 10% of investigated localities. The little percentage (10%) of sampling sites show greater, but yet, medium similarity between 50 and 60%, in October.

Discussion

The macrozoobenthos community of the Danube in the Belgrade region during May and October of 2004 was made up of 15 faunistical groups: Oligochaeta, Chironomidae, Gastropoda, Bivalvia, Amphipoda, Ephemeroptera, Odonata, Trichoptera, Coleoptera, Hirudinea, Decapoda, Hydrozoa, Polychaeta, Mysidacea, and Nematoda, with 62 taxa. Bearing in mind that in present investigation of the Danube in Belgrade region some taxa: Nematoda, Coleoptera, and Mysidacea, were not identified to species level, the total number of taxa is certainly much higher. It was characterized by dominance of the oligochaete component, as was also the case in earlier years (Jakovcev, 1987, 1988; Martinovic-Vitanovic et al., 1999b, 2004, 2006), accompanied by Chironomidae, Gastropoda, Bivalvia, Amphipoda and Hirudinea, and followed by other groups being less diverse and frequent. In the Danube across Serbia, during a 16-year period (Martinovic-Vitanovic et al., 2006), a rich invertebrate community with 136 potamobenthos taxa from 22 groups was established. Oligochaeta was dominating group accompanied by Gastropoda, Bivalvia, and Hirudinea, other groups being less frequent and diverse.

The spring aspect of the communities was characterized by absence of the group Bivalvia, whereas in the fall this group was present with a relatively small percentage of the bottom fauna. It was unusual that we did not find representatives of the group Bivalvia, an important component of the bottom fauna of lowland rivers. This is atypical for potamobenthos of the Danube in the Belgrade region (Martinovic-Vitanovic et al., 2004) and was caused by factors of an unknown nature. In addition, remains of Mollusca shells were found in the substrate at the Stari Banovci and Zemun locations. These remains came not only from organisms

that lived at the given locations, but also from ones carried there by the river's current. In October of 2004, we recorded a greater number of insect groups (Ephemeroptera, Odonata, Trichoptera, Coleoptera and Diptera – Chironomidae) in the benthofauna of the investigated sector of the Danube. The other macrozoobenthic groups were common to both aspects.

Aquatic oligochaetes are one of the main groups in lowland rivers. According to Jakovcev et al. (1995), the total number of oligochaete species of inland waters in Serbia (Yugoslavia) is 77, while Uzunov (1988) reported 82 species of oligochaetes in the Danube. Moog (1995) listed 107 species of freshwater oligochaetes occurring in Austria, of these 61 species were also found in the Austrian stretch of the River Danube and its backwaters (Moog et al., 2000). Fesl and Humpesch (2003) report 35 oligochaete species found, which accounts for more than half of the species known to occur in the Austrian Danube, including 25 species that were recorded in the region downstream of Vienna for the first time.

Qualitative composition of the oligochaete assemblages on the given sector of the Danube in May of 2004 was richer than in October in regard to the number of species – 16 and 12, genera – 12 and eight and families – three and two, respectively.

The family Tubificidae is distributed everywhere in the world, but it originated in the Northern Hemisphere ((Brinkhurst, Jamieson, 1971). Members of this family are adapted for entrenchment in a soft substrate. They live in muddy substrates, tolerate organic pollution, and are indicators of an alpha-mesosaprobic or polysaprobic zone. Concerning qualitative composition, the given worms are found in zoobenthos samples more often than are other representatives of Oligochaeta (Timm, 1987). Tubificidae are dominant at depths exceeding 1 m. The densest and most frequently occurred populations of their representatives are found in rivers polluted by communal sewage.

Distribution of the species *Isochaetides michaelseni* is linked with the Danube river. Together with *Tubifex tubifex*, the species *Limnodrilus hoffmeisteri* builds dense assemblages in the Danube's water. These two species are the leading forms in meso- and polysasaprobic mud in all larger streams (Schwank, 1982). *Limnodrilus claparedeanus* frequently occurred together with *L. hoffmeisteri* and being typical representative in high-polluted waters (Uzunov et al., 1988; Uzunov, 1983; Moog, 1995) therefore indicate alfa-mesosaprobic conditions (indicator value 2.9). *Limnodrilus udekemianus* is present with small populations in as well oligosaprobic as polluted waters (Timm, 1987). *Branchiura sowerbyi* withstands elevated water temperatures i.e. thermal pollution. The Balkan Peninsula is the centre of distribution of the genus Psammoryctides (Dumnicka, 1978). The presence of *Psammoryctides albicola* is characteristic of large lowland rivers, while *P. barbatus* is an inhabitant of rivers with muddy and sandy substrates.

Naididae live on erosive substrates of rocks and gravel. The main factors determining their distribution and abundance are the nature of the substrate and the presence and type of vegetation. Representatives of this family favour dense and luxuriant vegetation, maximal development of the periphyton offering shelter for their most abundant populations. Their occurrence is characteristic of oligo- to beta-mesosaprobic zones. Hrabe (1941) described *Paranais frici* from material collected in 1934 from Čilistov side arm of Czechoslovak section of Danube. This is the first finding of *Paranais frici*, and according to Brinkhurst

and Jamieson (1971), its presence is characteristic of the Danube. *Stylaria lacustris* is the leading form to a depth of 1 m in zones overgrown with vegetation in organically polluted rivers. The greatest abundance of its populations is achieved during the period from May to November. The response of species of the family Naididae (*Nais elinguis*, *N. communis*) to different types of pollution of the watercourse varies, but it has been established that organic pollution of rivers with a hard erosive substrate dictates significant increase in the abundance of representatives of this family (Learner et al., 1978).

The only species of the family Enchytraeidae was the species *Enchytraeus albidus*.

As the leading component of the benthos of polluted large lowland rivers, Oligochaeta are of considerable significance for their self-purification and improvement of water quality (Dumnicka, 1978). Oligochaete species that are tolerant of organic pollution of the watercourse – *Tubifex tubifex*, *Limnodrilus claparedeanus*, *L. hoffmeisteri,* and *Nais communis* – develop dense populations (Schwank, 1982). The high occurrence frequency and dominance of species from the family Tubificidae (and their high abundance too) found in our investigations indicates the presence of great amounts of biodegradable organic substances (Timm, 1987; Finogenova, 1996; Martinovic-Vitanovic et al., 1999a, b) in water of the Danube in the Belgrade region during May and October of 2004.

The Danube in the Belgrade region is exposed to constant pollution of mainly organic origin because Belgrade is one of the rare cities in Europe in which urban communal wastewaters are not adequately treated (Martinovic-Vitanovic et al., 1999a). For this reason, the given sector of the Danube is an increasingly less natural ecosystem that represents an ideal habitat for development of an abundant oligochaete community (Finogenova, 1996).

Tubificidae that prefer a muddy substrate and tolerate a high organic load are characteristic of α-mesosaprobic and even polysaprobic water (Uzunov, 1979; Uzunov et al., 1988). With participation in the oligochaete assemblages from 60% to 100%, members of this family were dominant at all of the investigated locations in both May and October. At the Brestovik location in May, this was the only recorded group of the potamobenthos, with eight identified species. With the total number of species (11) and their participation of 57.9% in oligochaete assemblages in May and October of 2004 (total number of species 19) Tubificidae are the dominant oligochaete family. In spring as compared with fall, the family Naididae was more diverse and constituted a greater percentage of the oligochaete fauna, its participation then comprising values of 33.3% (Stari Banovci) and 12.5% (Zemun), whereas the family's participation was less than 10% at the Zemun location (9.1%) and 12.5% at the Brestovik location in the fall.

The complex of environmental factors (abiotic and anthropogenic) is what dictates the composition, structure, and distribution of the Oligochaeta and other benthic groups, assemblages on the investigated sector of the watercourse.

The results of investigations of the potamobenthos with the special emphasis on Oligochaeta in the Danube on the sector of the river in Belgrade region during 2004 show that the composition and the structure of benthic assemblages depends on abiotic factors such as flow rate (i.e. streambed stability as a function of hydrological conditions) and sediment

composition. Both abundance and species richness of an oligochaete assemblage may be affected by habitat stability that is lower under less stable conditions. Sediment composition, and homogeneity of the habitat are the major structuring forces of the oligochaete, and other benthic groups, communities regarding species richness (Fesl, Humpesch, 2003; Martinovic-Vitanovic et al., 2006), so is a substrate type (Dumnicka, 1978; Sporka 1998). Fesl (2002) and Fesl and Humpesch (2003) report that beside habitat stability heterogeneity of the substrate had a strong effect on benthic community structure in Danube. In the present study the substrate/habitat which is of mixed type exerts noticeable influence on composition and distribution of the bottom fauna and Oligochaeta assemblages in Belgrade region affecting species richness, as confirmed by results from 16 years of investigations (Martinovic-Vitanovic et al., 2006).

The faunistical similarity of macrozoobenthic assemblages at all investigated locations of the Danube in Belgrade region during 2004 was in the range of medium and high QS values, and in broader zone from 29.3 to 73.7% recorded in May, while in October QS values were lower and grouped in narrower range from 31.1 to 52.2%.

The majority of locations in Belgrade region in May and in October 2004, 60%, and 100%, respectively, have medium similarity from 30 to 60%. In May, only, the greatest similarity between 60–80% have 30% of investigated locations, as is the case with the least similarity between 20 and 30%, only 10% of investigated localities.

The distribution and diversity of potamobenthos communities in Danube River in Belgrade region is mostly affected, apart from influence of the substrate – presence of different habitat types, by the permanent presence of biodegradable organic pollution received from tributaries (Tisa, and Sava) and/or with poorly treated industrial or communal wastewaters. Thus, besides the changes in characteristics of the Danube in investigated transitional zone (part between riverine and lacustrine sections), as a result of damming the river (Chapman, 1997), according to Martinovic-Vitanovic and Kalafatic (2002), Jakovcev (1988) and Martinovic-Vitanovic et al. (1999b, 2004, 2006), the saprobic status of the Danube in Belgrade region as judged from the benthic fauna saprobial analysis in present study being in the α-mesosaprobic zone corresponds to α-meso- and polysaprobic conditions reported for the same sector of the Danube in the studies of whole course of the Danube in Serbia during 2001, and a 16-year period from 1987 to 2003 (Martinovic-Vitanovic, Kalafatic, 2002; Martinovic-Vitanovic et al., 2006).

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