

## QUALITATIVE COMPOSITION OF COMMUNITIES OF AQUATIC MACROINVERTEBRATES ALONG THE COURSE OF THE GOLIJSKA MORAVICA RIVER (WEST-CENTRAL SERBIA)

VESNA DJIKANOVIĆ<sup>1</sup>, DUNJA JAKOVČEV-TODOROVIĆ<sup>1</sup>, VERA NIKOLIĆ<sup>2</sup>,  
M. PAUNOVIĆ<sup>1</sup> and P. CAKIĆ<sup>1</sup>

<sup>1</sup>*Siniša Stanković Institute for Biological Research, 11060 Belgrade, Serbia*

<sup>2</sup>*Institute of Zoology, Faculty of Biology University of Belgrade, 11000 Belgrade, Serbia*

**Abstract** — As the largest and most significant river of the Moravica region, the Golijska Moravica River arises below the highest peaks of the Golija Mountains. Faunistic-ecological research on aquatic macroinvertebrates was carried out during 2003 and 2004. Macrozoobenthos communities of the Golijska Moravica had not previously been the subject of any hydrobiological studies, and this was the main reason why we conducted their systematic and complex investigation. A list of taxa of aquatic macroinvertebrates is presented and their qualitative composition analyzed. During the period of investigation, a total of 13 groups and 147 taxa were found.

**Key words:** Macroinvertebrates, community composition, Golijska Moravica, Western Morava River basin, Western Serbia

UDC 592(497.11-15)(497.11-191.2):574.5

### INTRODUCTION

The composition of macrozoobenthos communities of the Golijska Moravica River during the years 2003 and 2004 is analyzed in the present faunistic-ecological study. A total of 73 samples of the bottom fauna were taken along the entire length of the watercourse.

Complex investigation of macrozoobenthos in river ecosystems of Serbia from the faunistic and ecological aspects has been conducted before by Baračkov (1973), Đukić (1975), Đukić et al. (1986, 1992, 1997), Đurković et al. (1998), Filipović (1954, 1957, 1965, 1966, 1969, 1976), Jakovčev (1983, 1986, 1989), Janković (1976, 1981, 1983a, 1983b, 1987, 1998), Jovanović (1998), Karaman (1964, 1995, 1998), Konta (1997), Marinković-Gospodnetić (1975), Marković (1995, 1998a, 1998b), Marković et al. (1997a,b, 1998, 1999), Marković and Janković (1986, 1989), Marković and Miljanović (1995), Martinović-Vitanović et al. (1995, 1998a, 1998b), Miljanović (2001), Mitrović-Tutundžić (1973), Obušković et al. (1994),

Paunović et al. (1998, 2003, 2006), Simić (1993, 1996, 1998), Simić et al. (1993, 1994, 1997), Stanković et al. (1995), and Živić et al. (2000, 2001, 2005).

The Moravica region has pronounced highland characteristics with distinctly broken relief. Owing to a predominance of silicate rocks in the geological substrate, there are numerous springs of varying strength on the region's surface. The region is rich in rivers, rivulets, and mountain brooks (Gajić, 1989). Located in Western Serbia, it occupies an area of 3,116 km<sup>2</sup>, i.e., 3.41% of the area of Serbia (Kovačević et al., 1997).

The largest river of this region is the Moravica or Golijska Moravica, which arises below a "ridge" of massifs where the Golija and Javor Mountains meet at the place called "Kozja Stena". The river is 98 km long and has a drainage area of 1 486 km<sup>2</sup>. Density of the river's network within its watershed is high and comprises a value of 1 252 m/km<sup>2</sup>. The Moravica flows to the north and receives a considerable number of tributaries. The best-known right-hand tributaries are the rivers Pakašnica, Nošnica,

Grabovica, and Ličanska Reka. The most significant left-hand tributaries are the rivers Budoželjska Reka, Lučka Reka, Veliki Rzav (Big Rzav), and Mali Rzav (Little Rzav).

Brook trout (*Salmo trutta* L.) occurs throughout the entire length of streams belonging to the Moravica's watershed, i.e., it represents a clean salmonid region (Report OI Ivanjica, 2005).

The Golijska Moravica is a right-hand tributary of the Western Morava. The confluence of the Moravica and Đetinja Rivers gives rise to the Western Morava, whose total length is 211 km (Gavrilović and Đukić, 2002).

The main purpose of the present work was to establish the qualitative composition of macrozoobenthos communities of the Golijska Moravica River and thereby make a significant contribution to our knowledge of the biodiversity of Serbia and neighboring regions.

#### MATERIAL AND METHODS

The material for analysis was collected during 2003 and 2004. The entire length of the Golijska Moravica was investigated at a total of eight localities, from the source region to the lower part of the watercourse (Fig. 1). Material was collected every 20-25 days from November to the end of May.

The following parameters were determined on site: geographic coordinates, elevation above sea level, river width, average depth, throughput, and substrate type. Data on geographic coordinates and elevation above sea level were assembled with a GPS hand station of the Garmin eTrex type in the WGS 1984 system (with a measuring error of 6-10 m, 8 m on the average). River width was determined by means of visual estimation or by extending a graduated string from one bank to the other at places where it was possible to do so. Depth was determined with a weighted graduated string or using data obtained from OI Ivanjica. The flow rate was determined by measuring the speed of movement of a leaf or small ball downstream over a known (i.e., measured) distance.

#### Sampling localities

I. Vučačka Reka. Together with numerous neighboring brooks on the slopes of the Golijska Mountains, the stream Vučačka Reka forms the Golijska Moravica River. Measuring 4 km in length, Vučačka Reka has a channel width that varies from 2 to 4 m and depth of up to 90 cm. This torrential stream has a throughput of 1.2 m<sup>3</sup>/sec, elevation of 952 m a.s.l., and geographic coordinates of 43E 19' 88.3" N and 20E 11' 33.4" E.

II. Golijska Reka. The stream Golijska Reka is a right-hand tributary of the Golijska Moravica. It is a watercourse of the torrential type with a length of 10 km, channel width of 4-7 m, and depth of 10-22 cm. The throughput of this stream is 0.94 m<sup>3</sup>/sec. Elevation of the stream is 666 m a.s.l., while its geographic coordinates are 43E 27' 36.8" N and 20E 13' 21.3" E.

III. Pakašnica. This stream is a right-hand tributary of the Moravica. A torrential watercourse with a length of 5 km, it has a channel width of 4-6 m, depth of up to 25 cm, and throughput of 0.98 m<sup>3</sup>/sec. The stream is at an elevation of 646 m a.s.l. and has geographic coordinates of 43E 28' 15.2" N and 20E 14' 0.90" E.

IV. A locality just below the place where the Pakašnica empties into the Moravica. Width of this part of the river's channel varies in the range of 5-7 m, its depth in the range of 15-30 cm. The river at this point has a throughput of 1.23 m<sup>3</sup>/sec. The given locality is at an elevation of 638 m a.s.l. and has geographic coordinates of 43E 28' 28.5" N and 20E 14' 46.2" E.

V. The Rimski Most locality on the Moravica. The channel on this part of the watercourse is 6-7 m wide and has a depth ranging from 15 to 32 cm. The stream here has a throughput of 1.3 m<sup>3</sup>/sec. Lying at an elevation of 629 m a.s.l., this locality has geographic coordinates of 43E 28' 13.3" N and 20E 14' 08.2" E.

VI. The Međurečje locality on the Moravica. The river's channel here has a width ranging from 6.5 to 9 m and depth that varies from 15 to a maximum



**Fig. 1.** Localities where sampling of the bottom fauna was conducted in the Golijška Moravica River (map scale of 1:100,000 C OziExplorer 3.93.3b).

value of 140 cm. The Moravica's throughput at this locality is 0.93 m<sup>3</sup>/sec. At an elevation of 556 m a.s.l., the locality's geographic coordinates are 43E 31' 16.2" N and 20E 13' 28.9" E.

VII. Pećine, a settlement on the Moravica between the Medjurečje locality and the town of Ivanjica. The channel is 13 to 26 m wide here, and depth varies from 15 to 95 cm. The river's throughput is 0.95 m<sup>3</sup>/sec. Lying at an elevation of 512 m, Pećine has geographic coordinates of 43E 32' 38.2" N and 20E 15' 19.0" E.

VIII. Senjak, a place on the Moravica between the towns of Ivanjica and Arilje. Width of the channel here ranges from 7.5 to 18 m. The river's depth varies from 35 to 40 cm, while its throughput is 2.83 m<sup>3</sup>/sec. This locality lies at an elevation of 442 m a.s.l. and has geographic coordinates of 43E 36' 20.2" N and 20E 12' 15.5" E. Biological material, i.e., samples of the bottom fauna, was collected using standard sampling procedure. A total of 73 samples were collected. A hand-held benthos net with mesh size of 500 µm was used to collect qualitative samples. Sampling with the aid of this net was carried out by a combined procedure involving stirring the bottom up by foot and collecting the disturbed material with the net (the "kick and sweep" technique). Macrozoobenthic organisms were also collected individually by hand and rinsed to get rid of particles of various solid substrates. To ensure habitat heterogeneity or multihabitat sampling, samples were taken from different substrate types, then combined in a single composite sample. Immediately after sampling, the biological material was immersed in 4% formalin on site for preservation.

Further processing of the collected and conserved material was carried out in the Laboratory of Hydrobiology, Department of Hydroecology and Water Protection, Siniša Stanković Institute for Biological Research, Belgrade. Analysis of representatives of the bottom fauna was performed with the aid of binoculars from Carl Zeiss with magnification of 0.63-6.3x and an Olympus 235536 binocular microscope with ocular magnification of 10x and objective magnification of 10, 40, and 100x. The collected macrozoobenthic organisms were identified

**Table 1.** List of taxa of aquatic macroinvertebrates of the Golijska Moravica River.

SAMPLING LOCALITIES / TAXA	I	II	III	IV	V	VI	VII	VIII
<b>NEMATODA</b>							+	
<b>TURBELLARIA</b>								
<i>Dugesia lugubris</i> Schmidt, 1861			+				+	
<b>OLIGOCHAETA</b>								
<i>Nais bretscheri</i> Michaelsen, 1899			+			+	+	+
<i>N. variabilis</i> Piguët, 1906			+					+
<i>N. elinguis</i> Müller, 1773			+				+	+
<i>N. pseudobtusa</i> Piguët, 1906			+				+	+
<i>N. communis</i> Piguët, 1906			+				+	+
<i>N. barbata</i> Müller, 1773			+				+	+
<i>Nais</i> sp.								
<i>Paranais frici</i> Hrabe, 1941			+				+	+
<i>Uncinaiis uncinata</i> Ørsted, 1842			+					+
<i>Ophidonais serpentina</i> Müller, 1773							+	+
<i>Dero digitata</i> Müller, 1773							+	
<i>Aulodrilus limnobius</i> Bretscher, 1899			+					
<i>Spirosperma ferox</i> Eisen, 1879			+				+	+
<i>Spirosperma velutinus</i> Grube, 1879			+		+			+
<i>Branchiura sowerbyi</i> Beddard, 1892					+		+	+
<i>Limnodrilus hoffmeisteri</i> Claparede, 1862							+	+
<i>L. claparedeanus</i> Ratze, 1868			+				+	+
<i>L. udekemianus</i> Claparede, 1862				+				+
<i>L. profundicola</i> Verrill, 1871			+		+		+	
<i>Tubifex tubifex</i> Müller, 1774		+				+	+	+
<i>Potamotheix hammoniensis</i> Michaelsen, 1902					+			+
<i>Psammoryctides albicola</i> Michaelsen, 1901			+		+	+		+
<i>Isochaetides michaelseni</i> Lastockin, 1937		+	+				+	
<i>Criodrilus lacuum</i> Hoffmeister, 1845			+			+	+	+
<i>Enchytraeus albidus</i> Henle, 1837								+
<i>Propappus volki</i> Michaelsen, 1915		+	+		+	+	+	
<i>Eiseniella tetraedra</i> Savigny, 1826			+					+
<i>Lumbriculus variegatus</i> Müller, 1774			+		+		+	+
<i>Rhynchelmis limosella</i> Hoffmeister, 1843			+					
<i>Stylodrilus parvus</i> Claparede, 1862			+					
<i>S. heringianus</i> Claparede, 1862			+					+
<i>Stylodrilus</i> sp.								+
<i>Tatriella slovenica</i> Hrabe, 1936			+					
<b>HIRUDINEA</b>								
<i>Erpobdella octoculata</i> Linnaeus, 1758								
<i>Erpobdella testacea</i> Savigny, 1922								+
<i>Haemopsis sanguisuga</i> Linnaeus, 1758							+	+
<i>Glossiphonia complanata</i> Linnaeus, 1758								+
<b>GASTROPODA</b>								
<i>Ancylus fluviatilis</i> Müller, 1774							+	+
<b>AMPHIPODA</b>								
Gammaridae			+	+			+	
<b>ODONATA</b>								
<i>Gomphus vulgatissimus</i> L., 1758			+					+
<b>PLECOPTERA</b>								
<i>Dinocras cephalotes</i> Curtis, 1827	+	+	+				+	
<i>Perla bipunctata</i> Pictet, 1833	+	+	+	+				+
<i>Protonemura meyeri</i> Pictet, 1841			+				+	+
<i>Nemoura cinerea</i> Retzius, 1783	+		+				+	
<i>N. erratica</i> Claassen, 1936		+	+		+			
<i>Nemoura</i> sp.		+	+				+	
Nemouridae			+					
<i>Leuctra fusca</i> Linnaeus, 1758	+	+	+	+	+	+	+	+
<i>L. inermis</i> Kempney, 1899			+					
<i>Leuctra</i> sp.						+		
<i>Capnia vidua</i> Klapálek, 1904			+				+	+



Table 1. Ctd.

<i>Ryacophila</i> sp.		+	+					
<b>DIPTERA</b>								
<i>Antocha</i> sp.			+	+			+	+
<i>Tipula</i> sp.			+			+	+	
Tipulidae			+				+	
<i>Ibisia marginata</i> Fabricius, 1781		+	+		+	+	+	+
<i>Helius longirostris</i> Meigen, 1818								
<i>Rhypho. hemorrhoidalis</i> Ze., 1838			+					
<i>Rhypholophus</i> sp.								+
<i>Gnomphomyia</i> sp.							+	+
Limoniidae								
<i>Dicranota robusta</i> Lundström, 1912			+					
<i>Dicranota</i> sp.			+				+	+
<i>Pedicia</i> sp.								+
<i>Psychoda</i> sp.								+
<i>Melanogaster</i> sp.			+					
Chironomidae	+	+	+	+		+	+	+
Ceratopogonidae								+
Simuliidae								+
Stratiomyidae								+
Blephariceridae			+				+	
<b>HETEROPTERA</b>								
<i>Mesovelia</i> sp.			+					
Aphelocheiridae			+					
Velidae								+
Hebridae			+					
<b>COLEOPTERA</b>								
<i>Elmis aenea</i> Müller, 1806			+		+		+	
<i>Elmis</i> sp.							+	
<i>Esolus angustatus</i> Müller, 1821			+				+	
<i>Limnius volckmari</i> Panzer, 1793		+	+	+	+		+	
<i>Limnius</i> sp.							+	
<i>Riolus cupreus</i> Müller, 1806		+	+	+	+	+	+	+
<i>Stenelmis canaliculata</i> Gyll., 1808							+	
<i>Stenelmis</i> sp.							+	
<i>Platambus maculatus</i> Linnaeus, 1758								+
<i>Gyrinus aeratus</i> Stephens, 1835							+	
Halipidae			+				+	
<b>Σ</b>	<b>14</b>	<b>33</b>	<b>94</b>	<b>25</b>	<b>25</b>	<b>18</b>	<b>84</b>	<b>65</b>

to the lowest taxonomic level using appropriate keys for determination (Belfiore, 1983; Brinkhurst, 1971; Croft, 1986; Edington and Hildrew, 1995; Fres, 1997; Hynes, 1977; Ikononov, 1959; Illies, 1978; Kerovec, 1986; Lozek, 1956; Macan, 1970; Müller-Liebenen, 1969; Nilsson, 1997a, 1997b; Pflieger, 1990; Savage, 1989; Timm, 1999; Wallace et al., 1990) in the aforementioned laboratory, where the material is stored.

## RESULTS

Seventy-three samples of the bottom fauna were taken from different types of substrate in the course

of investigating aquatic macroinvertebrates of the Moravica River during 2003 and 2004. A total of 13 groups and 147 taxa (132 determined to the species level, 15 to the family level) were found. They are presented in Table 1.

The following groups were best represented in composition of the community of macroinvertebrates: Ephemeroptera, Trichoptera, Oligochaeta, Plecoptera, Chironomidae, Diptera, and Coleoptera. The other identified groups (Nematoda, Turbellaria, Hirudinea, Gastropoda, Amphipoda, Odonata, and Heteroptera) were found in a small number of samples.

The number of taxa at individual localities ranged from 17 (at locality 1) to 94 (at locality 3) taxa.

Within the insect component (represented by a total of 107 taxa), the greatest species diversity and richness were recorded for the groups Trichoptera (29 taxa/28 species) and Ephemeroptera (27 species). They were followed by the groups Plecoptera (15 taxa/14 species), Diptera (19 taxa/12 species), and Coleoptera (11 taxa/10 species). The other identified groups (Nematoda, Turbellaria, Hirudinea, Gastropoda, Amphipoda, Odonata, and Heteroptera) were represented by a small number of taxa (Table 1).

In regard to dominance, the species *Leuctra fusca* (Plecoptera), *Rhitrogena semicolorata*, and *Baetis vernus* (Ephemeroptera) *Ibisia marginata* and *Riolus cupreus* (Coleoptera) were constant in the bottom fauna of the Golijska Moravica throughout the two-year period of investigation.

At all the described localities, the insect component was best represented and characterized by the greatest diversity of groups. Increased representation and diversity of members of the groups Oligochaeta and Diptera (especially the family Chironomidae) was recorded at the downstream localities 7 and 8. There the river's current slows down, the channel widens, sedimentation is greater, and soft types of substrate (silt and sand) are present to a greater extent, all of which together contribute to alteration of the qualitative composition of macrozoobenthos communities in favor of Oligochaeta and Chironomidae.

## DISCUSSION

A total of 147 taxa from 13 groups were found during two-year investigation of the Golijska Moravica River.

With respect to the nature of its current and physico-chemical characteristics, the Golijska Moravica belongs to the category of distinctly ritronic watercourses.

Throughput values vary from 0.93 to 2.83 m<sup>3</sup>/

sec, which puts the investigated watercourse in the group of fast streams and corresponds to the range (0.6-3.5 m<sup>3</sup>/sec) given by Wetzel (1975) as the framework within which rheophilic organisms of the bottom fauna can remain firmly fixed to the substrate.

Dominant in the composition of macrozoobenthos communities of the investigated watercourse were larvae of the insect groups Ephemeroptera, Trichoptera, Plecoptera, Chironomidae, Diptera, Coleoptera, and Heteroptera. Such a nature of macrozoobenthos communities was dictated by the varied composition and structure of the bottom substrate, as well as by suitable features of the terrain and characteristics of the river's current. In comparison with Serbian highland streams whose macrozoobenthos communities have been analyzed to date (Baračkov, 1973; Konta, 1997; Marković, 1995, 1998a, 1998b; Marković et al., 1997, 1998; Marković and Miljanović, 1995; Obušković et al., 1994; Paunović et al., 1998; Simić, 1993; Simić et al., 1994, 1997, 2003, 2006; Živić et al., 2005), the Moravica River does not differ significantly, i.e., larvae of insect groups are dominant in it.

The animal population of the investigated highland stream is diverse and rich. The bottom fauna is characterized by special life forms that are adapted to conditions of fast water: a flattened body shape, as in *Ecdyonurus* sp. and *Epeorus* sp. (Ephemeroptera), *Dugesia* sp. (Turbellaria), *Perla* sp. (Plecoptera), *Elmis* sp. (Coleoptera), and *Ancylus* sp. (Gastropoda); and close adherence to the substrate, as in *Sericostoma* sp., *Glossossoma* sp., *Goera* sp., and *Lepidostoma* sp. (Trichoptera) and members of the family Chironomidae.

Structure of the bottom fauna is highly varied. Occurring most frequently are macrozoobenthos communities of the lithorheophilic type (Ephemeroptera, Trichoptera, Plecoptera, Coleoptera, Amphipoda, Gastropoda, and Turbellaria), followed by ones of the psammorheophilic (Nematoda, Chironomidae, certain representatives of Ephemeroptera and Plecoptera, and *Spirosperma* of the group Oligochaeta) and psam-

mopelorheophilic (Oligochaeta, Chironomidae, and certain representatives of Trichoptera) types.

The insect groups found at downstream localities, e.g., Ephemeroptera, Trichoptera, Diptera, and Coleoptera, together with the groups Oligochaeta and Chironimidae, characterize the macrozoobenthos communities collected on the Moravica River at the beginning of November of the year 2003. Certain representatives of the groups Ephemeroptera, Oligochaeta, and Chironomidae were represented at the end of November of the same year. Bottom fauna samples collected in the middle of December of 2003 along the course of the Moravica River were characterized by the presence of the species *Baetis vernus* and *Rhitrogena semicolorata* (Ephemeroptera), in addition to the species *Psammoryctides albicola* of the group Oligochaeta and representatives of Chironomidae.

The best represented forms in bottom fauna samples collected during the winter of 2004 were the species *Rhitrogena semicolorata*, *Baetis vernus*, and *Ephemera danica* from the group Ephemeroptera, followed by *Brachyptera risi* from the group Plecoptera; *Psammoryctides albicola*, *Limnodrilus hoffmeisteri*, and *Nais elinguis* from the group Oligochaeta; *Lepidostoma* sp. (Trichoptera); and representatives of Chironomidae. Along the entire course of the Moravica, bottom samples collected in the spring were characterized by dominance of representatives of the groups Plecoptera (*Protonemura meyeri*), Ephemeroptera (*Rhitrogena semicolorata*, *Ephemera danica*, and *E. vulgata*), Trichoptera (*Sericostoma* sp.), Coleoptera (*Riolus cupreus*), Oligochaeta (*Propappus volki*, *Lumbriculus variegatus*, *Nais elinguis*, *Limnodrilus hoffmeisteri*, and *L. claparedeanus*), and Chironomidae.

The ecological characteristics and living requirements of representatives of the bottom fauna groups collected along the watercourse dictate a pattern of constant seasonal dynamics. Numerous bottom fauna groups were present during both the autumn-winter and spring periods, i.e., throughout the entire period of investigation of the Moravica River, and the insect component played a significant part in formation of characteristic macrozoobenthos com-

munities of the given river as a highland stream.

Along the entire course of the river, the species with the best spatial representation in macrozoobenthos communities were *Baetis vernus*, *Rhitrogena semicolorata*, *Paraleptophlebia submarginata*, and *Ecdyonurus venosus* (Ephemeroptera); *Glossossoma* sp., *Goerra pilosa*, *Lepidostoma* sp., and *Sericostoma* sp. (Trichoptera); *Leuctra fusca*, *Dinocras cephalotes*, *Perla bipunctata*, and *Capnia vidua* (Plecoptera); *Ibisia marginata* and *Antocha* sp. (Diptera); *Limnius volckmari* and *Riolus cupreus* (Coleoptera); and *Propappus volki*, *Lumbriculus variegatus*, and *Psammoryctides albicola* (Oligochaeta).

In the course of the conducted investigation, we identified both macrozoobenthos representatives that were here found for the first time in the waters of our country, i.e., species new to the fauna of Serbia (*Tatriella slovenica* Hrabě, 1936; and *Baetis alpinus* Pictet, 1843); and ones that according to Illies (1978) have to date been rarely found in this part of the Balkan Peninsula (*Acylus fluviatilis* Müller, 1774; and *Dinocras cephalotes* Curtis, 1827).

In addition to this, the presence of forms that according to Timm (1980) are Ponto-Caspian species (*Paranais frici* and *Isochaetides michaelsoni*) and penetration of the invasive species *Branchiura sowerbyi* (Pauković et al., 2005) were also registered in the present investigation.

\*

Hydrobiological investigation of the Moravica River, especially its bottom fauna, has contributed significantly to our knowledge of the biodiversity of Serbia.

*Acknowledgment* — The present work was carried out within the framework of activities of a project funded by the Ministry of Science of the Republic of Serbia (Project No. 143023).

## REFERENCES

- Baračkov, Z. (1973). *Ekološka proučavanja naselja dna Grošničke reke*. Prirodno-matematički fakultet u Kragujevcu, Master's Thesis, 100 pp.
- Belfiore, C. (1983). *Ephemeropteri (Ephemeroptera)*. Guida per il Riconoscimento Delle Specie Animali Delle Acque



- Interne Italiane. Consiglio Nazionale Delle Ricerche AQ/1/201. 112 pp.
- Brinkhurst, R. O. (1971). *A Guide for the Identification of British Aquatic Oligochaeta*. Freshwater Biological Association Scientific Publication No. 22, Second Edition. 55 pp.
- Croft, P. S. (1986). *A Key to the Major Groups of British Freshwater Invertebrates*. Field Studies **6**, 531-579.
- Đukić, N. (1975). Oligochaeta nekih stajaćih voda Vojvodine. *Zbornik za Prirodne Nauke Matice Srpske*, **48**, 140-178.
- Đukić, N., Maletin, S., Kilibarda, P., Miljanović, B., and S. Jovanović (1986). Fauna dna u nekim kanalima hidrosistema DTD i njen značaj za ribarstvo. *Godišnjak Jugoslovenskog Društva za Zaštitu Voda*, 138-143.
- Đukić, N., Maletin, S., Miljanović, B., and Z. Marković (1992). Kvalitet vode i distribucija populacija Oligochaeta u reci Đetinji. *Godišnjak Jugoslovenskog Društva za Zaštitu Voda*, 152-155.
- Đukić, N., Maletin, S., Tepavčević, D., Miljanović, B., and A. Ivanc, A. (1997). Correlation between Oligochaeta community and nutrient concentration in the river Danube. *Ekologija* **32** (2), 31-36.
- Đurković, A., Marković, G., and V. Simić (1998). Biološki monitoring reke Despotovice tokom 1997. *Godišnjak Jugoslovenskog Društva za Zaštitu Voda*, 365-368.
- Edington, J. M. and A. G. Hildrew (1995). *Caseless Caddis Larvae of the British Isles. A Key with Ecological Notes*. Freshwater Biological Association Scientific Publication No. 53 (Ed. J. M. Elliott). 143 pp.
- Filipović, D. (1954). Ispitivanja živog sveta tekućih voda Srbije. I. Prilog poznavanju naselja planinskih potoka Katušnice (Zapadna Srbija). *Zbornik radova Instituta za ekologiju i biogeografiju, SANU-Institut za ekologiju i biogeografiju. Zbornik radova* **5** (8), 117-133.
- Filipović, D. (1957) Limnološka i biogeografska problematika malih tekućica u Jugoslaviji. *Zbornik Radova*, **1**, 2, 4-14.
- Filipović, D. (1965). Dinamika i ekologija ekosistema Lisinskog potoka na Kopaoniku. Doctoral Dissertation, Belgrade, 101 pp.
- Filipović, D. (1966). Limnološka karakteristika izvorskog regiona Lisinskog potoka na Kopaoniku. *Arh. Biol. Nauka (Beograd)* **18** (3-4), 325-337.
- Filipović, D. (1969). Recherches biocenologiques d'un cours d'eau salmonicole de montagne Balkanique (Serbie). *Ekologija* **4** (1): 61-90.
- Filipović, D. (1976). Istorijat proučavanja Ephemeroptera (Insecta) u našoj zemlji i rezultati dosadašnjih ispitivanja u Srbiji. *Arh. Biol. Nauka (Beograd)* **28**, 1-2, 95-101, Beograd.
- Fres, C.O.H. (1997). *The Dragonflies of Great Britain and Ireland*. Harley Books (B.H. & A. Harley Ltd.), Second Edition, 116 pp.
- Gajić, M. (1989). *Flora i vegetacija Golije i Javora*. Faculty of Forestry – Belgrade and OOUR Šumarstvo „Golija“ Ivanjica.
- Gavrilović, Lj., and D. Đukić (2002). *Reke Srbije*. Zavod za udžbenika i nastavna sredstva, pp. 7-218. **Poglavlje: Reke Crnomorskog sliva, Zapadna Morava**, pp. 84-85.
- Hynes, H. B. N. (1977). *A Key to the Adults and Nymphs of the British Stoneflies (Plecoptera) with Notes on Their Ecology and Distribution*. Freshwater Biological Association Scientific Publication No. 17. Third Edition, with minor revisions, 1977. 90 pp.
- Ikonomov P. (1959). *Ephemeroptera na Makedonija*. Sistematika i faunistika. II Prilozi (sliki i dijagrami). Skopje, 109 pp.
- Illies, J. (1978). *Limnofauna Europea*, Gustav Fischer Verlag, Stuttgart-New York; and Swets & Zeitlinger B.V., Amsterdam, 534 pp.
- Jakovčev, D. (1983). Prilog poznavanju Oligohetne faune triju pritoka Južne Morave, In: *Drugi Simpozijum o Fauni S. R. Srbije – Zbornik*, 47-50.
- Jakovčev, D. (1986). Prilog poznavanju Oligohetne faune u slivu Velikog Timoka. *Biosistematika* **12**, 1, 67-77.
- Jakovčev, D. (1989). Saprobiološka analiza reke Save na osnovu faune dna u okviru beogradskog regiona, In: *Zbornik Radova na Savetovanju „Rijeka Sava – Zaštita i Korišćenje Voda“*, 442-445. JAZU.
- Janković, M. (1976). Ispitivanje naselja Chironomidae Peka posle zagađenja rudničkom jalovinom. *Arh. Biol. Nauka (Beograd)* **28** (3-4), 153-160.
- Janković, M. (1981). Sastav i struktura faune Chironomidae (Diptera) donjeg toka Save. *Glas SANU CCCXXIX*, **48**, 111-120.
- Janković, M. (1983a). Proučavanje Chironomidae (Diptera) sliva Velikog Peka. *Zbornik Radova o Fauni SR Srbije*, **2**, 55-146.
- Janković, M. (1983b). Fauna Chironomidae reke Gračanke. *Glasnik Prirod. Muz.*, ser. B, knjiga **38**, 105-121.
- Janković, M. (1987). Stanje faune dna Velikog Timoka u uslovi-ma datog zagađenja. *Glas SANU CCCXLIX* **51**, 92-106.
- Janković, M. (1998). Fauna Chironomidae Velike Morave. *Zbornik Radova o Fauni SR Srbije* **5**, 106-139.
- Jovanović, B. J. (1998). Diverzitet faune Gastropoda (Mollusca) borskog regiona (Srbija). VI naučno-stručni skup o prirodnim vrednostima i zaštiti životne sredine. *Zbornik Radova „Naša Ekološka Istina“*, 239-242.

- Karaman, G. S. (1964). Taksonomija i ekologija grupe slatkovodnih Amphipoda podroda *Rivulogammarus* Kar. u Jugoslaviji. Doctoral Dissertation, Kotor.
- Karaman, G. S. (1995). Diverzitet Amphipoda (Crustacea) Jugoslavije sa pregledom vrsta od međunarodnog značaja, In: *Biodiverzitet Jugoslavije sa pregledom vrsta od međunarodnog značaja* (Eds. V. Stevanović and V. Vasić), 319-328. Faculty of Biology and Ecolibri, Belgrade.
- Karaman, G. S. (1998). Novi podaci Amphipoda borskog regiona i susjednih oblasti (Srbija) (232. Prilog poznavanju Aphipoda). VI Naučno-stručni skup o prirodnim vrednostima i zaštiti životne sredine. *Zbornik Radova „Naša Ekološka Istina“*, 235-237.
- Kerovec, M. (1986). *Priručnik za upoznavanje beskralješnjaka naših potoka i rijeka*, 127 pp. SNL, Zagreb.
- Konta, P. S. (1997). Analiza uticaja ekoloških faktora na makrozoobentos Lomničke reke. Master's Thesis, Faculty of Biology, University of Belgrade, 99 pp.
- Kovačević, B., Kovačević, R., Labus, D., and I. Popović (1997). *Moravički Okrug*. Glas Srbije, Kraljevo.
- Ložek, V. (1956). *Klíč Československých Mekkyšu*. Vyda Vatelstvo Slovenskej Akademie Vied, sekcia biologických a lekárskeých vied, Bratislava.
- Macan, T. T. (1970.) *A Key to the Nymphs of the British Species of Ephemeroptera with Notes on Their Ecology*. Freshwater Biological Association Scientific Publication No. 20, Second Edition, 69 pp.
- Marinković-Gospodnetić, M. (1975). Fauna Trichoptera SR Srbije. *Zbornik Radova o Entomofauni SR Srbije* 1, 219-236.
- Marković, Z. (1995). *Reka Đetinja, makrozoobentos u oceni kvaliteta vode*. Ministry of Environmental Protection of the Republic of Serbia and Užice Research Center, Užice, 131 pp.
- Marković, Z. (1998a). *Izvori brdsko-planinskih područja Srbije, ekološka studija makrozoobentosa*. Faculty of Biology, University of Belgrade. 318 pp.
- Marković, Z. (1998b). Fauna Plecoptera izvora i izvorištaorskog područja. VI naučno-stručni skup o prirodnim vrednostima i zaštiti životne sredine. *Zbornik Radova „Naša Ekološka Istina“*, 189-192.
- Marković, Z., and M. Janković (1986). Kvalitet vode reke Đetinje pod uticajem otpadnih voda Titovog Užica, In: *VI Kongres Ekologa Jugoslavije, Plenarni Referati i Izvodi Saopštenja, Aneks*, 14 pp.
- Marković, Z. and M. Janković (1989). Fauna Ephemeroptera reke Đetinje. *III Simpozijum o Fauni Srbije, Uvodni Referati i Rezimeji*, 29.
- Marković, Z., and B. Miljanović (1995). Makrozoobentos Krivaljske reke. III Naučno-stručni skup o prirodnim vrednostima i zaštiti životne sredine, *Zbornik Radova „Naša Ekološka Istina“*, 221-225.
- Marković, Z., Miljanović, B., and V. Mitrović-Tutundžić (1997a). Saprobiološka ocena kvaliteta vode reke Banje na osnovu makrozoobentosa kao bioindikatora. *Godišnjak Jugoslovenskog Društva za Zaštitu Voda*, 350-354.
- Marković, Z., Mitrović-Tutundžić, V., and B. Miljanović (1997b). Effect of pollution on the macrozoobenthos diversity and structure in the river Obnica (Serbia, Yugoslavia). *Ekologija* 32 (2), 37-46.
- Marković, Z., Miljanović, B., and V. Mitrović-Tutundžić (1998). Makrozoobentos kao pokazatelj kvaliteta reke Jablanice. *Godišnjak Jugoslovenskog Društva za Zaštitu Voda*, 369-372.
- Marković, Z., Miljanović, B., and V. Mitrović-Tutundžić (1999). Makrozoobentos kao pokazatelj kvaliteta vode reke Kolubare. *Godišnjak Jugoslovenskog Društva za Zaštitu Voda*, 261-266.
- Martinović-Vitanović V., Kalafatić, V., and D. Jakovčev (1995). Saprobiološka istraživanja sliva reke Vlasine, In: *24. Konferencija o Aktuelnim Problemima Zaštite Voda „Zaštita Voda '95“*. 125-129, Belgrade.
- Martinović-Vitanović, V., Kalafatić, V., Jakovčev, D., Paunović, M., and M. J. Martinović (1998a). Reka Veternica – sastav i struktura biocenoza, saprobiološki status i kvalitet vode. *Ekologija* 5, 3, 22-28.
- Martinović-Vitanović, V., Kalafatić, V., Martinović, J., Jakovčev, D., and M. Paunović (1998b). Biocenoze Vlasine i reka njenog sliva sa posebnim osvrtom na faunu dna kao pokazatelj kvaliteta vode u jesenjem aspektu 1996. godine, In: *27. Konferencija o Aktuelnim Problemima Zaštite Voda*, 333-340. Jugoslovensko Društvo za Zaštitu Voda, „Zaštita Voda“, Kotor.
- Miljanović, B. (2001). *Makrozoobentos reka Kolubare, Obnice i Jablanice*, Monografija, Biblioteka Academia, Zadužbina Andrejević, Belgrade, 80 pp.
- Mitrović-Tutundžić, V. (1973). Uticaj različitih tipova zagađenja na naselje dna nekih reka u Srbiji; In: *Naučni Skup – Čovek i Životna Sredina*, SANU, Belgrade, 1-8.
- Müller-Liebenan, I. (1969). *Revision der europäischen Arten der Gattung Baetis Leach, 1815 (Insecta, Ephemeroptera)*. HEFT 48/49, 214 pp.
- Nilsson, A. (1997a). *Aquatic Insects of North Europe – A Taxonomic Handbook*, 1, 274 pp. Apollo Books, Stenstrup, Denmark.
- Nilsson, A. (1997b). *Aquatic Insects of North Europe – A Taxonomic Handbook*, 2, 440 pp. Apollo Books, Stenstrup,

- Denmark.
- Obušković, Lj., Maslić, M., Cakić, P., and D. Jakovčev (1994). Hidroekološka istraživanja nekih voda na području Stare Planine. In: *Konferencija o Aktuelnim Problemima Zaštite Voda*, 188-192. Jugoslovensko Društvo za Zaštitu Voda, Igalo.
- OziExplorer 3.93.3b. Available at [www.ozieplorer.com](http://www.ozieplorer.com). D & L Software PtyLtd.
- Paunović, M., Tanasković, M., Kalafatić, V., Jakovčev, D., and V. Martinović-Vitanović (1998). Biocenoze Vlasine i reka njenog sliva sa posebnim osvrtom na faunu dna kao pokazatelj kvaliteta vode u prolećnom aspektu 1996. godine. *Vodoprivreda*, **30**, 225-230.
- Paunović, M., Kalafatić, V., Jakovčev, D., and V. Martinović-Vitanović (2003). Oligochaetes (Annelida, Oligochaeta) of the Vlasina river (South-East Serbia): diversity and distribution. *Biologia* (Bratislava) **58**, 903-911.
- Paunović, M., Jakovčev-Todorović, D., Simić, V., Stojanović, B., and A. Veljković (2006). Species composition, spatial distribution and temporal occurrence of mayflies (Ephemeroptera) in the Vlasina River (Southeast Serbia). *Arch. Biol. Sci. (Belgrade)* **58** (1), 37-43.
- Pfleger, V. (1990). *A Field Guide in Colour to Molluscs*, 216 pp. Aventinum nakladatelství.
- Savage, A. A. (1989). *Adults of the British Aquatic Hemiptera Heteroptera: a Key with Ecological Notes*. Freshwater Biological Association Scientific Publication No. 50, 173 pp.
- Simić, V. (1993). Saprobiološka valorizacija Svrliškog i Trgoviškog Timoka na osnovu sastava makrozoobentosa. Master's Thesis, Faculty of Biology, University of Belgrade, 263 pp.
- Simić, V. (1996). Mogućnosti ekološkog monitoringa rečnih ekosistema Srbije na osnovu makrozoobentosa. Doctoral Dissertation, Faculty of Biology, University of Belgrade, 612 pp.
- Simić, V. (1998). Mogućnosti korišćenja zajednice faune dna kao indikatora stanja rečnih ekosistema. *Godišnjak Jugoslovenskog Društva za Zaštitu Voda*, 349-356.
- Simić, V., Simić, S., and A. Ostojić (1993). Uticaj otpadnih voda Svrlijga na kvalitet vode Svrliškog Timoka. *Godišnjak Jugoslovenskog Društva za Zaštitu Voda*, 151-159.
- Simić, V., Ostojić, A., Karaman, S., Blesić, B., and S. Pešić (1994). Istraživanje zoobentosa i zooplanktona u vodama Kragujevačkog regiona. *Godišnjak Jugoslovenskog Društva za Zaštitu Voda*, 198-203.
- Simić, S., Ostojić, A., Simić, V., and D. Janković (1997). Promene u strukturi planktona i bentosa na delu toka Dunava od Velikog Gradišta do Prahova tokom letnjeg aspekta. *Ekologija* **32** (2), 65-80.
- Stanković, S., Marković, Z., Miljanović, B., and M. Bobić (1995). Ekološki pokazatelji kvaliteta vode Borske reke: I – Mikrobiološki pokazatelji; II – Makrozoobentos; III – Zooplankton. In: *Međunarodna konferencija – Preventivni Inžinjering i Životna Sredina*, A12-1 – A12-3.
- Timm, T. (1980). Distribution of aquatic oligochaetes. In: *Aquatic Oligochaete Biology* (Eds. R. O. Brinkhurst and D. G. Cook), 55-57. Plenum Press, New York.
- Timm, T. (1999). *Eesti rongusside (Annelida) määraja*. [A Guide to the Estonian Annelida]. Naturalist Handbooks I, 208 pp. Estonian Academy Publishers, Tallinn.
- Živić, I., Marković, Z., and M. Brajković (2000). Sekundarna produkcija makrozoobentosa Puste Reke. In: 29. Konferencija o Aktuelnim Problemima Zaštite Voda „Zaštita Voda 2000“, 175-180. Mataruška Banja.
- Živić, I., Marković, Z., and M. Brajković (2001). Prilog poznavanju kvalitativnog sastava makrozoobentosa i kvaliteta vode Crvene Reke. In: 30. Konferencija o Aktuelnim Problemima Zaštite Voda „Zaštita Voda 2001“, 175-181.
- Živić, I., Marković, Z., and J. Ilić (2005). Composition, structure, and seasonal dynamics of macrozoobenthos in the Temska and Visočica Rivers (Serbia). *Arch. Biol. Sci. (Belgrade)* **57** (2), 107-118.
- Wallace, I. D., Wallace, B., and G. N. Philipson (1990). *A key to the Case-Bearing Caddis Larvae of Britain and Ireland*. Freshwater Biological Association Scientific Publication No. 51 (Ed. J. M. Elliott), 237 pp.

**КВАЛИТАТИВАН САСТАВ ЗАЈЕДНИЦЕ АКВАТИЧНИХ МАКРОИНВЕРТЕБРАТА  
ДУЖ ТОКА ГОЛИЈСКЕ МОРАВИЦЕ, ЦЕНТРАЛНО-ЗАПАДНА СРБИЈА**

ВЕСНА ЂИКАНОВИЋ<sup>1</sup>, ДУЊА ЈАКОВЧЕВ-ТОДОРОВИЋ<sup>1</sup>, ВЕРА НИКОЛИЋ<sup>2</sup>,  
М. ПАУНОВИЋ<sup>1</sup> и П. ЦАКИЋ<sup>1</sup>

<sup>1</sup>Институт за биолошка истраживања "Синиша Станковић", 11060 Београд, Србија

<sup>2</sup>Институт за зоологију, Биолошки факултет, Универзитет у Београду, 11000 Београд, Србија

Река Голијска Моравица је највећа и најзначајнија река Моравичког краја, која извире испод највиших врхова Голије. Током 2003. и 2004. године на овој брдско-планинској текућици спроведена је фаунистичко-еколошка студија организама

фауне дна – акватичних макробескичмењака. Заједница макрозообентоса реке Моравице, до сада, није била предмет хидробиолошких истраживања и то је основни разлог зашто је урађено њено систематско и фаунистичко проучавање.