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Taxonomic composition and community structure of Trichoptera (Insecta) on the territory of the City of Niš (Serbia)

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***Abstract*:**
Vulić, I., Vasov, I., Savić, A.: ***Taxonomic composition and community structure of Trichoptera (Insecta) on the territory of the City of Niš (Serbia). Biologica Nyssana, 5 (1), Septemeber 2014: 53-61.***

The research of Trichoptera community was performed within the territory of the city of Niš on 10 localities. These localities have different physical and chemical characteristics ranging from hot springs to cold karst streams. Some of them are with a measurable human influence (in the city of Niš), while others are practically without it (Dušničko vrelo). A total number of 16 genera Trichoptera within 11 families were noted. Number of identified species was 20. It was determined that the highest species diversity is in localities with the least human influence. During this study, the presence of the species that has the status of a strictly protected species in Republic of Serbia was recorded. The largest number of localities belongs to β – mesosaprobic waters. It has been found that group Trichoptera is suitable for independent application in bioindicator purposes.

Key words: Trichoptera, Nišava river, saprobiological analysis, diversity, taxonomic composition, community structure

***Apstract*:**
Vulić, I., Vasov, I., Savić, A.: ***Taksonomski sastav i struktura zajednice Trichoptera (Insecta) na teritoriji grada Niša. Biologica Nyssana, 5 (1), Septemeber 2014: 53-61.***

Istraživanje zajednice Trichoptera sprovedeno je na teritoriji grada Niša na 10 istraživanih lokaliteta. Lokaliteti su različitih fizičko-hemijskih karakteristika u rasponu od termalnih izvora do hladnih kraških tekućica. Neki od njih su pod značajnim antropogenim uticajem (u samom gradu Nišu) dok su drugi gotovo bez njega (Dušničko vrelo). Konstatovano je ukupno 16 rodova Trichoptera u okviru 11 familija. Identifikovano je ukupno 20 vrsta. Utvrđeno je da je specijski diverzitet najveći na lokalitetima sa najmanjim antropogenim uticajem. Tokom istraživanja konstatovana je vrsta koja ima status strogo zaštićene vrste u Republici Srbiji. Najveći broj lokaliteta pripada beta mezosaprobnim vodama. Ustanovljeno je da je ova grupa pogodna za samostalnu primenu u bioindikatorske svrhe.

Ključne reči: Trichoptera, diverzitet, reka Nišava, saprobiološka analiza, taksonomski sastav, struktura zajednice

Introduction

Order Trichoptera is the largest among the orders of primarily aquatic insects, which include: Ephemeroptera, Plecoptera, Odonata and Megaloptera. Its diversity is similar to that of the order Diptera (Holzenthal et al., 2007).

Trichoptera are considered to be the most common group of macro-invertebrates in the freshwater ecosystems. They are widespread and inhabit a variety of habitat types, within the multiple trophic levels (Savić 2013).

Trichoptera larvae are a very important component of trophic dynamics and energy flows in the aquatic ecosystems they inhabit. Many species of Trichoptera are sensitive to pollution, so their presence and relative abundance are used in biological assessment and monitoring of water quality (Holzenthal et al., 2007).

There are 23 families of Trichoptera recorded in Europe (including Arctopsychidae and Ptilocolepidae, but excluding Apataniidae, because it is considered a subfamily of Limnephilidae) and a total of 133 genera, including the genus Alpopsyche (Botosaneanu & Giudicelli, 2004, according to Waringer & Graf, 2013) with about 1100 recent species (Ibrahimi et al., 2012). According to the available data, the Trichoptera fauna of the Balkan Peninsula includes 21 families and a high number of 90 genera.

Within the territory of Serbia, Trichoptera larvae were investigated as part of macrozoobenthos studies in mountain streams and rivers. The adult forms were studied by a small number of authors, including Marinković-Gospodnetić (1975, 1980) and Radovanović (1931, 1935, 1953), as cited by Živić et al. (2000).

The first checklist of the Trichoptera fauna in Serbia included 173 species (Živic et al., 2002). The Trichoptera fauna of Serbia currently includes 186 species, 49 genera and 18 families (Živic et al., 2006).

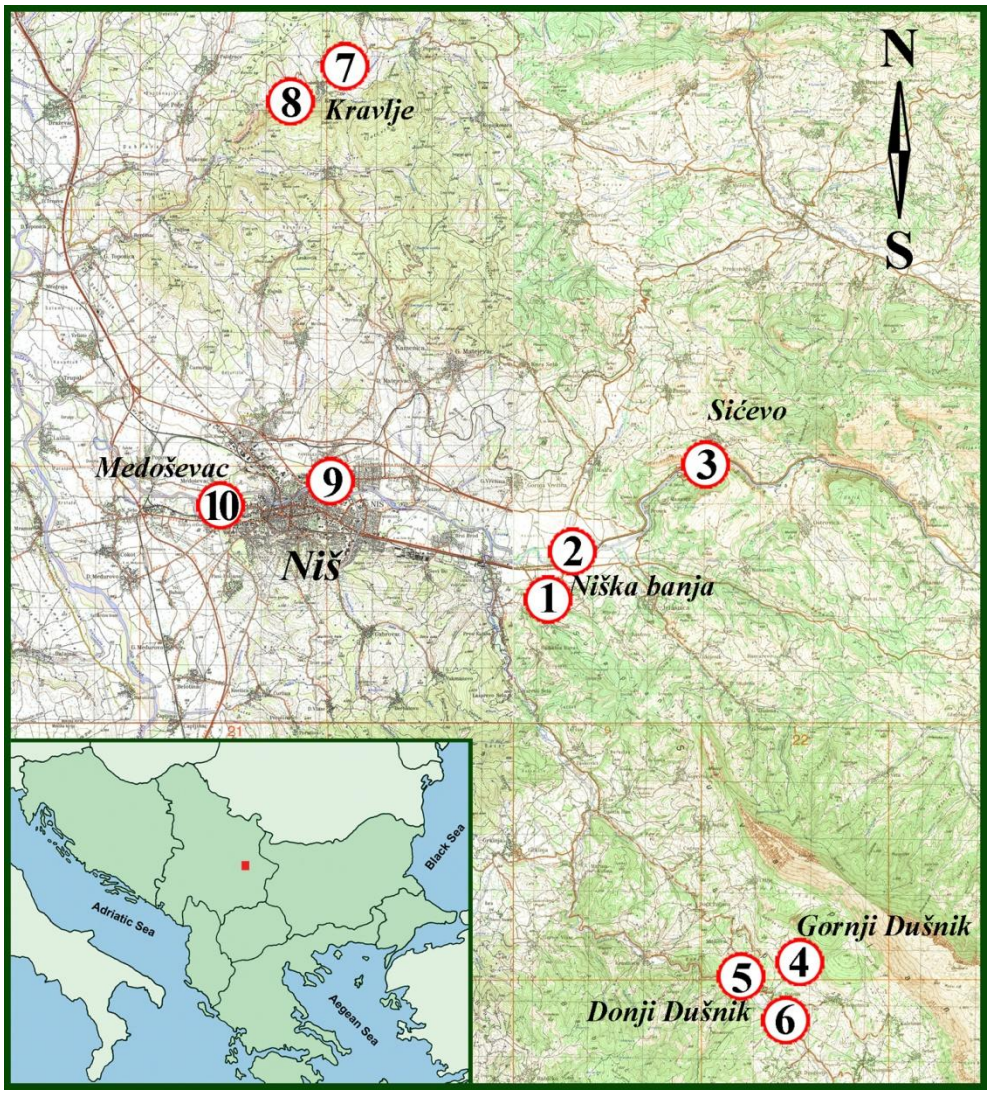

Figure 1: Map of the studied area with localities

Table 1. Database of localities and GPS coordinates

Locality	Name of locality	N	E	Altitude (m)
1	Niška Banja - spring	43° 17.468'	22° 00.749'	266
2	Niška Banja near Jelašnica road	43° 17.903'	22° 00.498'	212
3	Nišava R. near Sićevo	43° 19.893'	22° 04.429'	233
4	Dušničko Vrelo spring	43° 10.433’	22° 07.033'	501
5	Dušnička Reka R.	43° 10.297’	22° 07.056’	466
6	Kutinska Reka R.	43° 09.820'	22° 05.972'	395
7	Banja Topilo upstream from warm water discharge	43° 26.889'	21° 52.726'	256
8	Banja Topilo downstream from warm water discharge	43° 26.894'	21° 52.692'	253
9	Nišava R. at Bulevar (near the mouth of Gabrovačka Reka R.)	43° 19.517'	21° 55.266'	195
10	Nišava R. near Medoševac	43° 19.330'	21° 52.375'	189

Material and methods

Material was collected in November and December 2012 and February and May 2013 at 10 representative sites at the Nišava River and its tributaries (**Fig. 1**).

Selected sites were located at points above and below the pollutant discharge. Choice of sampling sites was heavily influenced by need for variety in following factors: altitude, bedrock, slope, flow rate, bottom substrate, microclimate conditions etc.

Localities 1 and 2 are thermal water bodies at Niška Banja. In contrast, localities 4 and 5 are a typical cool karst spring (Locality 4) and upper course of a karst river (Locality 5). Locality 6 is the tributary of the Nišava River-Kutinska reka River. The following two localities are at the Miljkovačka reka River: Locality 7 is above the thermal springs of Banja Topilo, while Locality 8 is located below the same thermal springs. Localities 9 and 10 are at the Nišava River, in the urban area **(Tab. 1)**.

Explorations were conducted once a month, during a single day in order to accurately compare chemical parameters, which change a lot faster than the biotic parameters.

Physical parameters were measured directly at the sampling sites. The following physical characteristics were determined: temperature, turbidity and conductivity. Temperature and conductivity were measured using a device - Photometer System PC MultiDirect (Lovibond ®) while turbidity of water was determined using the Lovibond PC Checkit device.

Chemical parameters were mostly measured directly, using the Photometer - System PC MultiDirect (Lovibond ®) device (the saturation and oxygen concentration, pH). Biochemical oxygen demand (BOD5) was obtained using the standard methodology, recommended by APHA (1999).

Sampling was conducted by using a square frame kick net (35 × 35 cm, mesh size 300 μm). The treated area of bottom surface was 35 x 35 cm. The bottom substrate was disturbed and macroinvertebrate individuals were separated from the substrate and carried by a stream as water was entering the sampling net. Samples were then fixed in 4% formaldehyde, placed in labeled plastic bags and transported to the laboratory. In the laboratory, the samples were rinsed under the tap, using two screens - with larger and smaller diameter of buds. A total of 40 samples were analyzed. Separated materials have been sorted in transparent bottles containing 70% ethanol and later determined by use of identification keys.

The determination of each individual was performed by using a binocular magnifying glass and microscopes in specially equipped laboratories at the Center for Biological and Environmental Monitoring of Surface Waters in the City of Niš (Bioekocen), at the Faculty of Science and Mathematics, University of Niš. The observation and measurements of very small body parts were done by using binocular Leica MZ - 16A Stereomicroscope with Leica DFC320 Digital Camera and Leica DM2500 Microscope System with Leica DFC490 Digital Camera.

The individuals of the order Trichoptera were identified by using the following keys: individuals from families Glossosomatidae, Beraeidae,

Table 2. Average values of physical-chemical parameters at the studied localities

Locality	Turbidity	Temperature	pH	Conductivity	Oxygen mg/l	Oxygen %	BOD5	Shading %
1	0.35	30.6	7.5	477	3.59	48.5	5.14	40
2	3.63	23.5	7.7	466	4.74	58	5.57	15
3	1.91	12.4	7.9	421	5.81	64.25	5.33	15
4	0.12	10.4	7.6	246	7.29	61.54	4.02	0
5	2.24	10.1	7.9	290	7.82	91.25	9.68	40
6	4.88	9.2	7.9	364	8.77	113.75	10.72	2
7	1.82	11.8	8.1	404	7.87	71	9.12	20
8	2.6	8.2	8	435	8.3	101.25	8.82	5
9	1.93	11.3	8.1	459	6.83	84.25	5.91	6
10	2.29	11.9	8.1	518	5.77	84.75	5.73	5

Table 3. Average abundance of Trichoptera species (individuals/ m^2)

	Localities									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Glossosomatidae										
Agapetus ohripes Curtis 1834				2.72						
Beraeidae										
Beraea pullata (Curtis 1834)				277.55	46.26	8.16	5.44			
Beraeodes minutus (Linnaeus 1761)					2.72			2.72		
Hydropsychidae										
Cheumatopsyche lepida (Pictet 1834)			165,9	8.16			111.56	2.72		
Hydropsyche angustipennis (Curtis 1834)			2.72							
Hydropsyche contubernalis McLachlan 1865			78.9				2.72		2.72	
Hydropsyche fulvipes Curtis 1834		5.44							2.72	
Hydropsyche instabilis (Curtis 1834)			95.25		2.72			76.2	8.16	
Hydropsyche pellucidula (Curtis 1834)		2.72	117.01		2.72		5.44	8.16		
Hydropsyche sp.								2.72		
Limnephilidae										
Halesus radiatus (Curtis 1834)				51.7				43.54		
Stenophylax permistus McLachlan 1895					24.49	21.77	2.72	16.33		
Lepidostomatidae										
Lasiocephala basalis (Kolenati 1848)				43.54						
Leptoceridae										
Setodes sp.				21.77	27.21	8.16				
Psychomyiidae										
Lype reducta (Hagen 1868)					2.72					
Tinodes unicolor (Pictet 1834)								8.16		
Psychomyia pusilla (Fabricius 1781)			38.09	5.44			32.65		163.26	
Phryganeidae										
Phryganea bipunctata Retzius 1783				8.16						
Polycentropodidae										
Neureclipsis bimaculata (Linnaeus 1758)				2.72						
Rhyacophilidae										
Rhyacophila dorsalis (Curtis 1843)			2.72	2.72				2.72		
Rhyacophila fasciata Hagen 1859			8.16				2.72	8.16		
Sericostomatidae										
Sericostoma personatum (Kirby & Spence 1826)				2.72	5.44					

Limnephilidae, Lepidostomatidae, Phryganeidae, Psychomyiidae and Leptoceridae were identified according to the Wallace et al. (1990) identification key, while individuals belonging to families Rhyacophilidae, Polycentropodidae and Hydropsychidae were identified by using the Edingtom and Hildrew (1995) identification key.

Saprobity is expressed according to the saprobity index S, in accordance with the method devised by Pantle - Buck (1955).

$$S = \frac{\Sigma h \times s}{\Sigma h}$$

S stands for saprobic index of the communities, h for the relative abundance and s for the saprobic value, which is characteristic for each species.

For needs of saprobiological analysis, lists of indicator species by Sladaček were used (Sladaček 1973), while for the evaluation of the frequency of species, a modified scale of 6 degrees to Rusev-in was used (Rusev 1993).

Results

During the analysis of the physical-chemical parameters, it was determined that locality 1 stood out from the rest due to low values of turbidity, high temperatures and minimal values of average concentration of oxygen. The lower value of turbidity was observed only at the locality 4. The highest values of turbidity were recorded at the locality 6. pH values at all localities were close to the values characteristic for neutral water (about 7). Lower alkalinity values were noticed at localities 7, 8, 9 and 10 (**Tab. 2**).

The greatest number of species was recorded at the Locality 4 (11 species). Localities with high species diversity were locality 8 (9 species) and locality 3 (8 species). Most individuals were sampled at locality 3 - a total of 187. The lowest number of species was recorded at Locality 2 - only two species. No Trichoptera individuals were recorded at localities 1 and 10 (**Tab. 3**).

The family Psychomyiidae was represented by three genera, families Beraeidae, Hydropsychidae and Rhyacophilidae by two genera, while other families were represented by one genus each.

Five species belonging to the genus Hydropsyche were recorded, while other genera were represented by single species only.

The species *Hydropsyche pellucidula* (Curtis 1834) was observed at five of the investigated localities while species *Cheumatopsyche lepida* (Pictet 1834), *Stenophylax permistus* McLachlan 1895, *Hydropsyche instabilis* (Curtis 1834), *Beraea pullata* (Curtis 1834) and *Psychomyia pusilla* (Fabricius 1781) were recorded at four investigated localities each. The following species were recorded at only a single locality: *Agapetus ohripes* Curtis 1834 at locality 4, *Hydropsyche angustipennis* (Curtis 1834) at locality 3, *Lype reducta* (Hagen 1868) at locality 5, *Tinodes unicolor* (Pictet 1834) at locality 8, while *Phryganea bipunctata* Retzius 1783 and *Neureclipsis bimaculata* (Linnaeus 1758) were both recorded only at locality 3.

The saprobity index is presented as part of autumn, winter or spring aspect. The autumn aspect included samples collected in November 2012, the winter aspect included samples collected in December 2012 and February 2013, while the spring aspect included samples collected in May 2013.

In the autumn aspect, indicator species were present at localities 3, 5 and 8 (**Tab. 4**). The saprobity index has shown that all three sites had β - mesosaprobic water (β), which belongs to the class II water.

In the winter aspect, the lowest value of saprobity index was recorded at the locality 4. During this period, saprobity index values at all sites were within the limits characteristic for β - mesosaprobic water, except at locality 4 where the value of saprobity index indicated oligosaprobic water.

In the spring aspect, the saprobity index values at localities 5, 6 and 7 were within the range typical for oligosaprobic water, while the values recorded at localities 3 and 9 indicated β - mesosaprobic water (**Fig. 2**).

Following indicators of saprobity were used in this research: genus Hydropsyche and species *Sericostoma personatum*, *Rhyacophila septentrionis* (i.e. *Rhyacophila fasciata*), *Neureclipsis bimaculata* and *Stenophylax permistus*.

All species recorded during this study were typical for the European continent and known for many European countries (**Fig. 3**). All of them were also included in the checklist of the Trichoptera fauna in Serbia from 2006.

Localities where Trichoptera species were recorded are also the new sites for these species in Republic of Serbia.

Table 4. Saprobity index (S) values for all aspects

	Locality									
Aspect	1	2	3	4	5	6	7	8	9	10
Autumn			1.95		1.55			1.95		
Winter		1.95	1.82	1.4			1.75	1.62	1.95	
Spring			1.95		1.25	1.25	1.25		1.95	

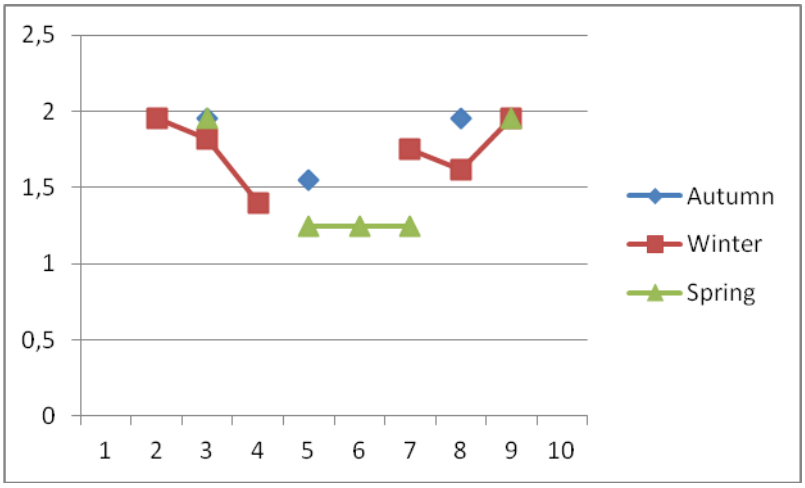

Figure 2. Saprobity index values in autumn, winter and spring aspect

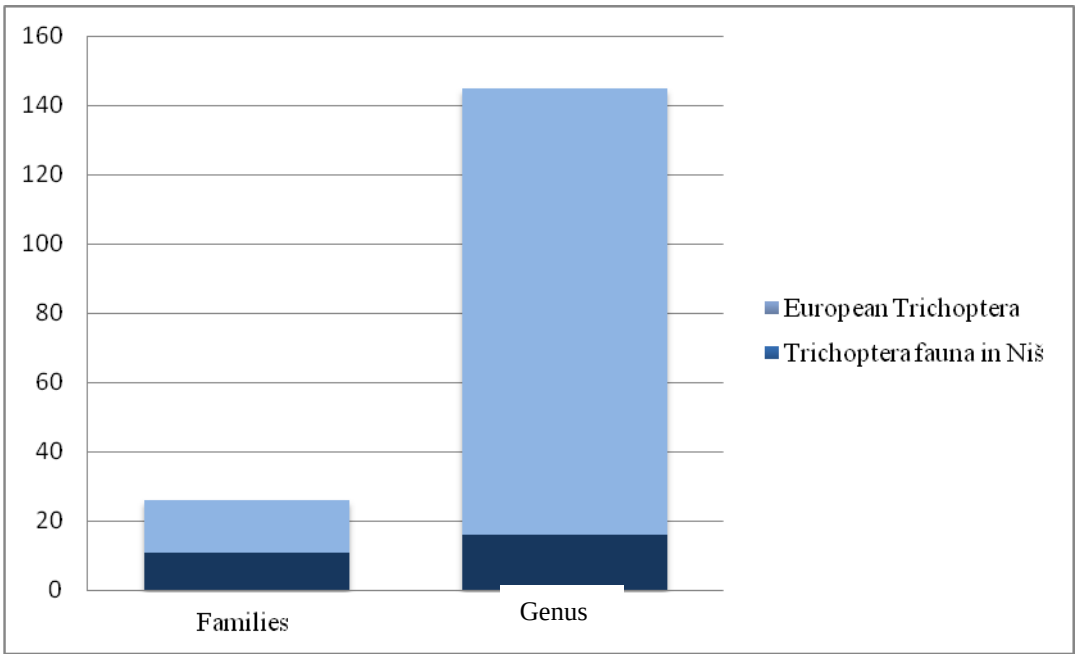

Figure 3. Comparison of the European genera and families with genera and families found within the territory of City of Niš

Discussion

The maximum value of temperature was observed at locality 1, which is a thermal spring at Niška Banja. At this locality, thermal pollution was dominant. The lowest values of turbidity were recorded at the locality Dušničko vrelo, which may be explained by the fact that this site is located in a place still under minimal anthropogenic influence.

In the period from November 2012 to May 2013, a total of 16 genera within 11 families were recorded. 20 species were identified, while two taxa were identified to genus level. The Trichoptera fauna in Niš contained a high percentage (47.83%) of European families and 11.63% of European

genera, which is a significant percentage considering that this order is insufficiently explored in our country.

The greatest number of species was recorded at the locality Dušničko vrelo (11 species), while the largest number of individuals was recorded at locality Nišava River near Sićevo. No species of Trichoptera were recorded at localities Niška Banja - spring and Nišava River near Medoševac.

In comparison to the number of species of Trichoptera previously recorded in other rivers in Serbia where the Trichoptera or other macrozoobenthos groups were studied, the diversity of the Trichoptera assemblage in Niš is greater than the diversity values observed in the following rivers: Vlasina (Schmidt-Kloiber et al., 2008), Ribnica and Lepenica (Jović et al. 2006), Jablanica (Stefanović 2009), Banja River (Živić et al. 2000), Vrelska padina I Ivanštica (Đuknić et al. 2010), Zapadna Morava (Novaković 2013), Pčinja (Simić & Simić 2003), Južna Morava (Novaković 2012), Velika Morava (Marković et al. 2011), Pusta reka (Živić et al. 2001). The greater diversity of this order was noticed at rivers Temska and Visočica (Živić et al. 2005) and Golijska Moravica (Đikanović et al. 2008), with respect to the diversity of the Trichoptera community in area of City of Niš. The diversity of the Trichoptera community in the study area is equally high as the diversity recorded along the entire flow of the Nišava River (Savić 2012).

Of all of the recorded species, *Beraeodes minutus* (Linnaeus 1761) stands out as one of the strictly protected river invertebrates in the Republic of Serbia (Radulović et al. 2012). This species was recorded in December 2012 at the locality Dušničko vrelo and in February 2013 at the locality Banja Topilo downstream, at the place where hot water discharge enters the river.

In autumn and winter, the saprobity index was within the limits characteristic of β-mesosaprobic waters. The saprobity was lower in spring due to the prevalence of indicators of oligosaprobic waters (or the species *Stenophylax permistus)*. Low values of the saprobic index may be associated with variations of water level in Nišava River. This river is characterized by highest water levels in spring months when rainfall and water from thawed snow are at the peak. Periods of high water level lead to dilution of pollutants that continue to influence the decrease in the saprobity index.

Most of the studied localities at β-mesosaprobic water bodies belong to class II waters. The results obtained during this study correspond to the results collected during the hydro-biological research of the Nišava river, according to the Water Framework Directive (2000/60/EC), when it was concluded that at the studied sites the saprobic index was within the limits of β-mesosaprobic waters (Branković et al. 2007).

Conclusion

During this study it was concluded that Hydropsychidae was the most common family in the study area. Out of the recorded total of 16 genera, the most common genus was Hydropsyche. Recorded species belonging to this genus inhabited both the polluted and the minimally contaminated locations. Therefore it was concluded that within the order Trichoptera the taxonomic level of the genus should not be considered reliable for bio-indicator purposes.

There are no literature data indicating that the sampling sites chosen for this study were previously used for studying the Trichoptera species in the Republic of Serbia.

The presence of a species with the status of a strictly protected species in the Republic of Serbia in studied localities provides additional significance for this area as an area of hydrobiological importance. As the sampled sites belonged to the oligosaprobic and β-mesosaprobic zone, this area may be considered to have great potential for production of high-quality drinking water.

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