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Rotifers in the Littoral Zone of Lake Shkodra/Skadar (Albania-Montenegro) as a tool for Determining Water Quality

Spase Shumka
Agricultural University of Tirana, Faculty of Biotechnology and Food, Tirana, ALBANIA

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Abstract

This study was undertaken with the purpose of investigating rotifer species composition and abundance in the littoral part of Lake Shkodra/Skadar with the intention to assess the water quality and trends. Qualitative and quantitative analysis of the rotifers of Lake Shkodra are based on samples collected during 2010 in the Albanian littoral zone of the lake. During the period investigated (spring–autumn), the main species recorded were Synchaeta stylata, Polyarthra major, P. euryptera, Anuraeopsis fissa fissa, Pompholyx complanata, Lecane bulla, L. lula, L. lunaris, Trichocerca pusilla, Filinia longiseta, Keratella cochlearis, K. quadrata, Brachionus angularis, B. diversicornis and B. calyciflorus, a cosmopolitan mixture. The rotifer species assemblage was dominated by Asplanchna priodonta, B. diversicornis and B. calyciflorus f. amphiceros, which comprised 25–30% of total rotifer density. During the spring–summer period the total density showed a rapid increase to more than 334ind/l. The results from the use of rotifers to test water quality purposes indicate that although various impacting factors, such as nutrient input from the tributaries, were high the lake is nevertheless in a mesotrophic state.

Keywords: Lake Shkodra, littoral, rotifers, species, zooplanktons.

Introduction

The number and range of studies on rotifers in Balkan countries are limited, with initial studies focusing on published data for species in the different countries, rather than recording and exploring their abundance and distribution in various lakes. Recently, biological monitoring undertaken in the light of the European Water Framework Directive[1] is gaining importance and within that framework the use of invertebrates as indicators of water quality is increasing, with an interest in the use of rotifers for such purposes.

Taseska O. et al[2] and Shumka S.[3] surveyed several natural lakes in the region with the focus on determining the presence of widespread species, with little intention of investigating interactions with other factors, whether physical or chemical. Such factors have a great influence on species abundance and spread, and can cause differences among different habitats and water bodies. A number of references to factors affecting species presence are reported by Taseska O. et al[2] with regard to lake water trophic state.

Duggan et al. suggested that rotifers may provide useful bioindicators of a lake's water quality, that has been evaluated as important asset in determining distribution of rotifer communities elsewhere[4-7]. Along with there has been presented lists of rotifer species indicative of different trophic states[8-12]. The present paper assesses the potential of the use of rotifer communities for determining the trophic status of a lake that is driven by various factors, physical, chemical and microbiological. The lake chosen for the study is the largest in the Balkans: Lake Shkodra (Albanian), or Lake Skadar (Slavic) (hereafter referred to as Lake Shkodra), the trans-boundary lake between Albania and Montenegro.

Material and Methods

The sampling localities at Lake Shkodra are shown in figure 1. For the survey zooplankton was collected using vertical hauls through the top 3 m of the water column with 0.2 m diameter plankton net with a 45 µm mesh size (haul speed ~1 ms^{-1}). Samples were preserved in 4% formalin. Rotifers were identified and counted, as this is the zooplankton group most useful for trophic state monitoring. In situ measurements were undertaken with sensors for oxygen, temperature, conductivity and pH, while total phosphorus (TP), chlorophyll a, total nitrogen (TN) and number of faecal bacteria were determined according to standard methodologies[13]. Identification of species was undertaken based upon[14-18]. Data analysis was performed in Microsoft Excel. Values for each indicator were averaged across seasons and plotted on a scatter chart to determine the linear correlation among variables (figure-2).

Site description: Lake Shkodra is a transboundary one shared among Albania and Montenegro at latitude 42°03'N 019°29'E , longitude 42º12'N 019º17'E (figure-1). The lake, which is located in karst terrain on the outer part of the south-eastern Dinaric Alps, has a surface area that fluctuates seasonally from 370–600 km^2. Its water level varies seasonally from 4.7 m (summer) to 9.8 m (winter) above sea level. The mean depth is 5 m and the total volume is 1890 x 106 m^3. The direct drainage basin of the lake is 5490 km^2, of which 4460 km^2 are in

Montenegro and 1030 km^2 are in Albania[18]. The largest inflow is the Morača River (Montenegro), which provides more than 62% of the lake water. The outlet river is the River Buna, which converges with the River Drin just a few hundred metres downstream of the outlet. The Drin has a total drainage area of about 14,000 km^2, almost three times larger than the catchment of Lake Shkodra. It is therefore not surprising that during high water discharges the Drin system impedes the outflow from the lake.

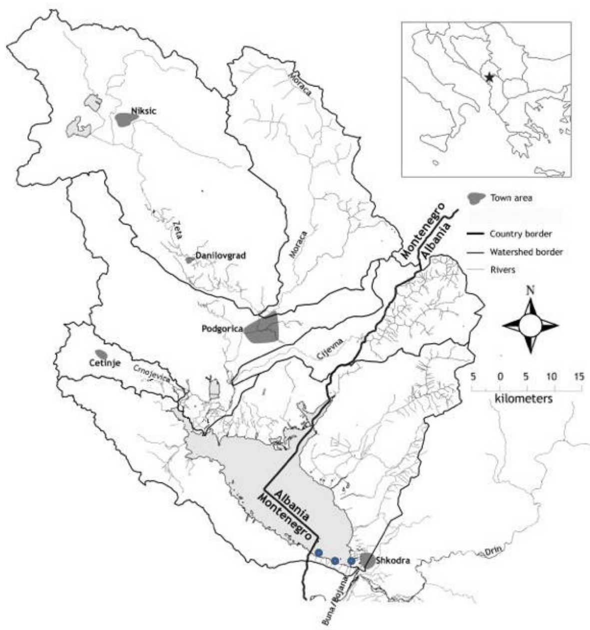

Figure-1
Map of Shkodra Lake with marked sampling stations

Lake Shkodra is a subtropical water body lying in an area that has an extremely high evaporation rate. A considerable amount of precipitation, limited mostly to winter months, coupled with high summer temperatures contributes to chemical weathering and the development of the karst landscape in the area. Mountains are situated at the south-western shores of the lake, while the northern and north-eastern shores are flat, providing an extensive semi-littoral zone with dense macrophyte cover. Frequent winds and shallow depths prevent the formation of permanent thermal stratification. The lake is regarded as mesotrophic with a tendency to become eutrophic in the summer months. Lake Shkodra has pronounced water-level fluctuations (high in winter and low in summer), which has resulted in a large wetland area that sustains rare and endangered bird species. In 1996, Lake Shkodra was included in the list of wetlands of international importance of the Ramsar Convention on Wetlands.

Results and Discussion

The Water Framework Directive of the EU has as own main objective improvements of water quality and securing good status for all waters by 2015 at the European scale. Contrary to previous practices, currently the ecological status of lakes is determined by the biological elements, such as composition, abundance and biomass of phytoplankton, composition and abundance of other aquatic flora, of benthic invertebrate fauna and of fish fauna. The physical–chemical parameters and the hydro-morphological character of the lakes are used as supporting elements.

Along with phytoplankton, zooplankton represents an important component of the ecology of lakes, often shaping the encountered ecological state. It might be considered as an important element in shaping the phytoplankton community depending on presence of keystone species, e.g. *Daphnia*, as well as their size[20]. Beside its importance, zooplankton is not included in the directive as a biological element to be monitored and assessed. Following[21], parameters of rotifer community structure may easily serve as sensitive biological metrics that can monitor changes in lake water quality, while many authors have described such parameters as excellent indicators of water assessment and pollution[6,8,22].

Table-1
Physical and chemical parameters in Shkodra Lake

	St 1 (City)			St2 (Shiroka)			ST3 (Zogaj)		
	Spring	Summer	Autumn	Spring	Summer	Autumn	Spring	Summer	Autumn
Density (ind/l)	73	344	290	51	280	220	27	133	79
Secchi	2.5 (1-2.9)	1.4 (08-2.2)	2.3 (1.3-2.6)	2.5 (1-2.9)	1.4 (08-2.2)	2.3 (1.3-2.6)	2.5 (1-2.9)	1.4 (08-2.2)	2.3 (1.3-2.6)
Temperatrure	17.8	23.4	16.2	17.8	23.1	16	17.6	23	16
Chlorophyl a	7.8	14.2	13.3	4.6	13	11.1	4.7	7.5	7.1
DO	7.8	5.7	6.4	8	6.1	6.6	8.2	6.3	7.2
TP (mg/l)	14.1	32.2	18.6	12.1	24	16	11.7	21	14.3
TN (mg/l)	334	278	267	289	230	230	200	189	167
Faecal bacteria (numbre/100 ml)	1900	2600	2400	700	900	800	50	50	60

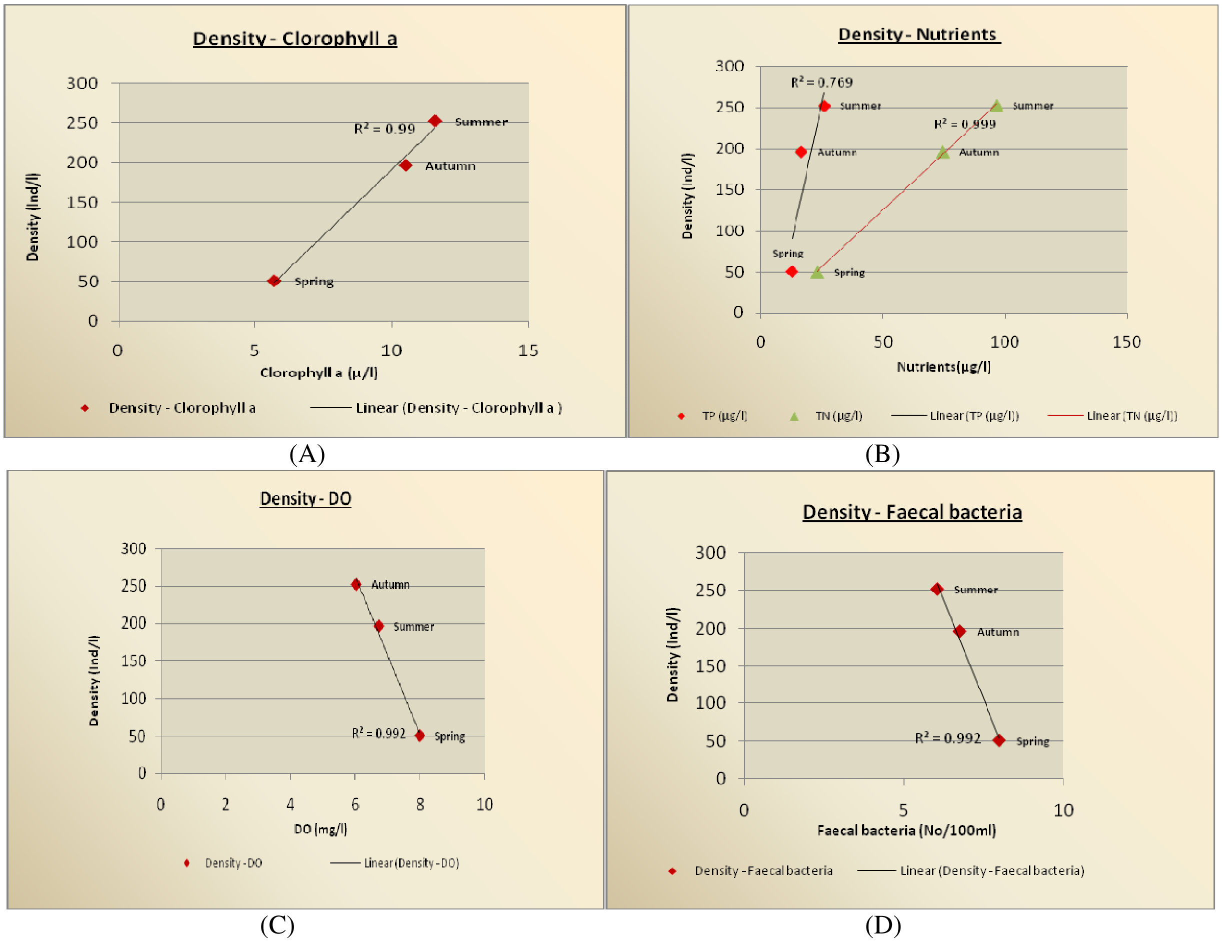

Figure-2
Relationship between rotifers density and chlorophyll a (A), TP-TN (B), DO (C) and Faecal bacteria (D)

At the monitoring stations in Lake Shkodra in 2010, oxygen levels at depth of 2 m varied from 8.2 mg/l in spring and autumn to around 5.7–6.3 mg/l in summer. Water temperatures in the lake varied from about 16.2°C in spring and autumn to 23–23.4°C in mid summer. Water transparency in the lake varied from 1–3 m, with the lowest values of < 1.5 m recorded in July. It has to be pointed out that relatively low water visibility in the lake occurred in spring due to high riverine sediment loads and also later in the summer concomitantly with high chlorophyll a levels. In general, TP levels in the lake varied between 11.7 and 32.2 µg/l (table-1) and TN concentrations ranged from 167 to 334 µg/l and were also highest at Station 1 (table-1). The values are contrary to the general picture and that was noted in spring time, where levels of TN were relatively high, probably as the result of the substantial loads of these substances in the surrounding rivers in January and February.

Generally, lakes are designated as phosphorus limited if the ratio of TN: TP is greater than 15, nitrogen limited in the case of TN: TP < 7, while if the TN: TP ratio is between 7 and 15, either phosphorus or nitrogen, or both, could be limiting factors. The TN: TP ratio in Lake Shkodra was mostly more than 20, indicating that phosphorus is a limiting nutrient in the lake. Previous studies of Lake Shkodra[22] recorded a much lower TN: TP ratio. Continuous utilization of fertilizers in the agricultural area of Lake Shkodra basin over the last 30 years is probably the main reason for this shift in the ratio.

The rotifer composition and communities responds to environmental factors and therefore can be used as biological indicator for assessment of water quality[22]. Several studies have provided lists of rotifer species that are indicative of different trophic states[9,10,24-28]. In our case the following species were dominant at station 1: *Brachionis angularis*, *B. diversicornis, B. falcatus, B. forficula, Anuraeopsis fissa, Pompholyx sulcata, P. complanata, Trichocerca capucina T. cylindrica, T. pusilla, Filinia longiseta, Keratella cochlearis, K. ticinensis, K. quadrata* and *Polyarthra trygla*. However, they were less common at stations 2 and 3 (table 2). Species of *Baracionus*, primarily *B. angularis* and *B. diversicornis*, comprised 35%, 25% and 20% of total rotifer density, respectively, at stations 1, 2 and 3 (figure-1). These organisms have previously been reported as good indicators of eutrophic state[29,22,6] with *B. angularis f. angularis, B. quadridentatus, K. quadrata, T.*

capucina, P. complanata, P. sulcata, F. longiseta and *F. terminalis* predominating in eutrophic water bodies.

Among the others[22], observing that *Ascomorpha ovalis, K. cochlearis, K. quadrata, Anuraeopsis fissa, T. capucina, F. longiseta*, were inhabitants of mesotrophic to eutrophic waters, while[21] described *Ascomorpha ovalis, Conochilus coenobasis, Conochilus dossuarius, Conochilus unicornis, Polyarthra dolichoptera* and *Synchaeta longipes* as associated with a low trophic state. Based on our records for sampling stations 2 and 3, *Ascomorpha ovalis, A. saltats, Synchaeta stylata, S. pectinata, S. oblonga, S. kitina, Polyarthra major, P. trygla, Conochilus unicornis* and *Anaueropsis fissa fissa* were mostly present in the mesotrophic waters of Lake Shkodra.

In the investigated material thirteen species of the family *Lecanidae* were recorded, where *Lecane bulla, L. curvirostris, L. elasma, L. luna, L. quadridentata* and *L. lunaris* were most common. This genus constitutes a group of both freshwater and saline rotifers, confirmed in our case due to the connection of Lake Shkodra with the Adriatic Sea via the River Buna.

The species abundance and composition and distribution, often reflect the trophic status of lakes[8,30,5,26], and rotifer contributions to the zooplankton community may increase with eutrophication[30]. As well as species composition[20], rotifer biomass and densities may be strongly dependent on the trophic state of lakes with abundance[32,33,34].

Horizontal analysis of rotifer composition of the zooplankton, and other environmental variables, in Lake Shkodra revealed that increase in nutrients and chlorophyll a values were correlated with increase in abundance of rotifers (figure- 2). The positive relation between rotifer density and total phosphorous and total nitrogen recorded here was reported previously by[9,2,21], among others.

Table-2
List of rotifer species present in Lake Shkodra littoral zone

Species Recorded	St 1 (City)			St2 (Shiroka)			ST3 (Zogaj)		
	Spring	Summer	Autumn	Spring	Summer	Autumn	Spring	Summer	Autumn
Asplanchnidae									
Asplanchna priodonta Gosse 1850	x	x		x	x		x	x	
Brachionidae									
Anauraeopsis fissa fisa Gosse 1851		x		x			x		
Brachionus angularis Gosse 1851	x	x	x	x	x	x	x	x	x
Brachionus diversicornis Daday 1883									
Brachionus calyciflorus Pallas 1776	x	x		x	x			x	x
Brachionus calyciflorus f. *amphiceros*	x	x							
Brachionus dimidiatus Bryce 1931	x								
Brachionus falcatus Zacharias 1898	x	x							
Brachionus forficula Werzejski 1891	x	x							
Brachionus havanaensis Rousselet 1911	x	x							
Brachionus plicatus Muller 1786	x			x					
Brachionus qudridentatus Hermann 1783	x			x					
Brachionus urceolaris Muller 1773				x					
Kellikottia longispina Kellikott 1879				x	x		x		
Keratella cochlearis Gosse 1851	x	x	x	x	x	x	x	x	x
Keratella hiemalis Carlin 1943	x								
Keratella quadrata Muller 1786	x	x							
Keratella ticinensis Callerio 1921	x	x							
Keratella valga Ehrenberg 1832		x							
Notholca acuminata Ehrenberg 1832	x			x	x				
Notholca foliacea Ehrenberg 1838	x			x					
Notholca squamula Muller 1786	x			x					
Platyias quadricornis Ehrenberg 1832	x								
Collothecidae				x	x				
Collotheca mutabilis Hudson 1885					x				
*Collotheca pelag*ica Rousselet 1893									
Conochilidae		x		x	x				
Conochiloides exiguus Ahlstrom 1938		x			x				
Conochilus hippocrepis Schrank 1830		x			x				
Conochilus unicornis Rousselet 1892		x			x			x	
Dicranophoridae									
Dicranophorus forcipatus Muller 1786		x							
Epiphanidae									

Epiphanes macrourus Barrois & Daday 1894		x	x	x	x				
Euchlanidae									
Dipleuchlanis propatula Gosse 1886		x							
Euchlanis dilatata Ehrenberg 1832		x							
Euchlanis meneta Myers 1930		x							
Filinidae									
Filinia longiseta Ehrenberg 1834	x	x		x	x	x	x	x	x
Filinia terminalis Plate 1886							x		
Gastropodidae									
Ascomorpha ecaudis Perty 1850	x	x		x			x		
Ascomorpha ovalis Carling 1943	x	x		x			x		
Ascomorpha saltans Bartsch 1870				x	x		x		
Gastropus hyptopus Ehrenberg 1838	x			x			x	x	
Gastropus stylifer Imhof 1891	x	x							
Hexarthridae									
Hexarthra mira Hudson 1871		x							
Lecanidae									
Lecane bulla Gosse 1851		x			x			x	
Lecane curvirostris Yamamoto 1941		x			x			x	
Lecane elasma Harring & Myers 1926		x							
Lecane elsa Nitzsch 1827					x				
Lecane flexilis Gosse 1886					x				
Lecane luna Muller 1776		x	x		x			x	
Lecane nana Murray 1913		x							
Lecane quadridentata Ehrenberg 1832		x	x		x				
Lecane obtuse Hauer 1889									
Monostyla bulla Gosse 1851		x		x					
Monostyla closterocerca Schmarada 1895		x		x					
Monostyla hamata Stokes 1896		x		x					
Monostyla lunaris Ehrenberg 1832		x		x	x			x	
Lepadellidae	x	x		x				x	
Colurella adriatica Ehrenberg 1831	x	x		x					
Colurella uncinata O. F. Muller 1773		x		x					
Lepadella erenbergi Perty 1850		x		x					
Lepadella ovalis Muller 1786		x							
Lepadella patella Muller1773		x			x				
Lepadella rhomboides Gosse 1886					x		x	x	
Lepadella triptera Ehrenberg 1830		x			x			x	
Squatinella rostrum Schmarda 1846					x			x	
Squatinella tridentatus Muller 1786		x			x			x	
Mytilinidae		x						x	
Lophocaris salpina Ehrenberg 1834		x			x				
Lophocharis oxysternon Gosse 1851		x							
Mytilina crassipes Luchs 1912		x	x	x	x			x	
Mytilina mucronata Ehrenberg 1832					x				
Mytilina ventralis Ehrenberg 1832					x				
Notomatidae							x	x	
Cephalodella forficula Ehrenberg 1831		x			x			x	
Cephalodella gibba Ehrenberg 1832		x			x			x	
Cephalodella misgurnus Wulfert 1937		x							
Monommata aequalis Ehrenberg 1832		x							
Notommata copeus Ehrenberg 1834		x							
Philodinidae									
Dissotrocha aculeata Ehrenberg 1832		x					x	x	
Philodina megalotrocha Ehrenberg 1832		x	x					x	
Rotaria rotatoria Pallas 1766	x	x	x		x				
Scaridiidae									
Scaridium longicaudum Muller 1786	x	x			x	x		x	

Synchaetidae									
Ploesoma hudsoni Imhof 1891		x	x		x				
Ploesoma truncatum Levander 1894	x	x	x	x	x	x	x	x	x
Polyarthra dolichoptera Delson 1925		x	x						
Polyarthra major Bueckhard 1900		x	x		x	x	x		
Polyarthra minor Voigt 1904		x							
Polyarthra remata Skorikov 1896		x							
Polyarthra trygla Ehrenberg 1834	x	x	x	x	x	x	x	x	x
Polyarthra vulgaris Carlin 1943		x		x	x			x	
Synchaeta kitina Rousselet 1832		x	x	x	x	x			x
Synchaeta oblonga Ehrenberg 1832			x		x	x			
Synchaeta pectinata Ehrenberg 1832			x			x			
Synchaeta stylata Wierzejski 1893			x		x	x			x
Testudinellidae									
Pompholyx complanata Gosse 1851					x				
Pompholyx sulcata Hudson 1885		x	x		x	x	x		
Testudinella incisa Hennann 1773		x	x		x				
Testudinella mucronata Gosse 1886		x	x						
Testudinella patina Herman 1783		x	x						
Testudinella pseudoliptica Bartos 1887		x	x						
Testudinella truncata Gosse 1886			x						
Trichocercidae									
Trichocerca bicristata Gosse 1887	x	x							
Trichocerca birostris Minkievicz 1900	x						x		
Trichocerca capucina Wierzejski & Zacharias 1893)	x	x		x			x		
Trichocerca cylindrica Imhof 1891	x	x		x					
Trichocerca iernis Gosse 1887	x			x			x		
Trichocerca longiseta Schrank 1802		x		x					
Trichocerca myersi Hauer 1931		x		x			x		
Trichocerca porcellus Gosse 1886	x								
Trichocerca pusilla Lauterborn 1898	x								
Trichocerca rattus Muller 1776	x	x					x	x	
Trichocerca rectangularis Events 1947	x								
Trichocerca rousseleti Voigt 1902	x	x		x			x		
Trichocerca similis (Wierzejski 1893)	x								
Trichocerca stylata (Gosse 1851)	x			x			x	x	
Trichocerca weberi (Jennings 1903)	x			x	x		x	x	
Trichotriidae									
Trichotria pocillum (Muller 1776)		x		x					
Trichotria tetractis (Ehrenberg1889)		x		x					

Conclusion

Analysis of the rotifer plankton community structure of Lake Shkodra reveals a horizontal variability in species diversity and density. Implementation of the Water Framework Directive is an important element in the process of EU integration of countries in transition such as Albania and where adapting monitoring practices rotifers must be considered as an important tool for monitoring water quality, combined with developing an understanding of a lake's typology.

The present survey shows that rotifers are valuable components among a set of biological tools to be considered for the daily work of implementation of WFD provisions. Particularities of a rotifer community (density and bio-indicators) can be used as direct biological metrics, reflecting the state of surface water bodies and enabling their long-term changes to be monitored. There is a need for a comprehensive approach and expansion of methods for assessing the ecological status of Lake Shkodra across other water bodies due to cost effectiveness and rapidity of the methods.

References

1. EC, Directive 2000/60/EC of the European Parliament and the Council of 23rd October 2000 establishing a framework for Community action in the field of water policy, 1–72 **(2000)**
2. Taseska, O., Kostoski, G., Gusheska, D., Rotifers based assessment of the Lake Dojran water quality, Balwois IV, 121–130, Ohrid **(2010)**
3. Shumka S., Feeding relations of Eudiaptomus gracilis (SARS) and influence on some parameters of their life

cycle in Lake Ohrid. – Verh. Internat. Verein. Limnol., **(27)**, 3708-3711 **(2001)**

4. Steinberg A., Ejsmont-Karabin J., Muirhead J.R. and MacIsaac H.J., Spatial and temporal stability of rotifer communities, *Hydrobiologia*, **(624)**, 107–114 **(2009)**
5. Ejsmont-Karabin J., Rotifer occurrence in relation to age, depth and trophic state of quarry lakes, *Hydrobiologia*, 313/314, 21–28 **(1995)**
6. Saksena D.N., Rotifers as indicators of water quality, *Acta Hydrochim. Hydrobiol.,* **(15)**, 481–485 **(1987)**
7. Vaishali S., Goldin Q., Madhuri. P.K., Occurrence of Rotifers and its Relation to the Water Quality during the Bioremediation process, *Int. Res. J. Biological Sci.*, **1(3),** 54-58 **(2012)**
8. Mäemets A., Rotifers as indicators of lake types in Estonia, *Hydrobiologia*, **(104)**, 357–361 **(1983)**
9. Berzins B. Pejler, B., Rotifer occurrence in relation to trophic degree. Hydrobiologia (182)171–180 **(1989)**
10. Matveeva L.K, Can pelagic rotifers be used as indicators of lake trophic state? *Verh. Internat. Verein. Limnol.*, **(24)**, 2761–2763 **(1991)**
11. Karabin A., Pelagic zooplankton (Rotatoria + Crustacea) variation in the process of lake eutrophication. I. Structural and quantitative features, *Ekol. Pol.*, **(33),** 567–616 **(1985)**
12. Thirupathaiah M., Sravanthy. Ch and Sammaiah. Ch., Diversity of zooplankton in Lower Manair reservoir, Karimnagar, AP, India, *Int. Res. J. Biological Sci.*, **1(7),** 27-32 **(2012)**
13. American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 16th Edition, APHA, New York **(1985)**
14. Voigt M., Rotatoria, Die Rädertiere Mitteleuropas. I. Textband 508 pp.; II Tafelband, Gebruder Bornträger, Berlin **(1957)**
15. Radwan S., Planktonic rotifers as indicators of lake trophy, Annales Univ, Mariae Curie, Sklodowska (biol.), **(31)** 227–235 **(1976)**
16. Koste W., Die Rädertiere Mitteleuropas (Textband, Tafelband). Gebr. Borntraeger, Berlin/Stuttgart, 673, 234 Tafeln **(1978)**
17. Istvan B., A kerekesférgek Rotatoria Kishatározója I. Vízgazdálkodási Intézet igazgatója, Budapest, 1–336 **(1986)**
18. Segers H., Rotifera 2. The Lecanidae (Monogononta). SPB Academic Publishing, 1–226 **(1995)**
19. Keukelaar F., de Goffau, A., Pradhan, T., Sutmuller, T., Misurovic, A., Ivanovic. S., Lake Shkoder Transboundary Diagnostics Analysis. Final Report: Summary, Royal Haskoning, World Bank, 26 **(2006)**
20. Lampert W. Sommer U., Species richness and diversity. In: Limnoecology. The ecology of lakes and streams, Oxford University Press, New York, 195, 197, 261 **(1997)**
21. Karabin A., The usefulness of zooplankton as Lake Ecosystem indicators: Rotifer state trophic index, *Pol. Jour. of Ecology*, 60 (2)339–350 **(2012)**
22. Sládeček V., Rotifers as indicators of water quality, *Hydrobiologia*, **100**, 169–201 **(1983)**
23. Rakočević J., Spatial and temporal distribution of phytoplankton in Lake Skadar, *Arch. Biol. Sci., Belgrade,* **64(2),** 585–595 **(2012)**
24. Pejler B., On the use of zooplankters as environmental indicators (In: Some Approaches to Saprobiological Problems, Ed: M. Sudzuki), Sanseido Co. Ltd., Tokyo, 9–12 **(1981)**
25. Pejler B., Zooplanktic indicators of trophy and their food. Hydrobiologia, **(101),** 111–114 **(1981)**
26. Duggan I.C., Green J.D. and Shiel R.J., Distribution of rotifers in North Island, New Zealand, and their potential use as bioindicators of lake trophic state, *Hydrobiologia*, **446/447**, 155–164 **(2001)**
27. Kuczyńska-Kippen N., Habitat choice in Rotifera communities of three shallow lakes: impact of macrophyte substratum and season, *Hydrobiologia*, **593**, 27–37 **(2007)**
28. Kulkarni D.A.1 and Surwase S.S., Studies on Occurance, Richness and Composition of Zooplankton in Seena river water at, Mohal, Dist- Solapur, MS, India, *Int. Res. J. Biological Sci.*, **2(2),** 25-28 **(2013)**
29. Radwan S. and Popilek B., Percentage of rotifers in spring zooplankton in lakes of different trophy, Hydrobiologia 186/187: 235–238 **(1989)**
30. Hillbricht-Ilkowska A., Trophic relations and energy flow in pelagic plankton, *Pol. Ecol. Stud.*, **(3)**, 3–98 **(1977)**
31. Zankai N.P., Predation of *Cyclops vicinus* (Copepoda: Cyclopoida) on small zooplankton animals in Lake Balaton (Hungary), *Arch. Hydrobiol.,* **99(3)**, 360–378 **(1984)**
32. Paturej E., Assessment of the trophic state of a restored urban lake based on zooplankton community structure and zooplankton-related indices, *Polish Journal of Natural Sciences*, **23(2)**, 440–449 **(2008)**
33. Sharma K.K., Kaur S., Neha A. and Shvetambri, Habitat Preference of Rotifers Inhabiting some Waters of Jammu province, J&K, India, *Int. Res. J. Biological Sci.*, **2(6),** 35-38 **(2013)**
34. Goswami A.P. and Mankodi P.C., Study on Zooplankton of Fresh Water Reservoir Nyari – II Rajkot district, Gujarat, India, *Int. Res. J. Biological Sci.*, **1(1),** 30-34 **(2012)**