ECOLOGIA BALKANICA
2019, Vol. 11, Issue 1 June 2019 pp. 93-107

Assessment of Ecological Potential and the Benthic Macroinvertebrates of Eight Reservoirs in Bulgaria

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Abstract. Hydrobiological monitoring and assessment of ecological status (potential) of eight Bulgarian reservoirs were carried out in 2015-2016. The water bodies are located in Ecoregion 7: West (Pchelina Reservoir) and East Aegean River Basins (Chetiridesette Izvora, Konush and Sinyata Reka Reservoirs) and Ecoregion 12: Danube River Basin (Bebresh, Telish, Gorni Dabnik and Sopot Reservoirs). We assessed their ecological potential based on hydrochemical parameters, Secchi disk transparency and chlorophyll *a* from pelagial samples. Semi - quantitative macrozoobenthic samples were collected from the littoral zone. We identified 102 macroinvertebrate taxa, including alien and (potentially) invasive species: *Branchiura sowerbyi* (Oligochaeta); *Dikerogammarus villosus* (Amphipoda); *Dreissena polymorpha* and *Corbicula fluminea* (Bivalvia). Based on the bioindicative role of macrozoobenthos, a set of biotic indices and metrics (Irish biotic index, total taxon number and the German trophic index PETI) were also used to estimate the ecological potential of the studied reservoirs. Our results demonstrated a mismatch between macroinvertebrate and abiotic assessment metrics. Therefore, further research is needed to improve the use of benthic macroinvertebrates as a biological quality element for the estimation of ecological potential of reservoirs in Bulgaria.

Key words: environmental parameters, chlorophyll *a*, macrozoobenthos, ecological assessment metrics, modified stagnant water bodies.

Introduction

The Water Framework Directive (WFD) defines ecological potential of highly modified water bodies (HMWB) and artificial water bodies (AWB) as "an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters" (WFD CIS Guidance document 4, 2003). The objectives of environmental protection and ensuring good status (based on both biological and chemical metrics) of surface waters are regulated in the Water Act of Bulgaria (State Gazzette, 1999). Three sets of quality elements have been proposed for the estimation of ecological status (potential) for different categories of surface water bodies: physical and chemical, hydromorphological and biological. The biological quality elements

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have a leading role in assessing the ecological conditions (Directive 2000/60/EC).

While the use of macrozoobenthos in the assessment of ecological status of rivers is enshrined in the Bulgarian legislation (Ordinance N4, 2013), there are no metrics adopted specifically for different lake types. According to the WFD CIS Guidance document 4 (2003), benthic invertebrate fauna is the most relevant group for ecological assessment of littoral and pelagial zones in HMWB and AWB. In some cases the following metrics for the estimation of ecological status of lakes (potential for reservoirs) are being used with greater or lesser success: total taxon number (TTN), total abundance, % Oligochaeta abundance and the adapted German trophic index PETI (CHESHMEDJIEV *et al.*, 2010; CHESHMEDJIEV & VARADINOVA, 2013).

The adapted Irish biotic index (YANEVA & CHESHMEDJIEV, 1999) has been used as a main tool in routine monitoring of ecological status and rapid biological assessment of river water quality in Bulgaria over the last 15 years. Its use in river basin management plans (RBMPs) of the East Aegean, West Aegean and Danube Basin Directorates follows the national legislation (Ordinance N4/2013; MARINOV *et al.*, 2016; RBMP of West Aegean Basin Directorate, 2016; RBMP of Danube Basin Directorate, 2016). The indicators, which are used to evaluate ecological status/potential of standing water bodies are still under development. The need to fill these gaps in knowledge of aquatic ecosystems in the different categories of water bodies is urgent, owing to the dynamically changing environmental situation and the implementation of the WFD with new approaches to water management.

Our aim was to assess the ecological potential of eight reservoirs in Bulgaria based on various abiotic and biotic metrics, initially developed for ecological status of natural water bodies. We used accepted metrics following Ordinance N4 (2013), Directive 2000/60/EC, such as primary production (chlorophyll *a*) and some environmental parameters. Further, we tested macroinvertebrate biotic indices, which are normally used for large lowland rivers (the Irish biotic index, TTN and PETI) and compared the results.

Material and Methods

Study area

Samples were collected from eight reservoirs (Bebresh, Pchelina, Gorni Dabnik, Telish, Sopot, Sinyata Reka, Konush and Chetiridesette Izvora Reservoirs; Fig. 1, Table 1) in the period 2015-2016. The studied reservoirs are located in both Ecoregion 7 and 12 on the territory of Bulgaria. They belong to six different lake types, according the WFD (Directive, 2000/60/EC) and the national typology of water bodies (CHESHMEDJIEV & VARADINOVA, 2013). Only Bebresh Reservoir has been classified as a mountain lake, while the others are reservoir lakes (BELKINOVA *et al.*, 2013). Sopot (L12), Pchelina (L13) and Gorni Dabnik (L14) Reservoirs are polymictic, middle and small lowland mesotrophic reservoirs. Telish Reservoir (L16) and Konush, Chetiridesette Izvora and Sinyata Reka (all L17) are small lowland meso- to eutrophic reservoirs (BELKINOVA *et al.*, 2013).

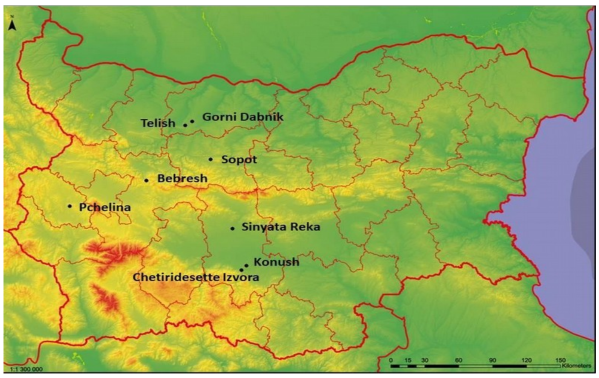

Fig. 1. Map of Bulgaria and location of the studied reservoirs.

Table 1. Sampling sites and basic information of the studied reservoirs.

Reservoir	Lake type	Lake area (ha)	Max depth (m)	Latitude N	Longitude E	Altitude (m a.s.l.)	Use
Bebresh	L2	73.6	20	42,84597	23,77806	454	Drinking water supply, irrigation
Sopot	L12	5 35	28	43,00786	24,42786	374	Irrigation
Pchelina	L13	538	19	42,51723	22,84385	664	Irrigation, industrial water supply, fish farming
Gorni Dabnik	L14	11 80	23	43,36828	24,32742	171	Industrial water supply
Telish	L16	2 32	28	43,3163	24,24247	230	Industrial water supply, commercial and recreational
Konush	L17	37.7	5	42,08147	25,03406	237	Irrigation, fish farming
Sinyata Reka	L17	52.8	6	42,46888	24,70333	309	Irrigation, fish farming
Chetiri-desette Izvora	L17	48.9	30	42,00530	24,93836	240	Irrigation

Gorni Dabnik, Telish, Konush and Sinyata Reka Reservoirs have been classified as HMWB and Bebresh, Pchelina, Sopot and Chetiridesette Izvora Reservoirs - as AWB (see Marinov *et al.*, 2016; RBMP of West Aegean Basin Directorate, 2016; RBMP of Danube Basin Directorate, 2016).

Sample collection and processing

Temperature, oxygen and conductivity were measured *in situ* using WTW portable meters (series 330i). The concentrations of total phosphorus (TP) and pH were determined according BNS ISO 10523:2012 and EN ISO 6878:2005, using portable photometer WTW, pHotoFlex Turb. Water transparency (SD) was measured using a Secchi disk with a diameter of 0.25 m. Chlorophyll *a* (chl *a*) was quantified from a composite sample from the pelagial (ISO 10260: 2002), representative of the euphotic zone of each of the monitored sites. In addition, we registered visually the presence of phytoplankton blooms (green/brown colouration) in the surface water layer (see Table 2).

A total of 20 semi-quantitative composite macroinvertebrate samples were collected with a hand-net (500 µm mesh size) from about 1 m^2 bottom in the littoral of the reservoirs (EN ISO 10870:2012). The invertebrates were sorted in the laboratory and identified to species or the nearest possible taxon level.

Assessment of ecological potential

The ecological potential based on abiotic parameters and chl *a* was determined according Ordinance N4 (2013). We used the ranges for the corresponding lake types, adapted for HMWB and AWB (see WFD CIS Guidance Document No., 4 2003): three ranges for physical and chemical metrics - good ecological potential (GEP), moderate (MoEP) and poor (PEP) and four ranges for chl *a* - GEP, MoEP, PEP and bad (BEP).

Currently, there are no criteria in use according Ordinance N4 (2013) for the assessment of ecological status of lakes using macrozoobenthos. Hence, we tested its bioindicative ability for ecological assessment of HMWB/ AWB, based on metrics (and their ranges) normally used for large lowland rivers (Cheshmedjiev & Varadinova, 2013). We calculated the adapted Irish biotic index (Yaneva & Cheshmedjiev, 1999), total taxon number based on the Irish biotic index (TTN), modified German trophic index PETI (Schweder, 1990), % Oligochaeta from the total abundance and Oligochaeta-based indices as defined by Parele & Astapenok (1975). The latter include: D2 (ratio of the abundance of tubificid species to all oligochaetes), D3 (ratio of the abundance of a specific tubificid species to all oligochaetes, including family Tubificidae) and D4 (ratio of the abundance of a specific tubificid species to all tubificids). Then these results were compared with our results on abiotic metrics and chl *a*.

Colour coding of different ranges of ecological potential follows WFD CIS Guidance Document No. 4 (2003): GEP - green and dark/ light grey stripes, MoEP - yellow and dark/ light grey stripes, PEB - orange and dark/ light grey stripes and BEP - red and dark/ light grey stripes, correspondingly for HMWB/ AWB.

Environmental factors and relevant ecological assessment

Various metrics indicated different ecological potential, while part of the measured values of the water parameters were outside the ranges for GEP. The values of the conductivity were relatively low and indicated GEP (Table 2). The values of the dissolved oxygen and its concentration were very high and outside the ranges or corresponded to GEP. The pH maintained values corresponding to GEP for five of the reservoirs; outside the ranges were the Chetiridesette Izvora, Sinyata Reka and Konush Reservoirs (pH > 9). The transparency in Telish, Konush, Sinyata Reka and Pchelina Reservoirs was very low and indicated MoEP. The values for TP also indicated MoEP for all lakes but Sopot and Konush Reservoirs during the summer, which had GEP. The highest value of chl *a* was measured in the Sinyata Reka Reservoir (78.19 µg. dm^{-3}), which corresponded to BEP. For all the other reservoirs, the values fluctuated between 0.60 and 78.19 µg.dm^{-3} across the different seasons (Table 2).

Taxonomic composition of the macrozoobenthos community

A total of 102 different taxa were determined in the studied reservoirs (Appendix 1). The most taxon-rich were: family Chironomidae (Diptera) – 32 taxa, followed by order Coleoptera (14), suborder Heteroptera (13) and subclass Oligochaeta (11). The highest number of taxa was recorded in the summer of 2015 in the Telish Reservoir (32) and in the spring of 2016 in the Konush Reservoir (18), while the lowest was the richness during the summer in the Sinyata Reka Reservoir (2).

The alien oligochaete *Branchiura sowerbyi* Beddard, 1892, amphipod *Dikerogammarus villosus* (Sowinsky, 1894), bivalves *Dreissena polymorpha* (Pallas, 1771) and *Corbicula fluminea* (O. F. Muller, 1774) were also found (Appendix 1). All of them were registered in autumn 2016 in the Gorni Dabnik Reservoir, while one or two species were recorded in the Sopot, Telish, Bebresh or Pchelina Reservoirs.

The highest density of bottom macroinvertebrates was recorded in summer 2016 in Konush (2062 ind.m^{-2}) and Telish in summer 2015 (1309 ind.m^{-2}), followed by 1197 ind.m^{-2} in spring 2016 in the Konush Reservoir. We registered the lowest density in spring in 2016 in the Bebresh Reservoir (16 ind.m^{-2}).

Macrozoobenthos and assessment of ecological potential

Most reservoirs had MoEP as based on the Biotic index (BI), with scores between 2-3 and 3 (Table 3). In only one reservoir (Telish, summer 2015) was determined GEP (BI=3-4) and two reservoirs, Bebresh (spring 2016) and Sinyata Reka (summer 2016), had PEP based on BI. The number of taxa indicated GEP or MoEP in most of the studied reservoirs. The highest TTN was registered in Telish Reservoir (17 taxa in summer 2016 and 14 in autumn 2016). Poor ecological potential was identified in three cases: Bebresh (summer 2016), Telish (spring 2016) and Sinyata Reka (summer 2016), where TTN was between 4 and 6 (Table 3).

According to the values of the PETI, Bebresh and Sopot Reservoirs had GEP and above (both in summer 2015). In five reservoirs, mostly in summer, we registered GEP, while Pchelina was classified with MoEP in spring 2016. In spring and autumn, PETI indicated mainly BEP (Table 3).

Oligochaeta-based indices were not always applicable because this group was sometimes absent from the macrozoobenthic community. The percentage of Oligochaeta, calculated for nine of the samples indicated GEP, in the rest of them this group was lacking (Table 3). The values of D2 were in the upper limit (0.8 - 1.0) of the scale and defined all water bodies as highly polluted. The only exception was autumn 2016 (Telish: D2 corresponded to relatively pure waters and we registered high difference between the values of D3 and D4; Table 4).

Table 2. Environmental parameters of the studied reservoirs measured in 2015-2016. Legend: Cond – conductivity (µS/cm); DO - dissolved oxygen (mg.dm^{-3}); O_2 - oxygen concentration (%); SD - Secchi depth (m), TP - total phosphorus (mg.dm^{-3}); chl *a* - chlorophyll *a* (µg.dm^{-3}); PB - "+" presence of phytoplankton blooms. For colour coding see "Material and Methods".

Reservoir	Season	Year	Cond	DO	O_2	pH	SD	TP	Chl *a*	PB
Pchelina	summer	2015	69.5	13.5	168	8.24		<0.01		
Pchelina	spring	2016	652	20.8	231	8.68	1.2	1.41	1.18	+
Bebresh	summer	2015	104.3	9.2	115	7.81		<0.01		
Bebresh	spring	2016	148.8	8.8	93	8.82	2.8	0.86	7.11	
Telish	summer	2015	171.8	9.8	110	8.23		<0.01		
Telish	spring	2016	224	9.1	102.3	8.65	0.5	0.77	11.85	+
Telish	autumn	2016	261	9.7	85	9	0.8	0.08	2.37	
Chetiride-sette Izvora	spring	2016	347	8.73	89	8.42	1.4	1.71	26.66	+
Sopot	summer	2016	304	9.25	113.6	7.13	3.4	0.8	8.51	+
Konush	summer	2016	199	9.5	121	10.4	0.6	0.071	9.87	+
Konush	spring	2016	617	13.7	151.2	8.58	0.6	1.46	78.19	+
Gorni Dabnik	summer	2015	224	9.9	116	8.39		<0.01		
Gorni Dabnik	spring	2016	250	8.97	99	8.71	3.7	0.8	2.37	
Gorni Dabnik	autumn	2016	273	10.4	93	8.8	1.7	0.08	0.6	
Sinyata Reka	summer	2016	370	14.1	160.2	9.39	0.8	0.87	2.22	+

Table 3. Ecological potential of the studied reservoirs in 2015-2016 based on macrozoobenthic BI, TTN and PETI indices. For colour coding see "Material and Methods".

Reservoir	Season	Year	TTN	BI	PETI	% Oligo
Pchelina	summer	2015	9	2--3	0.6	-
Pchelina	autumn	2015	11	3	0.29	-
Pchelina	spring	2016	11	3	0.25	-
Bebresh	summer	2015	11	3	0.93	4.45
Bebresh	spring	2016	4	2	-	19.05
Telish	summer	2015	17	4--3	0.62	17.44
Telish	spring	2016	6	2--3	0.12	-
Telish	autumn	2016	14	3	0.58	1.11
Chetiridesette Izvora	spring	2016	9	2--3	0.17	2.43
Sopot	summer	2015	10	2--3	0.95	6.9
Sopot	summer	2016	8	2--3	0.6	0.68
Konush	summer	2016	11	3	0.67	9.62
Konush	spring	2016	13	3	0.08	-
Gorni Dabnik	summer	2016	11	3	0.22	-
Gorni Dabnik	spring	2016	10	2--3	0.79	-
Gorni Dabnik	autumn	2016	8	2--3	0.14	5
Sinyata Reka	summer	2016	5	2	-	-

Table 4. Oligochaeta-based indices for the studied reservoirs following PARELE & ASTAPENOK (1975).

Reservoir	Season	Year	D2	D3	D4
Bebresh	summer	2015	1	0.77	0.77
Telish	summer	2015	0.99	0.99	0.99
Telish	autumn	2016	0.2	0.2	1
Sopot	summer	2015	1	1	1
Gorni Dabnik	autumn	2016	1	1	1

Discussion

Reference conditions for lake types are determined by the specific biological elements (in this case benthic invertebrates) and the supportive physical, chemical and hydromorphological characteristics (Directive, 2000/60/EC). The studied reservoirs have variable hydrometric conditions in terms of water surface area, depth and rate of water fluctuations as reflected also by their different lake type (BELKINOVA *et al.*, 2013). Three of them are large reservoirs, Gorni Dabnik (1180 ha), Sopot (535 ha) and Pchelina (538 ha), while the smallest Konush Reservoir has a surface area of only 37.7 ha. The low SD transparency in Pchelina, Telish, Konush and Sinyata Reka Reservoirs could be related to the visually registered phytoplankton blooms during our sampling, which triggered also the high concentration of dissolved oxygen in the same reservoirs. On the other hand, the highest values of SD were measured in the Gorni Dabnik and Sopot Reservoirs, where the mussels *Dreissena polymorpha* was registered. This bivalve is known to be an efficient filter feeder (e.g. MacIsaac, 1996; Trichkova *et al.*, 2013; Kalchev *et al.*, 2014) and must be responsible for the considerable increase in transparency in the reservoirs. Water transparency, pH and dissolved oxygen concentration are among the variables most affected by and most important for the mussel distribution (Caraco *et al.*, 2000; Kalchev *et al.*, 2012).

The values of pH indicated GEP for most samples, while these of TP suggested MoEP. The alkaline pH in the shallow reservoirs Konush and Sinyata Reka were likely due to hypoxic conditions and pollution from wastewater. Such conditions may lead to eutrophication and to affect greatly macroinvertebrate communities (Li-Na Du *et al.*, 2017). As a consequence, mass death of fish was observed in the summer of 2016 in Sinyata Reka Reservoir. Seasonal variations of chl *a* in all reservoirs could be explained with possible correlation between water-level fluctuations and presence/absence of submerged macrophytes (Zohary & Ostrovsky, 2011; Kalchev *et al.*, 2012; Song *et al.*, 2019).

According RBMP of the Danube (2016), physical and chemical parameters in Telish and Gorni Dabnik Reservoirs indicated GEP in 2016-2017. Based on our result, these water parameters were variable and indicated different ecological potential (GEP and above or MoEP) or were outside the ranges. The TP concentration could be used as a measure of eutrophication level (e.g. Blabolil *et al.*, 2016; Bobori *et al.*, 2018). We recorded high concentration of TP for the Telish and Gorni Dabnik Reservoirs, which corresponded to MoEP. Data from the RBMP of the Danube (2016), based on physical and chemical parameters identified the potential of the Sopot Reservoirs as MoEP, while based on our results the concentrations for TP and chl *a*, it had GEP.

Most of the identified macrozoobenthic taxa are commonly found in Bulgarian reservoirs with corresponding typology (Vidinova *et al.*, 2016) and we consider the established taxonomic composition to be representative to be used for assessment of ecological potential. We found one or more alien species in five of the reservoirs. On the one hand, alien and invasive species are more pollution-tolerant and they can influence environmental assessment (Uzunov, 1977; Cardoso & Free, 2008; MacNeil & Briffa, 2009; Orendt *et al.*, 2009; MacNeil *et al.*, 2012). On the other hand, environmental stress could increases the susceptibility of lakes to successful colonisation by invasive species (Evtimova *et al.*, 2019).

The ecological potential of the studied reservoirs was estimated in the range from good to bad, based on macroinvertebrate metrics. It is important to note that, the high number of species in the samples could not readily indicate GEP. Eurybiotic species are expected in these conditions, as we have a variety of disturbances in the littoral zone. Most of the recorded taxa are of Hirudinea, Gastropoda, Bivalvia and Chironomidae and are indicative of eutrophic conditions (MoEP). Thus, TTN estimates higher potential than BI and likely GEP corresponds to MoEP. MoEP based on BI is registered in seven reservoirs, which may be due to their use: intensive irrigation, industrial water supply, angling, aquaculture and commercial fishing, and lead to degraded environmental conditions (Trichkova *et al.*, 2013; Evtimova & Donohue, 2016; Simons *et al.*, 2019). According Cheshmedjiev & Varadinova (2013), PETI provides inconclusive results for lakes, which was confirmed also by our results. In a future study, we will test and compare the reliability of trophic indices for the assessment of the ecological potential with the saprobiotic indices of Pantle-Buk (1955) and Rothsctein (1962).

Oligochaeta-based indices had limited application in the estimation of the ecological potential of the studied reservoirs, as oligochaetes were recorded in six and tubificids - in five of them. Tubificidae endures hypoxic and anoxic conditions and generally consume organic waste which transform in faeces, containing mineral particles and ultrafine organics (GEORGIEVA *et al.*, 2012; RIVERA-USME *et al.*, 2015). Supported by the fact that all reservoirs had GEP, based on the %Oligochaeta, while the ratio between the registered tubificids to the overall number of oligochaetes classified most of the reservoirs (with tubificids recorded) as organically polluted. This was confirmed by the overall similar values of the indices D3 and D4 according PARELE & ASTAPENOK (1975).

Although reservoirs share some common features with lakes, they have higher nutrient inputs and water-level fluctuations, leading to intensified eutrophication and/or producing a shift in communities (EVTIMOVA & DONOHUE, 2016; BOBORI *et al.*, 2018). The association among biological, physical, chemical and morphological components of the ecosystems is the basis of hydrobiological monitoring and overall classification of the ecological potential. Generally, we found a mismatch between the estimated ecological potential based on various macroinvertebrate and abiotic assessment metrics. According LYCHE-SOLHEIM *et al*. (2013), the major variability of littoral benthic invertebrates is partly defined by the consistent effects of morphological pressures, typical for HMWB and AWB. This is one of the reasons WFD requires a solid link between the variability in the structure of macrozoobenthic invertebrates (as a BQE) across European water bodies and their ecological potential (Directive 2000/60/EC). This appears to be a challenging task in the case of reservoirs, owing to the numerous pressures that affect their communities (e.g. GROOM & HILDREW, 1989; EVTIMOVA & DONOHUE, 2014) and special approach should be employed when applying different status classification metrics. In addition, the ecological potential of HMWB or AWB does not depend on the surface area or depth of the water body (MAZUR *et al.*, 2017), but is a result of physical alterations by human activity (DIRECTIVE 2000/60/EC).

Conclusion

Currently, the metrics adapted for the assessment of ecological status of Bulgarian lakes and reservoirs, based on benthic macroinvertebrates are poorly researched. Therefore, we tested metrics using this quality element (in the sense of WFD) with assessment ranges applicable for large lowland rivers, as suggested in the Bulgarian legislation. Our results demonstrated that different metrics provided different (sometimes contrasting) estimation of ecological potential. This mismatch might not be triggered by the ranges of the used metrics but by the fact that the specific taxon composition is influenced by numerous factors, natural or human-induced, like the variability of hydrological regime and the associated shift of the littoral. Thus, estimation of status based on the ratio between different macrozoobenthic groups (PETI, % Oligochaeta) could prove unreliable, especially in reservoirs with higher water-level fluctuations. Additionally, the loss of sensitive taxa can be a useful indicator of widespread environmental degradation, including eutrophication. Further studies are needed to test other metrics for the assessment of ecological potential of reservoirs and the need to adapt them for HMWB and AWB. Among the possible candidates are various trophic indices, autecological data or saprobic valencies of selected species.

Acknowledgements

The Oligochaeta determination and index calculation is funded by "Program for Support of Young Researchers and PhD Students at the Bulgarian Academy of Sciences (Grant no.DFNP-17-145/ 01.08.2017)”.

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Received: 31.10.2018
Accepted: 31.05.2018

Appendix 1. List of benthic macroinvertebrates found in the studied reservoirs. Legend: Sp – spring, Su – summer, Au – autumn, 15 – 2015, 16 – 2016, Be – Bebresh, Db – Gorni Dabnik, Te – Telish, Ch – Chetiridesette Izvora, Ko – Konush, So – Sopot, Pc – Pchelina, SR – Sinyata Reka, * - invasive species.

OLIGOCHAETA	
Oligochaeta indet.	PcSp16, DbSp16
Enchytraeidae	
Enchytraeus sp. cf. *albidus* Henle, 1837	TeAu16
Fridericia sp.	BeSp16
Lumbricidae	
Lumbricidae g. sp. juv.	TeSu15, TeAu16
Lumbriculidae	
Lumbriculus variegatus (Muller, 1774)	TeAu16
Naididae	
Nais variabilis Piguet, 1906	ChSp16, KoSu16
Ophidonais serpentina (Muller, 1774)	BeSu15, TeSu16
Stylaria lacustris (Linnaeus, 1767)	ChSp16, SoSu16
Tubificidae	
**Branchiura sowerbyi* Beddard, 1892	BeSu15, TeSu15, TeAu16, SoSu15, GDAu16
Limnodrilus claparedianus Ratzel, 1869	TeSu15
Limnodrilus sp.	BeSu15, TeSu15, GDAu16
Tubifex tubifex (Muller, 1774)	GDAu16
HIRUDINEA	
Erpobdellidae	
Erpobdella octoculata (Linnaeus, 1758)	GDAu16
Glossiphonidae	
Glossiphonia complanata (Linnaeus, 1758)	TeAu16, GDAu16
Helobdella stagnalis (Linnaeus, 1758)	PcAu15, BeAp15
Placobdella costata (Fr. Muller, 1846)	PcAu15, PcAp16
AMPHIPODA	
Gammaridae	
* *Dikerogammarus villosus* (Sowinsky, 1894)	GDSu16, GDAu16
Gammarus dacicus (Dobrenau & Manolache, 1942)	TeAu16, GDAu16
Gammarus komareki Schaferna, 1922	ChSp16
ISOPODA	
Asellidae	
Asellus aquaticus (Linnaeus, 1758)	PcAu15, TeAu16, SoSu16, GDAu16
EPHEMEROPTERA	
Baetidae	
Cloeon dipterum (Linnaeus, 1761)	PcSu15, PcAu15, BeSu15, ChSp16, SoSu15, KoSu16, KoSp16, GDSu15
Cloeon simile Eaton, 1870	GDSu15
Caenidae	
Caenis robusta Eaton, 1884	PcAu15, BeSu15, TeSu15, SoSu15, GDSu15, GDSu16
ODONATA	
Coenagrionidae	

Ceriagrion tenellum (de Villers, 1789)	PcSp16
Ischnura elegans (Vander Linden, 1820)	PcSu15, PcAu15, TeSu15, SoSu15, KoSu16, GDSu15, GDSu16
Gomphidae	
Gomphus vulgatssimus (linnaeus, 1758)	BeSu15
Libellulidae	
Crocothemis erythraea (Brulle, 1832)	TeSu16, GDSu16
Orthetrum albistylum (Selys, 1848)	BeSp16, GDSu15
HETEROPTERA	
Corixidae	
Sigara iactans Jansson, 1983	ChSp16, KoSu16, SRSu16
Sigara lateralis (Leach, 1817)	KoSu16, SRSu16
Sigara striata (Linnaeus, 1758)	PcSu15, PcAu15, KoSu16, SRSu16
Sigara sp.	TeAu16, KoSu16,
Gerridae	
Aquarius paludum (Fabricius, 1794)	KoSp16
Gerris sp.	PcSu15, TeSu15, TeSp16, TeAu16, GDSu16
Micronectidae	
Micronecta pusilla (Horváth, 1895)	ChSp16
Micronecta scholtzi (Fieber, 1860)	PcSu15, BeSp16, TeAu16, SoSu15, SoSu16, KoSu16, KoSp16
Micronecta sp.	BeSu15, TeSu15, TeSp16, SoSu16, GDSu16
Naucoridae	
Ilyocoris cimicoides (Linnaeus, 1758)	PcSu15, KoSu16, KoSp16
Nepidae	
Nepa cinerea Linnaeus, 1758	TeSu15, KoSp16
Notonectidae	
Notonecta sp.	PcSp16, SoSu16, KoSu16, SRSu16
Pleidae	
Plea minutissima Leach, 1817	KoSp16, SRSu16
COLEOPTERA	
Dytiscidae	
Agabus sp.	TeSu15
Cybister sp.	GDSu15
Herophydrus sp.	KoSp16
Laccophilus minutus (Linnaeus, 1758)	KoSp16
Nebrioporus/Deronectes g. sp.	TeSu15
Gyrinidae	
Orectochilus villosus villosus (Müller O.F., 1776)	KoSp16
Helophoridae	
Helophorus (Rhopahelophorus) flavipes Fabricius, 1792	KoSp16
Helophorus (Rhopahelophorus) griseus Herbst, 1793	KoSp16
Helophorus (Rhopahelophorus) longitarsis Wollaston, 1864	KoSp16
Hydrophilidae	
Chaetarthria sp.	KoSu16
Coelostoma sp.	TeSu15, KoSp16
Cymbiodyta marginella (Fabricius, 1792)	TeSu15, KoSp16

Enochrus (Lumetus) bicolor (Fabricius, 1792)	TeSu15, KoSp16
Spercheus emarginatus (Schaller, 1783)	KoSp16
TRICHOPTERA	
Ecnomidae	
Ecnomus tenellus (Rambur, 1842)	TeSu15, SoSu15
Hydropsychidae	
Hydropsyche angustipennis (Curtis, 1834)	TeAu16
Hydropsyche sp. (early instar larvae)	TeAu16, GDSu16
Leptoceridae	
Oecetis cf. *ochracea* (Curtis, 1825)	PcSu15, BeSu15
Limnephilidae	
cf. *Micropterna lateralis* (Stephens, 1837)	BeSu15
DIPTERA: varia	
Chaoboridae	
Chaoborus (Chaoborus) crystallinus (De Geer, 1776)	PcSu15
Scatophagidae g. sp.	TeSu15
Ephydridae g. sp.	TeSu15
Rhagionidae g. sp.	TeSu15
Ceratopogonidae g. sp.	PcSu15, BeSp16, TeSu15, SoSu15, GDSu15, GDAu16, SRSu16
Culicidae g. sp.	PcAu15
Limoniidae g. sp.	TeSu15
Psychodidae	TeSu15
Tabanidae g. sp.	TeAu16, GDSu15
Tipulidae g. sp.	PcAu15, TeAu16
DIPTERA: Chironomidae	
Chironomidae g. sp.	PcAp16, SoSu16, GDSu16, SRSu16
Ablabesmyia longistyla Fittkau, 1962	SoSu15
Ablabesmyia mallochi (Walley, 1925)	BeSu15
Brillia bifida (Kieffer, 1909)	BeSp16
Chironomus gr. *plumosus* (Linnaeus, 1758)	KoSp16
Cladotanytarsus lepidocalcar Krueger, 1938	KoSp16, SRSu15
Cladotanytarsus sp.	BeSu15, TeSu15, KoSu16
Cricotopus flavocinctus (Kieffer, 1924)	KoSp16
Cricotopus (C) sp.	TeSu15
Cricotopus (Isocladius) gr. *sylvestris* (Fabricius, 1794)	PcAu15, TeSu15, TeSp16, ChSp16
Cricotopus (Isocladius) sp.	
Cryptochironomus supplicans (Meigen, 1830)	BeSu15, TeSu15, SoSu15
Einfeldia sp.	KoSp16
Endochironomus sp.	KoSu16
Eukiefferiella gr. *devonica* (Edwards, 1929)	KoSu16
Eukiefferiella sp.	PcSu15
Glyptotendipes pallens (Meigen, 1804)	KoSu16
Glyptotendipes sp.	PcSu15, PcAu15, TeSu15, SRSu15
Glyptotendipes cauliginellus (Kieffer, 1913)	KoSu16, KoSp16
Harnischia sp.	BeSu15
Parachironomus sp.	PcSu15, TeSu15, TeSp16
Paratanytarsus sp.	KoSp16

Paratrissocladius excerptus (Walker, 1856)	BeSp16
Polypedilum sordens (van der Wulp, 1875)	PcAu15, TeSp16, KoSu16
Polypedilum nubeculosum (Meigen, 1804)	PcSu15, BeSu15
Polypedilum (Tripodura) bicrenatum Kieffer, 1921	PcAu15, TeSu15, ChSp16, SoSu15 KoSu16
Polypedilum sp.	ChSp16
Procladius (Holotanypus) sp.	PcSu15, BeSu15, SoSu15, GDSu15
Psectrocladius (Ps.) limbatellus (Holmg., 1869) */sordidellus (Zett., 1838)*	BeSu15
Tanypus punctipennis Meigen, 1818	PcSu15, GDSu15
Tanytarsus sp.	BeSu15, SoSu15
Stenochironomus sp.	TeAu16
GASTROPODA	
Limneidae	
Lymnaea stagnalis (Linnaeus, 1758)	PcSu15, PcAu15, PcSp16, SoSu15
Radix balthica (Linnaeus, 1758)	BeSu15
Radix auricularia (Linnaeus, 1758)	PcSu15, PcAu15, TeSu15, TeSp16, ChSp16, GDSu15
Planorbidae	
Ancylus fluviatilis O.F. Muller, 1774	TeAu16
Planorbarius corneus (Linnaeus, 1758)	ChSp16, KoSu16
Physidae	
Physella acuta (Draparnaud, 1805)	PcSp16, TeSu15, TeAu16, ChSp16, KoSu16, KoSp16, GDSu15, GDSu16
Viviparidae	
Viviparus acerosus (Bourguignat, 1862)	PcSu15, PcAu15, PcSp16, TeSu15, TeSp16, SoSu15, SoSu16, GDSu15, GDSu16
BIVALVIA	
Corbiculidae	
**Corbicula fluminea* (O. F. Muller, 1774)	GDAu16
Dreissenidae	
**Dreissena polymorpha* (Pallas, 1771)	PcAu15, PcSp16, TeSu15, TeSp16, SoSu15, SoSu16, GDSu15, GDAu16
Sphaeriidae	
Pisidium sp.	TeAu16
Unionidae	
Unio tumidus Philipson, 1788	GDAu16