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Short Communication: Zooplankton as indicator of trophic status of lakes in Ilmen State Reserve, Russia

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Abstract. *Mashkova IV, Kostryukova AM, Shchelkanova EE, Trofimenko VV. 2021. Short Communication: Zooplankton as indicator of trophic status of lakes in Ilmen State Reserve, Russia. Biodiversitas 22: 1448-1455.* Zooplankton is a potentially powerful tool for assessing the trophic state of aquatic ecosystems. The current paper studied taxonomic composition and biomass of zooplankton communities in ten lakes within Ilmen State Reserve, Chelyabinsk region, Russia and identified the influence of trophic status on its formation. Integrated samples were taken from epilimnion in the summer of 2016-2019. Several criteria were used to determine trophic status: the taxonomic structure and biomass of zooplankton; some hydroecological indicators some hydroecological indicators and the Carlson index. The trophic status of the studied lakes, determined based on the zooplankton biomass, revealed that most of the lakes were in the status of mesotrophic. The number of zooplankton species in the lakes was 44 with *Pleuroxus laevis, Bosmina longirostris, Simocephalus vetulus* were the most numerous species in mesotrophic lakes; while *Chaetonotus ploenensis, Keratella quadrata frenzeli, Leptodora kindti* are rare. Zooplankton communities of Bolshoye Miassovo and Maloye Miassovo Lakes were characterized by high species diversity and considered as one of the most significant among the foothill lakes of the eastern slope of South Ural. The study reveals that hydroecological assessment of the ecological status is not exactly precise, as values are not stable and can change not only under the anthropogenic influence but also due to many natural abiotic environmental factors. The research shows that species composition and biomass of zooplankton communities could provide a more accurate assessment of the trophic status of water-bodies.

Keywords: Biomonitoring, foothill lakes, South Ural, trophic status, zooplankton biodiversity

INTRODUCTION

The complexity of an ecosystem is influenced by the number of species and the variety of relationships among them (Hubalek 2000). This structural complexity is largely determined by the impact of changing environmental factors, including abiotic ones. Quantitative assessment of biological diversity takes into account the richness and uniformity of the distribution of species in the community (Gilyarov 2001). These components of diversity differ in the gradients of environmental factors (Gilyarov 2001).

Biodiversity assessment is very important in environmental protection since it indicates the relationships between the structure and functioning of ecosystems which allows us to monitor and give practical recommendations regarding the state and dynamics of biotic communities (Cardinale et al. 2013). Diversity in biological systems is considered in various aspects such as richness, uniformity, diversity, and dominance of functional groups (Gilyarov 2001) depending on the task of a specific analysis. There is a concept of a direct relationship between species richness and environmental quality indicators (Sládeček 1973; Rimadiyani et al. 2019).

The concept of trophic status is widely used to characterize hydroecological state of water-bodies. The given characteristic allows assessing a water-body according to its biological productivity that is dependent on biogenic elements content. Deteriorating trophic status is crucial for many water-bodies now, as the anthropogenic impact leads to intensifying eutrophication. The Trophic State Index (TSI) designed by Robert Carlson is used to quantify a trophic status (oligo-, meso-, eutrophic) (Carlson 1977). Its calculation is based on three hydro-ecological indicators, namely water concentrations of chlorophyll *a*, total P, and water clarity according to the Secchi disk (Carlson 1977). Carlson proposed formulas for calculating the index for each of these indicators, and each variant of calculating the index serves as a numerical measure of the trophic status of a water body (Carlson 1977).

In aquatic ecosystems, zooplankton, as an object of biomonitoring in ecological research, is a potentially powerful tool for assessing the trophic state of reservoirs (Jekatierynczuk-Rudczyk et al. 2014; Kahirun et al. 2019). This is because a complete or partial change in the zooplankton community can occur with a change in the trophic status of the reservoir (Asep et al. 2018; Jurczak et al. 2019). Studies to see the relationship of trophic level in aquatic ecosystems using quantitative and qualitative assessment of zooplankton community have been repeatedly conducted (Ejsmont-Karabin and Karabin 2013; Mashkova et al. 2019; Kostryukova et al. 2020a,b; Mashkova et al. 2020a). Despite the contradictory views on bioindication (Azevêdo et al. 2015; Montagud et al. 2019), the possibility of using zooplankton in environmental studies is confirmed by many authors (Jurczak et al. 2019). A comprehensive study of aquatic ecosystems takes into account the adaptation of aquatic organisms to extreme conditions of biotic and abiotic factors (Mashkova et al. 2020b). Aquatic ecosystems can be formed only in a certain range of environmental variables, which was well demonstrated in the Sladechek model (Sládeček 1973).

South Ural is a part of Russia including the Chelyabinsk, the Orenburg regions and the Republic of Bashkortostan. The Chelyabinsk region (Fig. 1) is situated at the center of Eurasia, in the South part of the Urals, on the border of two parts of the world – Europe and Asia (Government of the Chelyabinsk region). The Chelyabinsk Region is one of the oldest mining territories and endowed with rich mineral resources. The region is Russia's monopolist in the production and processing of graphite (95%), magnesite (95%), metallurgical dolomite (71%), and talc (70%). The region's industrial development is determined by the metallurgical complex, machine-building, fuel-and energy, construction, and agricultural sectors (Federation Council of the Federal Assembly of the Russian Federation 2021).

The South Ural is called the lake region since there are more than 3,500 lakes here. Among them, the lakes of the unified Kisegach-Miassovo hydrological system, located partially or completely within the specially protected territory of the Ilmen State Reserve, are interesting to study. These lakes are characterized by similar habitat conditions for the species but differ in trophic status. There are few works on spatial distribution, seasonal changes in population, and biomass of the zooplankton in Chelyabinsk region (Rechkalov and Golubok 2011; Rechkalov and Golubok 2011; Golubok and Rechkalov 2013; Rogozin 2018). However, the ecology of zooplankton in cold temperate lakes is very little studied. The work aims to determine taxonomic composition and biomass of zooplankton communities in the lakes within the Ilmen reserve of the Chelyabinsk region and to identify the influence of trophic status on its formation. We expected that our research can be a good contribution to add knowledge on the ecological state of zooplankton in the region and can serve as baseline information to monitor the health and quality of the aquatic ecosystems.

MATERIALS AND METHODS

Study area

This study was conducted on ten lakes in the Chelyabinsk region, Russia (Figure 1). The lakes belong to Kisegach-Miassovo hydrological system, which is almost a closed chain comprising 10 large and medium-sized lakes linked by small rivers and flowing streams. The studied lakes are under human-made impacts with various degrees, suggesting different trophic statuses.

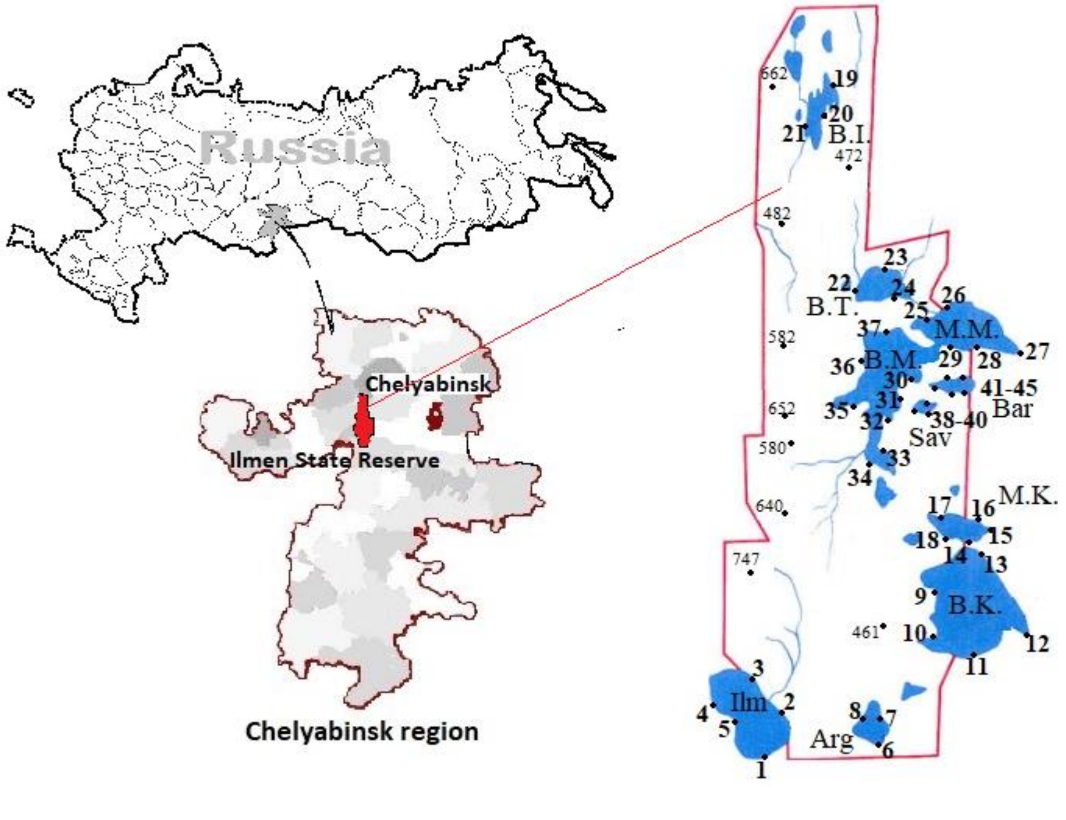

Figure 1. The map of the studied area of ten lakes in South Ural, Russia with altitudes ranging from 461 to 747 m above sea level. The sampling sites of each lake (coded as abbreviation) were: Ilm (1-5); Arg (6-8); B.K. (9-13); M.K. (14-18); Ishk (19-21); B.T. (22-24); M.M. (25-29); B.M. (30-37); Sav (38-40); Bar (41-45). The full names of the lakes are given in Table 1.

Table 1. The main characteristics of the lakes in South Ural, Russia

Lake name	Depth (m)		Surface	Features of the lake bottom	The presence of human activities	Features of the shoreline
	Avg	Max	km^2			
Argayash (Arg)	2.1	3.2	1.44	Silty, sometimes sandy	No	The shore is swampy, surrounded by pine forest growing on rocky hills
Bolshoy Tatkul (B.T.)	2.3	3.4	2.48	Silty, sometimes rocky	No	The lakeshore is sandy and rocky, mostly hilly, partly swampy, along the shore of mixed forests
Ilmenskoe (Ilm)	3.2	6.1	4.76	Silty	Three villages and a motorway	The shores are flat, swampy, part of the shore is in reed thickets, some sections of the shore are surrounded by natural forest and artificial forest plantations
Maloye Miassovo (M.M.)	4.7	7.8	12.0	Silty, sometimes sandy, rocky	Railway station, motorway, recreation sites, children's health camp	The northern and western shores are hilly, the eastern shore is flat, the southern shore is swampy, and the western and eastern shores are covered with mixed forest
Savelkul (Sav)	5.1	8.4	6.64	Silty	No	The shores of the lake are sandy and rocky, mostly flat, swampy from the north and partly from the west, mixed deciduous forests along the shore
Baraus (Bar)	6.5	10.0	1.08	Rocky-pebble, sometimes silty	Six villages, recreation sites	The southern shore of the lake is hilly, covered with mixed forest with a predominance of pine and birch, the northern shore is more flat and open, partially overgrown with birch trees, the southern and eastern shores are swampy
Ishkul (Ishk)	7.9	15.0	2.7	Silty, sometimes sandy, rocky	No	The shores are mostly hilly, covered with coniferous-deciduous forests, undergrowth vegetation is represented by fern and horsetail.
Maloy Kisegach (M.K.)	7.9	16.3	2.04	Sandy	No	The slopes of the shores are steep, rocky, covered with abundant vegetation, pine forests with an admixture of birch dominate
Bolshoye Miassovo (B.M.)	11.3	22.5	11.4	Silty	No	On all sides are surrounded by hills covered with mixed and pine forest, the shoreline is highly indented
Bolshoy Kisegach (B.K.)	18.0	35.2	14.2	Sandy	Several recreation sites and a village	The lake shores are rocky, covered with forest, and intended by numerous bays

Basic information about the lakes is shown in Table 1. Lakes of the Ilmen group are located within the low-mountain and foothill zones at an altitude of 270-375 m above sea level in rows along meridionally oriented mountain ranges (Table 1). Bolshoe Miassovo, Ishkul, Bolshoy Tatkul, Argayash, Savelkul, Baraus are located on the territory of the Ilmen state reserve and can be considered conditionally undisturbed, while Maloe Miassovo, Bolshoy Kisegach, Maloy Kisegach, and Ilmenskoe are affected by anthropogenic factors because they are partially located outside the reserve (Figure 1).

Sample collection

The primary data collection was gathered as follows: in June-July 2015 the samples from Ilmenskoe and Argayash were collected; then in June-July 2016 those from Savelkul, Baraus and Bolshoye Miassovo; while in 2017 were from Maloye Miassovo, Bolshoy Kisegach and Maloy Kisegach; and in 2018-2019 were the samples from Bolshoy Tatkul and Ishkul. The zooplanktons were caught in the upper layers of the lakes using a conical plankton net with the diameter of the upper ring was 18 cm, the lower ring was 24 cm, and the mesh cell size was 25 mkm). When sampling the water column of the lakes, horizons were determined: large with an interval of 3 m, medium with an interval of 2 m, shallow with an interval of 1 m. Samples from these horizons were taken using a bathometer. Integrated water samples at each site were brought to the laboratory for further research. The samples were fixed with 5% formalin, then reduced to 100 ml, three consecutive samples of 1 ml were studied with the binocular microscope and analyzed by the standard methods in the laboratory.

The species were counted and taxonomically identified (Tsalolihin 1994; Nogrady and Segers 2006). To identify most of the species and genera, a 100-400 magnification microscope was used. To study crustaceans under a microscope, they were transferred on a slide in a drop of glycerol and placed sideward with the antennae set aside from the body, if possible. Cover glasses were equipped with modelling clay to avoid damaging large species. For the analysis, average-weighted samples were prepared for each object. The results for the number of species were expressed as the number of animals per liter. The standard counting method was used to assess the number of zooplankton species. Rare species were counted in the third, half, and whole sample depending on the size. The dominant species were identified according to the abundance in taxonomic groups of crustaceans and rotifers separately. The lake clarity value was determined by a white Secchi disk (SD) with a diameter of 30 cm. We used Non-metric Multidimensional Scaling (NMDS) to examine zooplankton community.

Data analysis

Besides the primary data collected in this study, data of other researchers (Rechkalov and Golubok 2011; Rogozin 2018), as well as the results of our previous work, were used for analysis.

The Trophic Status Index was calculated according to the water clarity values using Carlson formula (Carlson 1977):

$$TSI = 10\cdot(6 - \log_2 SD),$$

Where: SD: water clarity according to Secchi disk, m.

The lake is classified as oligotrophic with TSI < 30-40, mesotrophic with TSI = 40-50, eutrophic with TSI = 50-70, hypereutrophic with TSI > 70.

To assess the similarity of plankton in different lakes and analyze the influence of abiotic factors on the formation of the zooplankton community, the Czekanowski-Sorensen coefficient was used, which was determined using GRAFS (Nowakowski 2004).

RESULTS AND DISCUSSION

The results of ecological variables that indicate the trophic character of the studied lakes, such as clarity and salinity, are presented in Table 2.

Figure 2 provides the assessment of similarity of zooplankton species diversity in the studied lakes according to the Czekanowski-Sorensen Index. Looking at Figure 2, it is apparent that the species structure of the lake Argayash is close to mesotrophic lakes. So it gives us grounds to refer to the lake as mesotrophic. The lakes Ilmenskoye and Bolshoy Kisegach, which are mesotrophic by status, are similar to the eutrophic lakes Ishkul and Maly Kisegach according to the species composition, so we assume that these lakes are of the transitional mesoeutrophic status. Thus, we could classify the lakes this way: Savelkul, Baraus are oligotrophic lakes; Bolshoye Miassovo, Maloye Miassovo, Bolshoy Tatkul and Argayash are mesotrophic; Ilmenskoe, Ishkul, Bolshoy Kisegach, and Maloy Kisegach are meso-eutrophic. If the trophic status of these lakes is classified according to the index of zooplankton species diversity, it does not always coincide with the results in Table 2.

A total of 44 species of zooplankton were recorded in the studied lakes ranging from 33 in Maloy Kisegach to 43 in Bolshoye Miassovo, Maloye Miassovo and Argayash. The recorded species belong to three main taxa, namely Cladocera, Copepoda and Rotifera. Most of them are widely distributed in the temperate zone. Zooplankton communities were very similar in taxonomic composition in all the studied lakes (Table 3).

The order of Cladocera had the greatest species diversity, ranging from 15 to 18 species (from 38% to 50% of their total number). Slightly fewer species have been recorded from the Rotifera class with 9 to 17 species (28% to 40%). In terms of species diversity, the order of Copepoda is represented almost equally in all the studied reservoirs with 9 species (20%).

Table 2. Results of ecological variables of the lakes in South Ural, Russia

Lake name	Salinity		Clarity (Secchi disc, m)	Trophic State Index (TSI)	Trophicity
	mg·L^{-1}	Type			
Argayash	362,3	HCO_3-Mg-SO_4	1.6	53	Eutrophic
Bolshoy Tatkul	230.1	HCO_3-Ca-Na	2.5	47	Mesotrophic
Ilmenskoe	337.6	HCO_3-Ca-Mg	2.3	48	Mesotrophic
Maloye Miassovo	417.0	HCO_3-Na-SO_4	3.7	41	Mesotrophic
Savelkul	123.0	HCO_3-Ca-Na	4.2	39	Oligotrophic
Baraus	115.0	HCO_3-Ca-Mg	4.5	38	Oligotrophic
Ishkul	218.4	HCO_3-Ca-Na	1.6	53	Eutrophic
Maloy Kisegach	298.6	HCO_3-Ca-Na	1.5	54	Eutrophic
Bolshoye Miassovo	240.3	HCO_3-Ca-Na	3.7	41	Mesotrophic
Bolshoy Kisegach	244.8	HCO_3-Ca-Na	4.0	40	Mesotrophic

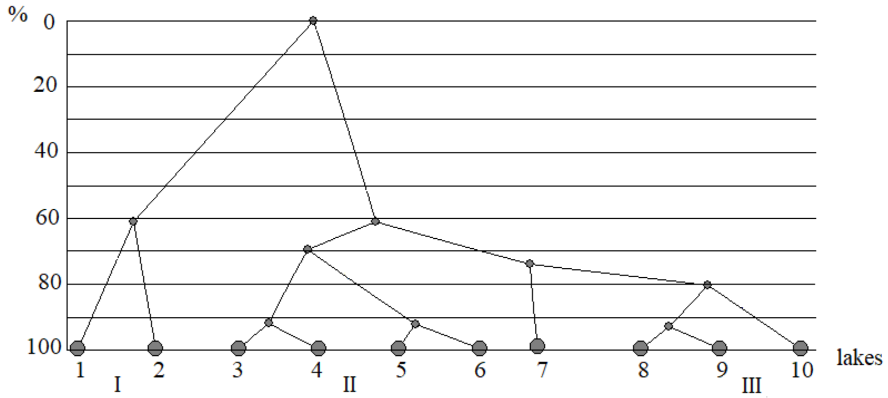

Figure 2. Ranging of the studied lakes (according to the Czekanowski-Sorensen index): I. oligotrophic lakes; II. mesotrophic lakes; III. mesoeutrophic lakes; 1. Savelkul; 2. Baraus; 3. Argayash; 4. Bolshoye Miassovo; 5. Bolshoy Tatkul; 6. Maloye Miassovo; 7. Ishkul; 8. Ilmenskoe; 9. Bolshoy Kisegach; 10. Maloy Kisegach

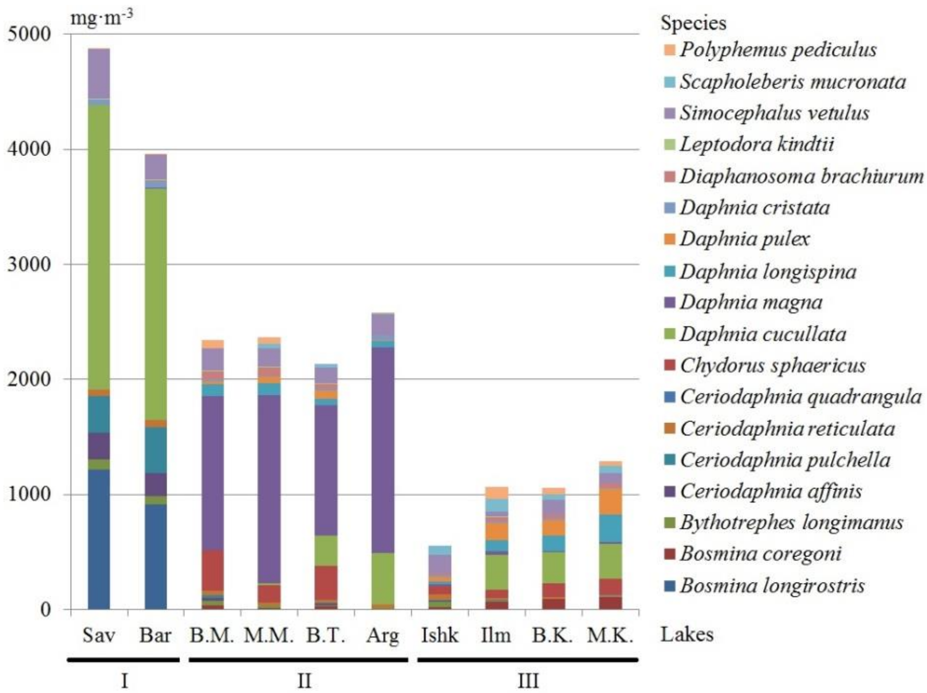

Figure 3. Ratio of Cladocera species biomass of different types of lakes: I-oligotrophic lakes; II-mesotrophic lakes; III-mesoeutrophic lakes

Table 3. Species composition and biomass of zooplankton species (mg·L^{-1})

Species	Lakes									
	Arg	**Sav**	**Bar**	**B.M..**	**M.M.**	**B.T.**	**Ishk**	**Ilm**	**B.K.**	**M.K.**
Order Cladocera, Class Crustacea										
Bosmina longirostris (O.F. Müller, 1776)	1.58	1216.75	915.64	7.09	1.16	1.9	1.37	0.51	0	0
Bosmina coregoni (O.F. Müller, 1785)	4.71	0.33	1.01	27.39	14.17	25.86	14.73	69.81	88.44	108.61
Bythotrephes longimanus (Leydig, 1860)	4.81	90.00	72.83	44.53	16.89	11.98	50.19	8.4	0	0
Ceriodaphnia affinis (Lilljieborg, 1862)	0.58	231.26	192.11	23.69	0.89	15.37	7.09	0.66	0.26	0.43
Ceriodaphnia pulchella (Sars, 1862)	1.36	317.92	405.74	18.17	1.6	2.47	8.72	1.03	0.03	0.05
Ceriodaphnia reticulata (Jurine, 1820)	28.37	52.16	58.67	40.55	25.51	25.61	46.89	18.02	20.41	16.51
Ceriodaphnia quadrangula (O.F. Müller, 1785)	0	0	0	3.66	3.15	2.41	1.01	0	2.38	3.75
Chydorus sphaericus (O.F. Müller, 1785)	2.15	0.67	0.58	347.19	150.14	294.27	70.55	73.11	117.31	141.11
Daphnia cucullata (Sars, 1862)	444.05	2474.24	2012.8	0.93	12.02	263.88	1.05	304.07	266.15	299.1
Daphnia magna (Straus, 1820)	1792.86	0.87	9.81	1342.85	1638.28	1129.7	21.46	34.56	12.97	14.91
Daphnia longispina (O.F. Muller, 1776)	52.9	0.17	0.33	103.7	105.3	54.4	21.73	93.87	137.73	237.73
Daphnia pulex (Leydig, 1860)	12.11	0	0	20.4	50.94	79.33	39.67	151.27	136.18	226.49
Daphnia cristata (Sars, 1862)	33.96	48.22	56.34	16.24	9.41	10.89	18.02	12.18	10.79	10.1
Diaphanosoma brachiurum (Levin, 1848)	1.15	2.71	3.33	77.39	73.8	43.7	8.96	36.38	34.35	38.18
Leptodora kindtii (Focke, 1844)	4.96	6.48	7.08	3.28	3.56	2.9	4.84	3.42	2.9	2.62
Simocephalus vetulus (O.F. Muller 1776)	182.83	426.23	221.11	192.22	166.08	140.64	154.9	45.87	125.27	84.18
Scapholeberis mucronata (O.F. Müller, 1785)	2.1	0	0	3.01	33.43	26.71	85.67	108.02	47.04	61.57
Polyphemus pediculus (Linnaeus, 1761)	13.18	3.64	1.82	68.64	58.03	0	0	103.48	51.21	41.36
Order Copepoda, Class Crustacea										
Eucyclops macrurus (Sars, 1863)	48.61	116.6	114.53	50.81	44.86	58.81	31.3	3.23	4.01	8.03
Eucyclops serrulatus (Fischer,1851)	5.68	0.21	0.44	7.92	11.68	8.96	3.92	26.36	19.04	19.48
Eudiaptomus graciloides (Lilljeborg, 1888)	107.28	135.35	175	51.77	52.95	40.47	25.16	14.8	15.39	9.21
Eudiaptomus vulgaris (Schmeil, 1896)	1.8	6.05	6.7	2.7	1.55	1.6	2.3	0	0	0
Cyclops vicinus (Uljanin, 1875)	21.13	15.97	18.88	9.38	4.76	8.51	10.79	4.76	4.15	2.69
Cyclops strenuus (Fischer, 1851)	1.63	0.35	0.44	8.42	6.11	6.35	0.05	40.59	19.56	16.11
Mesocyclops leuckarti (Claus, 1857)	6.09	8.49	12.53	1.03	0	0	32	0	0	0
Macrocyclops albidus (Jurine, 1820)	17.33	12.71	16.24	0.53	52.82	47.52	46.58	130.64	89.66	142.86
Thermocyclops oithonoides (Sars,1863)	90.03	230.93	234.54	184.23	175.06	57.48	0.75	5.75	4.57	1.1
Type Rotifera										
Asplanchna priodonta (Gosse, 1850)	2.04	3.66	2.26	1.39	1.83	4.95	0	0	0.75	0.65
Bipalpus hudsoni (Imhof, 1891)	0.04	0.64	0.56	0	*	0.23	0.71	0	0	0
Brachionus diversicornis (Daday, 1883)	4.19	0.42	0.45	2.15	2.62	3.01	0.32	3.95	4.32	4.09
Brachionus calyciflorus calyciflorus (Pallas, 1766)	0.83	0	0	0.55	0.52	4.37	0.36	14.84	15.96	17.56
Diplois daviesiae (Gosse, 1886)	0.24	0.69	0.96	0.65	0.22	0	0	*	*	0
Euchlanis dilitata (Ehrenberg, 1832)	0.91	2.62	2.75	1.29	0.86	1.06	0.05	0.24	0.28	0.31
Filinia longiseta (Ehrenberg, 1834)	1.55	0.63	0.71	0.53	0.73	0.54	0.82	2.31	2.97	2.75
Keratella cochlearis (Gosse,1851)	*	*	*	*	*	*	*	*	*	*
Keratella ticinensis (Callerio, 1921)	0.03	*	*	1.1	*	*	0	0	0	0
Keratella irregularis (Lauterborn, 1898)	1.4	2.23	2.8	2.34	1.88	1.5	0.83	0	0	0
Keratella quadrata (O.F. Muller, 1786)	0.3	0.68	0.64	0.5	0.34	0.55	0.19	0	0	0
Kellicottia longispina (Kellicott, 1879)	0.12	0.06	*	0.11	0.09	0.09	0	0.08	0.07	0.07
Lecane luna (O.F. Muller, 1776)	*	*	*	*	*	*	*	0	0	0
Lecane (M.) bulla bulla (Gosse 1832)	*	*	*	*	*	*	*	*	*	*
Mytilina ventralis ventralis (Ehrenberg, 1832)	0.99	3.52	3.62	1.77	1.44	1.29	0.23	0	0	0
Notholca labis (Gosse, 1887)	2.14	3.19	1.78	3.29	1.75	2.21	0.63	0.13	0.04	0.05
Trichocerca stylata (Gosse, 1851)	*	*	*	*	*	*	*	*	*	*

Note: * biomass of zooplankton species less than 0.03 mg·L^{-1}

Because the biomass of Rotifera representatives was negligible compared to the representatives of Cladocera and Copepoda groups, we considered the change in the biomass of representatives of these groups separate from each other in groups of lakes of different trophic status. As a result of the analysis, it was found that in lakes of different trophic status, the Cladocera biomass decreases in the direction of increasing trophic. So, in oligotrophic lakes, it had average of 4455.2 ± 416.5 mg·L^{-1}, while in mesotrophic lakes it had 2355.2 ± 228.5 mg·L^{-1}, and in mesoeutrophic lakes it had 1135.0±151.7 mg·L^{-1} (Figure 3).

Further, in oligotrophic and mesotrophic lakes, there were core complexes of zooplankton with distinct edification species: in oligotrophic lakes, these were *B. longirostris* and *D. cucullate*, while in mesotrophic lakes, this was *D. magna*. Whereas in the mesoeutrophic lakes, the biomass of different species of representatives of Cladocera is small and slightly different (Figure 3).

The biomass of Copepoda representatives also decreased with increasing trophic. Thus, in oligotrophic lakes, the biomass of Copepoda representatives had average of 552.9 ± 27.5 mg·L^{-1}, mesotrophic lakes had 299.0 ± 50.7 mg·L^{-1}, and mesoeutrophic lakes had 183.7 ± 39.7 mg·L^{-1} (Figure 3). In all of lake tropic types, there were dominant species, i.e., in oligotrophic lakes these were *T. oithonoides*, *E. graciloides* and *E. macrurus*, while in mesotrophic lakes were *T. oithonoides*, *E. graciloides*, *E. macrurus* and *M. albidus* and in mesoeutrophic lakes the pattern was changing with the dominant species were *M. albidus*, *C. strenuus* and *E. serrulatus* reach greater biomass (Figure 4).

Unlike Copepoda and Cladocera, Rotifera biomass slightly changed with increasing water tropism (in oligotrophic lakes was 16.7±1.7 mg·L^{-1}, in mesotrophic lakes, was 16.2±2.7 mg·L^{-1}, and in mesoeutrophic lakes was 23.9±1.7 mg·L^{-1}), but species diversity is reduced (Figure 4). In all types of lakes, there were dominant species, i.e., in oligotrophic lakes were *N. labis*, *M. ventralis ventralis*, *K. irregularis*, *E. dilitata* and *A. priodonta*; while in mesotrophic lakes the species of *M. ventralis ventralis*, *E. dilitata* and *A. priodonta* decreased, but *N. labis*, *K. irregularis* remained dominant, and the biomass of *B. diversicornis* increased. The edificator species *K. irregularis* and dominants *B. diversicornis*, *F. longiseta* are distinguished in the mesoeutrophic lakes (Figure 5).

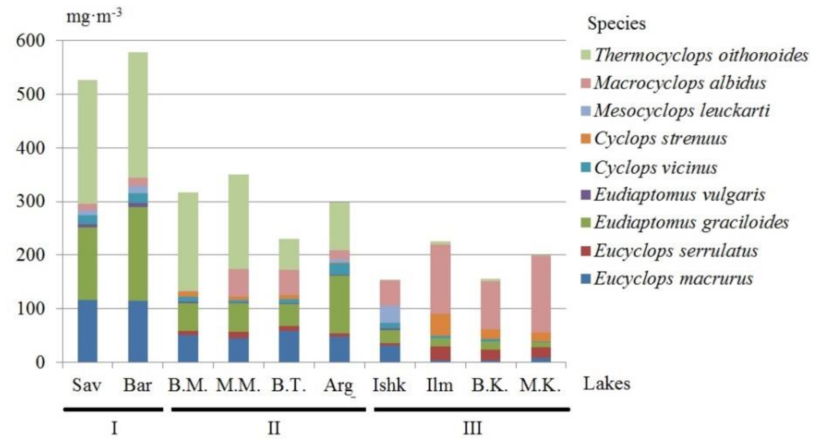

Figure 4. Ratio of Copepoda species biomass of different types of lakes: I-oligotrophic lakes; II-mesotrophic lakes; III-mesoeutrophic lakes

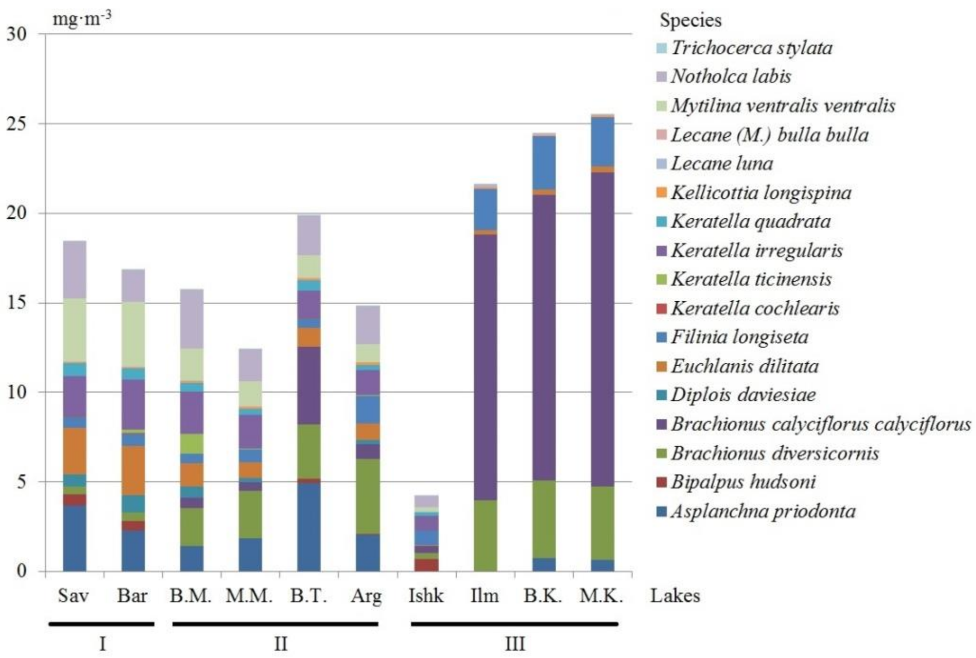

Figure 5. Ratio of Rotifera species biomass of different types of lakes: I-oligotrophic lakes; II-mesotrophic lakes; III-mesoeutrophic lakes

Total zooplankton biomass decreased from 5430.90 mg·L^{-1} (Savelkul) to 707.67 mg·L^{-1} (Ishkul) when the trophic content of water in natural fresh lakes of the unified Kisegach -Miassovo hydrological system changed in the direction of oligotrophic-mesotrophic-mesoeutrophic. If considered in separate groups, the biomass of Cladocera representatives decreased in this direction, from 4871.65 mg·L^{-1} (Savelkul) to 536.85 mg·L^{-1} (Ishkul), and Copepoda from 595 mg·L^{-1} (Baraus) to 163.68 mg·L^{-1} (Ishkul). The biomass of Rotifera representatives varied slightly, but it was higher in mesoeutrophic lakes with 25.48 mg·L^{-1} (Maloy Kisegach) than in oligo- and mesotrophic lakes with 12.31 mg·L^{-1} (Maloye Miassovo).

In summary, this study suggests that the zooplankton community provides a more accurate assessment of the trophic status of reservoirs and shows their gradual transition from one status to another. The assessment of hydro-ecological indicators is not very accurate since the level of indicators is unstable and can change not only under the influence of anthropogenic factors but also depending on many natural abiotic factors of the environment.

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