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CHANGES IN THE ZOOPLANKTON COMMUNITY OF THE ECOTONE ZONE BETWEEN ISKAR RIVER AND ISKAR RESERVOIR AND THE PELAGIAL OF THE RESERVOIR

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Abstract: Iskar Reservoir is the largest reservoir in Bulgaria and provides more than 2/3 of the water for the capital Sofia. There are no data about the zooplankton of the reservoir for the last 30 years. The qualitative and quantitative zooplankton parameters in the ecotone zone Iskar river – Iskar reservoir were studied from July 2009 to March 2014. The zooplankton community was composed of 29 species of Rotifera, 17 species of Cladocera, 4 species of Copepoda and 3 species of Protozoa. Some not typical plankton elements were also found. The broad characteristics of the zooplankton in Iskar reservoir were compared with the available previous data and publications. There is a significant difference in the species composition. *Daphnia hyalina* and *Syda crystalina* are among the dominants in earlier periods. Recently these two species weren't found in the zooplankton composition of Iskar reservoir. Among the copepods *Thermocyclops crassus* is a species, that a few years ago occurs sporadically in Bulgarian waters. At present, it is common for Iskar reservoir. The cladocera *Leptodora kindti* was registered for the first time in the reservoir. Some relations were found between the trophic state of the reservoir and the zooplankton community. The obtained preliminary results from this study indicate an advanced process of eutrophication.

INTRODUCTION

The zooplankton plays an important role in the functioning of lake, pond and reservoir ecosystems by serving as a channel for energy flux from the primary producers to the top consumers (Stockner and Porter 1988). Changes in the zooplankton species composition induced by pollution, therefore, may affect the functioning of freshwater ecosystems (Bays and Crisman, 1982; Guntzel et al.,

2002; Steiner et al. 2005). Most ecological research has been focused more on the pelagic zone than on the transition zone – ecotone between lentic and lotic water basins. Due to the presence of a "contact zone" the ecotone is usually inhabited by a large number of species (Mieczan et al., 2013).

In Bulgaria, the studies on the ecotone river-reservoir zones are several and their results concern different types of dams which makes difficult to draw general conclusions (Kovachev, Uzunov 1979, 1987, Naidenow W. 1981a, b, Naidenow, Baev 1987). Data concerning the changes of zooplankton in the ecotone between river and reservoir in Bulgaria were discussed by Kozuharov (1995, 1996), Kozuharov et al. (2007), Traykov et al. (2011). No data that fundamentally concern the zooplankton of Iskar reservoir can be found in the available literature for the last 30 years.

MATERIALS AND METHODS

Iskar Reservoir is the largest reservoir in Bulgaria. It is situated in South - West Bulgaria on the Iskar River (Fig. 1.) and provides more than 2/3 of the water for the capital Sofia. The waters of the reservoir are also used for production of electricity and for recreation.

The investigated reservoir can be presented by the following basic characteristic:

Geographical situation: 42°28′14″N 23°34′24″E
Catchment area: 1046 km²
Max. length: 10.9 km
Max. width: 3.38 km
Max. depth: 75 m
Water volume: 673.106 m³
Surface altitude: 820 m. a. s. l.

Figure 1. Location of Iskar reservoir on the territory of Bulgaria.

This investigation was designed to study the changes in zooplankton composition and abundance in relation to the changes of conditions in different parts of the system and the actual state of the reservoir. The present research is focused on the ecotone zone Iskar River – Iskar reservoir, investigations of the pelagic zone of the reservoir are comparative. The ecotone is a place with dynamic conditions of accumulation, decomposition and transfer of the pollutants within the river flow and later in the reservoir. Zooplankton communities are highly sensitive to environmental variations, especially in the ecotone zones (Naidenow, Baev 1987; Kovachev, Kozuharov 1994, Kozuharov 1995; Kozuharov 1996; Kozuharov et al. 2007). As a result, the changes in their abundance and composition can provide important indications of environmental change.

Field investigations were carried out in the period 2009 to 2014. Zooplankton samples were taken at four points, selected to represent the conditions in the ecotone and the pelagic zone (Fig. 2.). The geographic coordinates of the sampling sites were taken by GPS receiver Garmin 60CSx tuned on WGS 1984 datum.

Station 1 – N 42.26.37.2, E 23.32.39.3 (ecotone zone);
Station 2 – N 42.27.16.3, E 23.33.41.7 (ecotone zone);
Station 3 – N 42.28.06, E 23.33.35 (reservoir);
Station 4 – N 42.26.15, E 23.36.38 (reservoir).

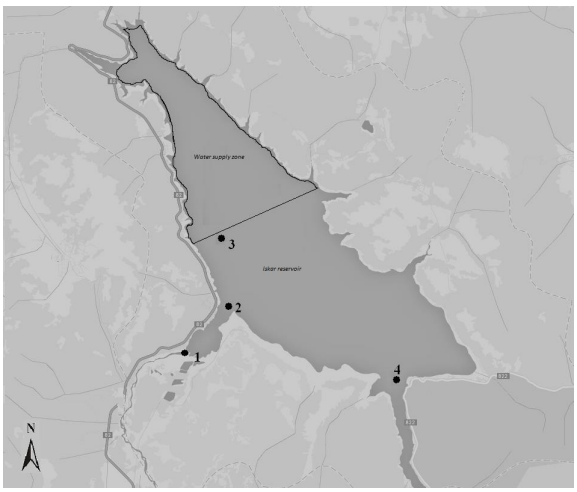


Figure 2. Scheme of Iskar Reservoir with positions of the sampling points.

Additionally, in June 2010 samples from the littoral zone near station 2 were collected. The reason was to have a comparative look on the littoral plankton complexes. In June 2013 samples from station 0, located in the river before its inflow into the system was collected. The goal was to check for the presence of drift plankton organisms from the small sand pit basins and other temporal water bodies, situated nearby.

As a whole 46 qualitative and quantitative zooplankton samples were taken. The samples were collected by using Apstein qualitative net (mouth diameter 16 cm, mesh size 38 mkm), and Judau quantitative net (mouth diameter 16 cm, mesh size 38 mkm). They were hauled from the bottom to the surface at different lengths depending on the site depth. In the shallow parts of the ecotone zone between the river and the reservoir quantitative samples were collected by direct filtering of 50 or 100 dm3 of water through the Apstein net. The zooplankton samples were preserved in 4 % formaldehyde. Quantitative samples were counted by using the Hensen's method modified by Naidenow (1984).

RESULTS AND DISCUSSION

A total number of 62 taxa (genus, species and subspecies levels) were found in the system. Except them, Nauplii and Copepodit stages of Copepoda were counted and calculated as important zooplankton components for the trophic relations. In most of the samples they were the most abundant zooplankton forms. The zooplankton community was composed of 29 species of Rotifera, 15 species of Cladocera, 5 taxa of Copepoda and 3 species of Protozoa. Some untypical zooplankton elements from Varia group were found (Table 1). Most of them were found in the upper part of the ecotone (Station 1), where the stream of the river is significant. As a natural process in the river stream, some benthic organisms are part of the biological drift (Kozuharov et al. 2007).

Table 1. Qualitative composition of zooplankton in the system Iskar River – Iskar Reservoir.

	Taxa	**Periods of investigation**	
		2009-2010	**2012-2014**
	Protozoa		
1	*Arcella catinis* Stepanek, 1942	x	x
2	*Difulgia* sp.	x	x
3	*Euglypha* sp.		x
	Rotifera		
4	*Keratella quadrata* O. F. Muller, 1773	x	x
5	*Keratella cochlearis* Gosse, 1851	x	x
6	*Keratella tecta* (Gosse, 1851)	x	x
7	*Kellicottia longispina* (Kellicott, 1879)	x	x
8	*Anureopsis* sp.	x	
9	*Asplanchna sieboldi* (Leydig 1854)		x

10	*Asplanchna* sp.	x	
11	*Colurella coluris*		x
12	*Lecane luna* (Muller, 1786)		x
13	*Pompholyx complanata* Gosse, 1851	x	x
14	*Polyarthra dolichoptera* Idelson, 1925	x	x
15	*Polyarthra remata* Skorikov, 1896	x	x
16	*Polyarthra vulgaris* Carlin, 1943	x	x
17	*Polyarthra minor* Voigt 1904		x
18	*Synchaeta* sp.	x	x
19	*Synchaeta cecilia* Rousselet 1902		x
20	*Trichocerca similis*(Wierzejski 1893)	x	x
21	*Trichocerca longiseta* (Schrank 1802)		x
22	*Trichotria* sp.		x
23	*Filinia terminalis* (Plate, 1886)	x	x
24	*Filinia longiseta* (Ehrenberg, 1834)	x	x
25	*Testudinella truncata* (Gosse, 1886)		x
26	*Testudinella sp.*	x	x
27	*Brachionus bidentata* Anderson, 1889		x
28	*Brachionus quadridentatus* Hermann, 1783		x
29	*Brachionus urceolaris* (Müller, 1773)		x
30	*Euchlanis dilatatta* Ehrenberg, 1832		x
31	*Polyarthra major* Burckhardt, 1900		x
32	*Trichocerca cylindrica* (Imhof, 1891)		x
	Cladocera		
33	*Diaphanosoma lacustris* Korjinek, 1981	x	x
34	*Daphnia cucullata* Sars, 1864	x	x
35	*Daphnia galeata* Sars, 1864	x	x
36	*Daphnia longispina typica*	x	x
37	*Daphnia sp. juv.*	x	x
38	*Bosmina coregoni* Baird, 1857	x	x
39	*Bosmina kessleri* Ujanin, 1872	x	x
40	*Bosmina longirostris* (Muller, 1785)	x	x
41	*Alona affinis* (Leydig, 1860)	x	x
42	*Alona rectangula* Sars, 1862		x

43	*Alona costata* Sars, 1862		x
44	*Chydorus* sp.	x	
45	*Chydorus sphaericus* (O.F. Müller 1785)		x
46	*Pleuroxus aduncus* (Jurine, 1820)		x
47	*Leptodora kindti* (Focke, 1844)		x
48	Ephipium- Daphnia gr. pulex		x
49	Ephipium- Daphnia gr. longispina		x
	Copepoda		
50	*Thermocyclops crassus* Ficher, 1853	x	x
51	*Eudiaptomus gracilis* (Sars, 1863)	x	x
52	*Cyclops strenuus* Fischer, 1851		x
53	*Cyclops vicinus* Uljanin, 1875	x	x
54	Nauplii Copepoda	x	x
55	Copepodites Copepoda	x	x
56	Harpacticoida		x
	Varia		
57	Chironomus - larvae		x
58	Oligochaeta - larvae		x
59	Oligochaeta: Naididae - larvae		x
60	Coleoptera: *Agabus sp.*		x
61	Hydracarina		x
62	Plecoptera - Leuctra		x
63	Baetis sp.		x
64	Tubifex		x

Table 2. Number of taxa groups during the analyzed period.

Zooplankton group	**Year**				
	2009	**2010**	**2012**	**2013**	**2014**
Protozoa	2	0	1	3	0
Rotifera	14	9	16	17	10
Cladocera	6	10	6	13	9
Copepoda	4	4	4	6	5
Varia	0	0	0	5	5
Total number of taxa	26	23	27	44	29

The zooplankton in Iskar reservoir was presented mainly by eurybiont species and components. Rotifera predominated in terms of species richness. The total number of zooplankton taxa (of genus, species and subspecies level) during the analyzed period varies in a narrow range (Table 2).

Some changes in the qualitative composition of zooplankton were established: 14 species were recorded during the period 2012-2014. Most of them were rotifers, typical for eutrophic waters. The main reason for this result is the inflowing pollutants from the Iskar River that affects the zooplankton which inhabits the ecotone zone between the river and the reservoir.

The Cladocera *Leptodora kindti* (Focke, 1844) was found for the first time in this reservoir during the present study. It is a typical plankton element for the warmer waters. It indicates changed climatic conditions in the region.

The broad characteristics of the zooplankton in Iskar reservoir were compared with the available previous publication (Klachev et al., 1993) and data. Some dominant species from earlier periods like *Daphnia hyalina* and *Syda crystalina* were not found at present. *Cyclops vicinus* and *Cyclops strenuus*, were dominants in the past time. Nowadays they were found only in the winter samples with low abundance. *Thermocyclops crassus* is a species, that a few years ago occurs sporadically in Bulgarian waters. At present it is common for Iskar reservoir and many other reservoirs in the country (Kozuharov et al. 2013). Such a drastic shift in the dominant complex of the reservoir indicates an advanced process of eutrophication in the studied system river – reservoir.

The observed general quantitative parameters of the zooplankton displayed an impressively high variability during the analyzed period. The absolute abundance of zooplankton varies between 560 ind/m^3 at station 1 in December 2013 and 138600 ind/m^3 at station 1 in July 2012. The biomass varied from 5,7 mg/m^3 at station 1 in July 2013 to 1128 mg/m^3 at station 2 in July 2013. The highest and lowest values were recorded at the same station 1, which is located in the ecotone zone between the river and the reservoir. The high variability shows the unstable and often changing conditions in ecotone zone and the unstable zooplankton community as a result of the first. The tendency in the development of the zooplankton shows higher values in the summer – July then in the late autumn and in the spring (Fig. 3).

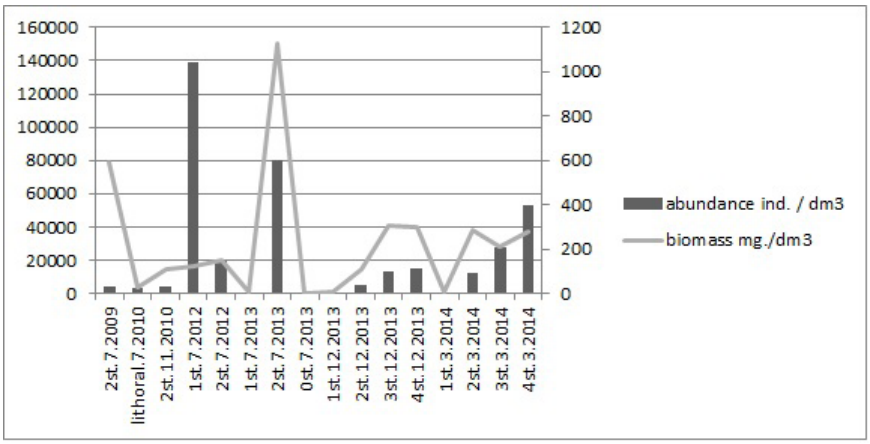


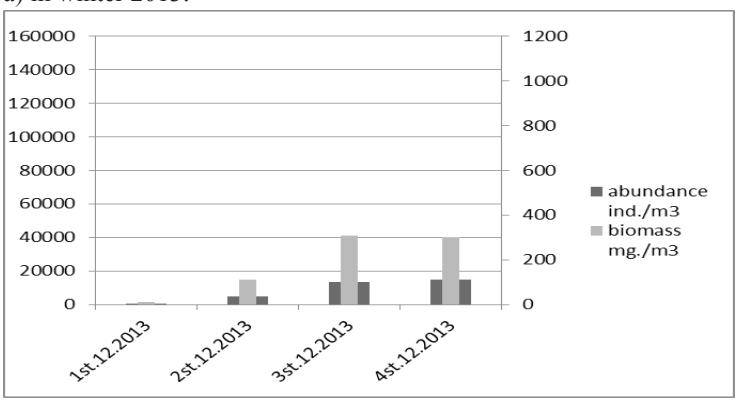
Figure 3. Abundance and biomass of the zooplankton at different stations during the period of the investigation.

That result shows that first maximum of the development of plankton communities in the ecotone zone is in the first part of the summer. The combination of high number and low biomass values of the ecotone sampling points demonstrate that small size elements like Rotifers, larval forms of Copepoda and small Chydorid Cladocerans dominate in the ecotone zone. These mostly filter feeders Rotifers depends on the inflowing organic meter from the river water.

The remaining 3 sampling points are situated in the pelagic zone of the reservoir. In general, at Stations 2, 3 and 4 the curve of the biomass follows this of the abundance. As can be expected the lowest values of the quantitative parameters of the zooplankton were registered in winter and spring. (Fig.4 a, b).

In late autumn and spring there is a shift in the zooplankton complex, therefore the abundance and biomass are low. On the other hand the temperature during these seasons is low.

a) in winter 2013.



b) in spring 2014.

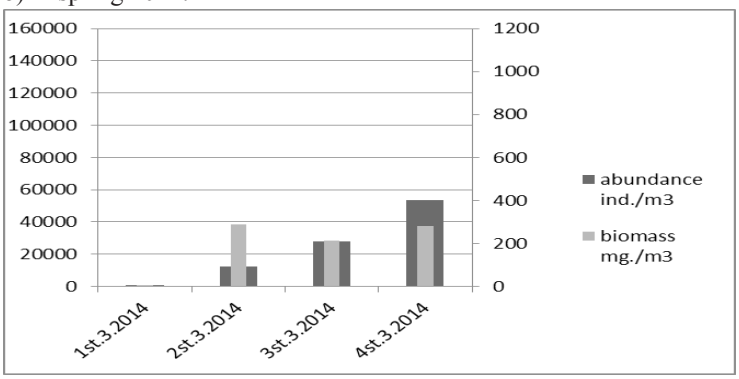


Figure 4. Abundance and biomass of the zooplankton at different stations sampled.

CONCLUSION

The results present significant changes in the qualitative composition of the zooplankton in Iskar reservoir. In the present investigation some species, included the dominant complex in the past weren't found in any of the samples. A large number of species, typical for eutrophic basins were found – especially in the ecotone zone between the river and the reservoir. Some of them are new for Iskar reservoir. Changes in the quantitative composition were also established. According to Kalchev et al. (1993) in 1987, on the base of the obtained results Iskar reservoir is classified as a mesotrophic water basin. In 1986 and 1987 the zooplankton biomass dominants were species that in the present study appear sporadically with in low numbers and biomass. The quantitative changes precede more changes in the qualitative composition in the future. These preliminary results show that more detailed analysis are needed for the establishment of the actual status of the reservoir. Also, some data to be collected for the other trophic levels in the biocoenosis are highly needed.

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