Preliminary Data on Benthic Macroinvertebrate Communities in the Reservoirs Koprinka and Zhrebchevo (Aegean Sea River Basin, South Bulgaria)

Violeta Tyufekchieva[1], Yanka Vidinova[1], Ivan Botev[1], Teodora Trichkova[1], Lubomir Kenderov[1], Dimitar Kozuharov[2], Yordan Uzunov[1], Zdravko Hubenov[1], Stefan Stoichev[1]

[1] *Institute of Biodiversity and Ecosystem Research, BAS, 2 Gagarin Str., 1113- Sofia, Bulgaria, Email: vtyufekchieva@yahoo.com,*
[2] *Biological Faculty, Sofia University, 8 Dragan Tsnakov Blvd., 1164- Sofia, Bulgaria*

INTRODUCTION

Our goal was to make a comparative study of composition and distribution of benthic macroinvertebrate communities and their relation to water physicochemical parameters in two cascade reservoirs Koprinka and Zhrebchevo in the Aegean Sea river basin, Bulgaria.

STUDY AREA

The reservoirs Koprinka and Zhrebchevo are located along the Tundzha River in the East Aegean Sea River Basin (South Bulgaria), at altitudes of 390 m a. s. l. and 270 m a. s. l., respectively (**Fig. 1**). The Koprinka Reservoir has a surface area of 11.2 km^2 and water volume of 140 mill. m^3. The Zhrebchevo Reservoir is much bigger with water volume of 400 mill. m^3. The reservoirs are used for electricity production, irrigation, aquaculture and recreational fishing.

Fig. 1. Study reservoirs with location of samplig sites Koprinka - K1, K2,K3 and Zhrebchevo - Z1, Z2, Z3, Z4.

MATERIAL AND METHODS

The sampling was made in 2009-2010. Quantitative samples were collected in August 2009 with a Petersen bottom sampler (17.0x16.5 cm) at deeper sites (from 23 to 2.5 m) and a hand dredge (17.5 cm) at shallow sites (<2 m). Additionally, qualitative samples were collected in August 2009 and May 2010 by hand-net with mesh size of 250 μm at different substrate types in the littoral area (at depths <0.5 m). Three sites were sampled in the Koprinka Reservoir and four sites in the Zhrebchevo Reservoir (**Fig.1**).
Standard water physico-chemical parameters were measured and analyzed.

RESULTS AND DISCUSSION

Totally, 33 macrozoobenthic taxa were recorded in the two reservoirs (**Table 1**). Of them, 10 taxa belonged to chironomids, 7 to oligochaets, and 6 to mollusks. One bivalve mollusk species is considered invasive to the inland waters of Bulgaria: *D. polymorpha*. Most abundant of the macrozoobenthic invertebrates were oligochaets followed by chironomids, and bivalve mollusks (**Fig. 2**). The species with the highest abundance was *T. tubifex*, followed by *D. polymorpha, L. hoffmeisteri and Ch. gr. riparius* (**Table 1**).

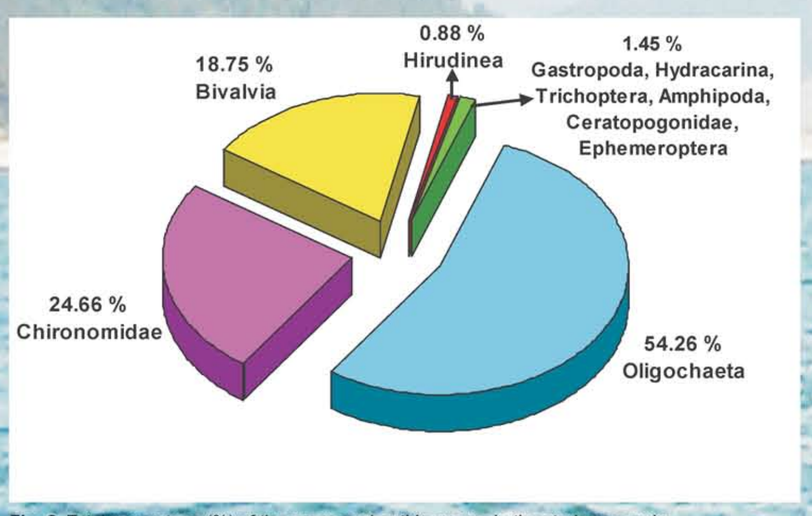

Fig. 2. Total percentage (%) of the macrozoobenthic groups in the study reservoirs.

Table 1. List of benthic macroinvertebrates found in the study reservoirs with total percentage and total abundance. (*) Species found in the littoral during qualitative sampling; (K) Koprinka Reservoir; (Z) Zhrebchevo Reservoir.

No.	Taxa	Species Code	Percentage, %	Abundance (K), ind./m^2	Abundance (Z), ind./m^2
	OLIGOCHAETA				
1	*Limnodrilus hoffmeisteri*	*Limnhof*	16.08	571	
2	*Limnodrilus udekemianus*	*Limnude*	4.35	154	
3	*Limnodrilus* sp.	*Limnind*	0.55	6	14
4	*Tubifex tubifex*	*Tibitub*	33.26	1176	5
5	*Dero digitata*	*Derodig*	0.01		1
6	*Nais pardalis*	*Naispar*	0.01		1
7	*Criodrilus lacuum**	*Criolac*			
	HIRUDINEA				
8	*Erpobdella octoculata*	*Erpooct*	0.44		16
9	*Helobdella stagnalis*	*Helosta*	0.06	1	1
10	**ARACHNIDA: HYDRACARINA**	*Hydrind*	0.38		14
	ISOPODA				
11	*Asellus aquaticus**	*Aselaqu*			
	AMPHIPODA				
12	*Gammarus* sp.	*Gammind*	0.02		1
	EPHEMEROPTERA				
13	*Caenis* sp.	*Caenind*	0.01		1
14	*Siphlonurus lacustris**	*Siphlac*			
	ODONATA				
15	*Libellula quadrimaculata**	*Libequa*			
16	**TRICHOPTERA**	*Trichind*	0.43	10	6
	DIPTERA				
	CHIRONOMIDAE				
17	*Cricotopus algarum*	*Cricalg*	0.38		14
18	*Cricotopus gr. sylvestris*	*Crgrsy*	1.41	2	48
19	*Cricotopus* sp.	*Cricind*	0.25		9
20	*Chironomus gr. plumosus*	*Chgrplu*	1.51	18	36
21	*Chironomus gr. riparius*	*Chgrrip*	15.80	511	50
22	*Chironomus* sp.	*Chirind*	0.25		9
23	*Cladotanytarsus mancus*	*Cladman*	0.25		9
24	*Criptochironomus gr. defectus*	*Crgrdef*	3.36	113	6
25	*Polypedilum nubeculosum*	*Polynub*	0.30		11
26	*Tanytarsus gr. gregarius*	*Tanygre*	1.15	39	2
	CERATOPOGONIDAE				
27	*Bezzia* sp.	*Bezzind*	0.16	6	
	GASTROPODA				
28	*Viviparus viviparus*	*Viviviv*	0.30		11
29	*Radix auricularia*	*Radiaur*	0.04		2
30	*Radix balthica*	*Radiball*	0.47		17
	BIVALVIA				
31	*Anodonta anatina**	*Anodana*			
32	*Unio pictorum**	*Uniopic*			
33	*Dreissena polymorpha*	*Dreipol*	18.75		666

Totally, 27 taxa belonging to 10 benthic systematic groups were recorded in the Zhrebchevo Reservoir and 14 taxa belonging to 7 benthic groups in the Koprinka Reservoir (**Table 1**). The invasive species *D. polymorpha* was recorded only in the Zhrebchevo Reservoir. Most abundant of the benthic macroinvertebrates in the Zhrebchevo Reservoir were Bivalvia (19%) followed by Chironomidae (5%). The species with the highest abundance was *D. polymorpha*. Most abundant of the benthic macroinvertebrates in the Koprinka Reservoir were Oligochaeta (54%) followed by Chironomidae (20%). The species with the highest abundance was *T. tubifex* (**Table 1**).

The average abundance of macrozoobenthos per site in the Koprinka Reservoir (2606 ind./m^2) was much higher than the Zhrebchevo Reservoir (944 ind./m^2). However, the abundance differed at different sites depending on sampling depth in the two reservoirs (**Fig. 3**). In the Zhrebchevo Reservoir, the highest abundance was recorded at site Z1 near the dam. It was due to the very high abundance of *D. polymorpha*, as well as chironomids and oligochaets. At other three sites the abundance was comparatively low. In the Koprinka Reservoir, the macrozoobenthos abundance was the highest at the two deeper sites K1 (24 m) and K2 (20 m) (**Fig. 3**). At site K1, it was due only to the oligochaets, while at site K2, the oligochaets and chironomids had almost equal densities. At shallow site K3 (6.5 m), the highest densities had the chironomids and trichopterans; oligochaets were not found.

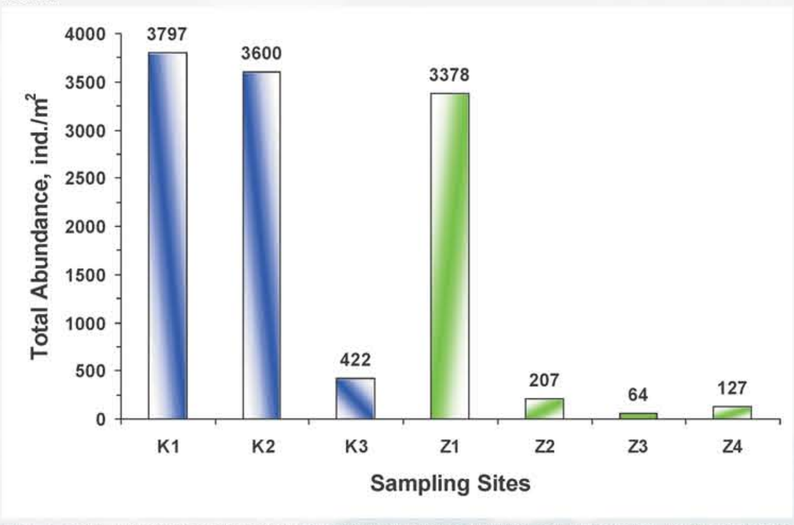

Fig. 3. Total abundance of benthic macroinvertebrates at three sampling sites in the Koprinka Reservoir (K1, K2, K3) and four sampling sites in the Zhrebchevo Reservoir (Z1, Z2, Z3, Z4).

The results of PCA analysis of physicochemical data are shown as correlation biplot diagram on **Fig. 4**. The first two principal components (λ_1= 0.707, λ_2=0.182) cumulatively explained 88.9% of total variance of data. The first axis is related to alkalinity, conductivity, Ca, Mg, K, HCO_3, Na, Cl, SO_4, DN, NO_3-N, DRSi and contrasts deeper sites in the Zhrebchevo Reservoir - Z1, Z2, Z3 (with higher values of these parameters), plotted on the left of the diagram, with deeper sites in the Koprinka Reservoir - K1, K2 (with lower values of above parameters, but higher of orthophosphate (P_{dis}) and total phosphorus (P_{tot}), plotted on the right of the diagram. The second axis is related to dissolved oxygen, pH and transparency, separating the shallow sites in both reservoirs (Z4, K3), plotted on the top of the diagram. They have higher values of dissolved oxygen and pH but low values of transparency. The highest values of transparency (350-450 cm) were measured at deeper sites in Zhrebchevo, the reservoir infested by *D. polymorpha* (**Fig. 4**).

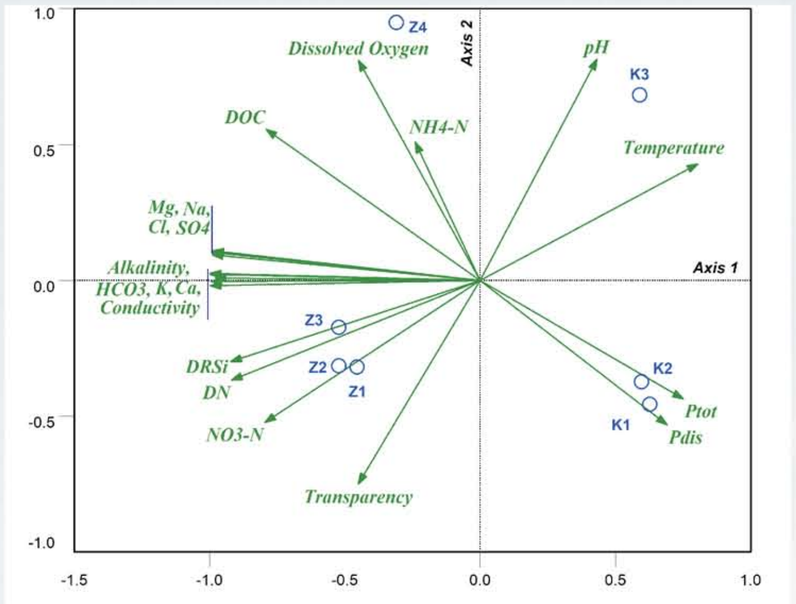

Fig. 4. Correlation biplot diagram based on principal component analysis of physicochemical variables from three sampling sites in the Koprinka Reservoir (K1, K2, K3) and four sampling sites in the Zhrebchevo Reservoir (Z1, Z2, Z3, Z4).

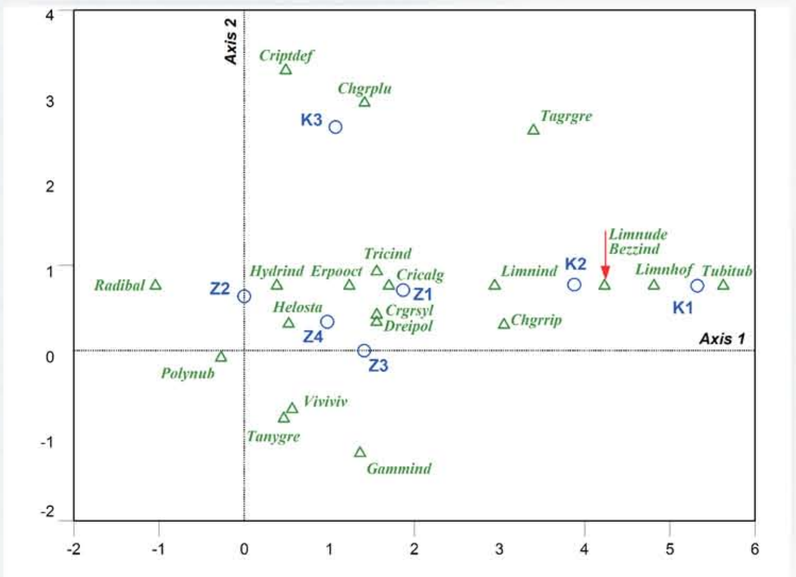

Fig. 5. Detrended correspondence analysis ordination diagram of macrozoobenthos data. K1, K2, K3 - Sampling sites in the Koprinka Reservoir; Z1, Z2, Z3, Z4 - sampling sites in the Zhrebchevo Reservoir. Only selected species with effective number of occurrences N_2>1 are displayed, with exception of some species with biological importance. For species codes see Table 1.

The results of ordination based on DCA of macrozoobenthos data are shown on **Fig. 5**. The eigenvalues (λ_1 = 0.809; λ_2 = 0.296) and length of gradient expressed in standard deviation units of species turnover (5.3 SD; 2.6 SD) of the first two axes denote a good separation of the species along the first axis. The variance explained by the first two axes is 25.8% and 9.4%. The oligochaet species *L. hoffmeisteri, L. udekemianus, T. tubifex*, the dipterean species *Bezzia* sp. and the chironomid *Ch.* gr. *riparius*, plotted on the right of diagram, have the highest species scores for the first axis (between 5.63 and 3.10). The species *L. hoffmeisteri, L. udekemianus* and *Bezzia* sp. were recorded only at deeper sites of the Koprinka Reservoir, where the content of orthophosphate and total phosphorus were higher than in the Zhrebchevo Reservoir, and there was dissolved oxygen deficit (1.5÷1.3 mg/l, saturation 16÷15 %) at bottom water layers. The species *T. tubifex* and *Ch. gr. riparius* were found also at deeper sites in the Zhrebchevo Reservoir but their abundance in the Koprinka Reservoir was much higher. According to some authors many species of tubificid oligochaets and chironomids are tolerant to low dissolved oxygen, such that these become the dominant profundal invertebrates in freshwater ecosystems. Also, the presence of high content of organic matter deposited on the bottom enhances the abundance of detritivores species such as *L. hoffmeisteri*, which was found only in the Koprinka Reservoir.

The deeper sampling sites in the Zhrebchevo Reservoir (Z1, Z2, Z3) with the highest values of transparency, DRSi, alkalinity, conductivity and the shallow site (Z4) in the same reservoir with the highest values of dissolved oxygen (**Fig. 4**) are dominated by the bivalve species *D. polymorpha*, the chironomids *Cr. gr. sylvestris, Cr. algarum, C. mancus, P. nubeculosum*, the leeches *E. octoculata* and the gastropods *Rh. balthica, V. viviparus*, plotted on the left of the ordination diagram. The Zhrebchevo Reservoir which is infested by *D. polymorpha* is characterized with high abundance of chironomids, leeches and snails. According to some authors the suspended matter agglutinated by zebra mussels was a very good food source for the chironomid species. The occurrence of zebra mussels also had positive effects on the densities of the scrapers and predators, particularly the leeches (Hirudinea). They are more abundant in the presence of zebra mussels. Gastropod densities also increased in the presence of zebra mussels, while large-bodied snail taxa tended to decline.

CONCLUSIONS

- The two study reservoirs in the East Aegean Sea River Basin, South Bulgaria were characterized with comparatively high diversity of benthic macroinvertebrate taxa (33), dominated by three macroinvertebrate groups Oligochaeta, Chironomidae and Bivalvia.
- The Zhrebchevo Reservoir which is infested by the invasive bivalve species *D. polymorpha*, was characterized by higher taxa diversity of benthic macroinvertebrates than the non-infested Koprinka Reservoir. However, the macrozoobenthos abundance was much higher in the Koprinka Reservoir.
- The quantitative diversity of macrozoobenthic taxa in the reservoirs was determined mainly by alkalinity, DRSi, orthophosphate (P_{dis}), total phosphorus (P_{tot}) content, pH, and dissolved oxygen.

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