Influence of trophic status on zooplankton structure in Chelyabinsk region lakes (Russia)

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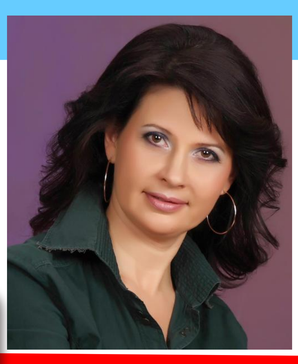

Objectives

The current research aims at identifying taxonomic structure of zooplankton communities of the lakes in Chelyabinsk region (Russia) and stating the influence of trophic status on its formation (figure 1**)**. Very few studies have explored the ecology of zooplankton species in the lakes of Chelyabinsk l

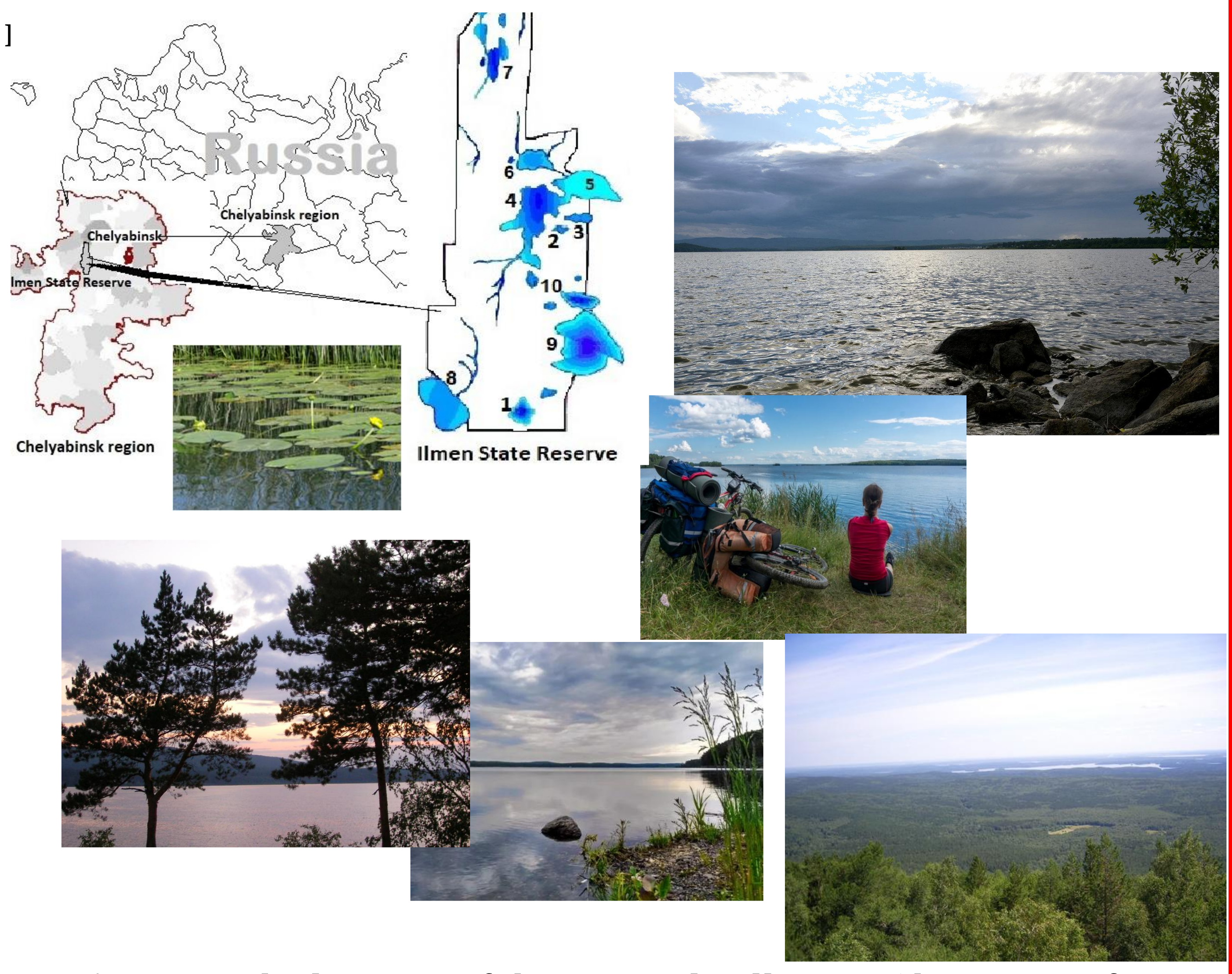

Figure 1. The location of the material collection (the names of the lakes under the numbers are given in table 1)

There is sporadic research of spacious distribution, seasonal abundance and biomass changes. But, the ecology of zooplankton in cold temperate lakes is studied very few, so our research can be a good contribution.

Materials/Methods

10 lakes in Chelyabinsk region (Russia) were studied. They belong to Kisegach-Miassovo hydrological system, locait at the height of 270-375 m above sea level. BM, Ishk, BT, Arg, Sav, Bar are located on the territory of the Ilmen State Reserve and could be considered as conventionally undisturbed, while MM, BK, MK and Ilm are affected by human activity. These lakes are partly outside the territory of the State Reserve. Them the connected with residential and recreational areas near the shores. Ishk, MK, BM, BK are deep lakes , they could be characterised by pronounced basins, the coastal areas of the are poorly developed with irregular shores. Ilm, MM, Sav, Bar belong to the lakes of medium depth, shores are clearly defined, bottoms and shores are rocky. Arg and BT are shallow lakes (table 1). They have significant silt deposits that sometimes reach 6 m. These lakes are bays once separated of the largest lakes.

Table 1. Information about water-bodies

Lake (the number corresponds to the location of the lakes in Figure 1)	Shortened names	Max. depth m	Surface km^2	Salinity mg·L^{-1}	Clarity Secchi disc, m	TSI	Trophicity
Argayash (1)	Arg	3.2	1.44	362.3	1.6	53	eutrophic
Bolshoy Tatkul (6)	BT	3.4	2.48	125.1	2.5	47	mesotrophic
Ilmenskoe (8)	Ilm	6.1	4.76	337.0	2.3	48	mesotrophic
Maloye Miassovo (5)	MM	7.8	12	184.4	3.7	41	mesotrophic
Savelkul (2)	Sav	8.4	6.64	123.0	4.2	39	oligotrophic
Baraus (3)	Bar	10.0	1.08	115.0	4.5	38	oligotrophic
Ishkul (7)	Ishk	15.0	2.7	148.6	1.6	53	eutrophic
Maly Kisegach (10)	MK	16.3	2.04	121.6	1.5	54	eutrophic
Bolshoye Miassovo (4)	BM	22.5	11.4	198.3	3.7	41	mesotrophic
Bolshoy Kisegach (9)	BK	35.2	14.2	144.8	4.0	40	mesotrophic

Results and Discussion

We analyzed 33 integrated samples to find out the influence of various levels of studied environmental factors on the formation of the zooplankton community. 44 species of zooplankton were found. Zooplankton communities turn out to be very similar in taxonomic composition in all the lakes (figure 2). This is due to the fact that the lakes form the unified hydrological system. However Cladocera was distinguished by the richest species diversity ranging from 15 in oligotrophic lakes to 18 in mesotrophic. Slightly fewer species have been registered in Class Rotatoria - from 9 species in eutrophic lakes to 17 species in oligo and mesotrophic lakes. In terms of species diversity, Order Copepoda is represented almost equally in all the studied water-bodies - 9 species (figure 2). The communities differ mainly in the structure of dominance not in species composition.

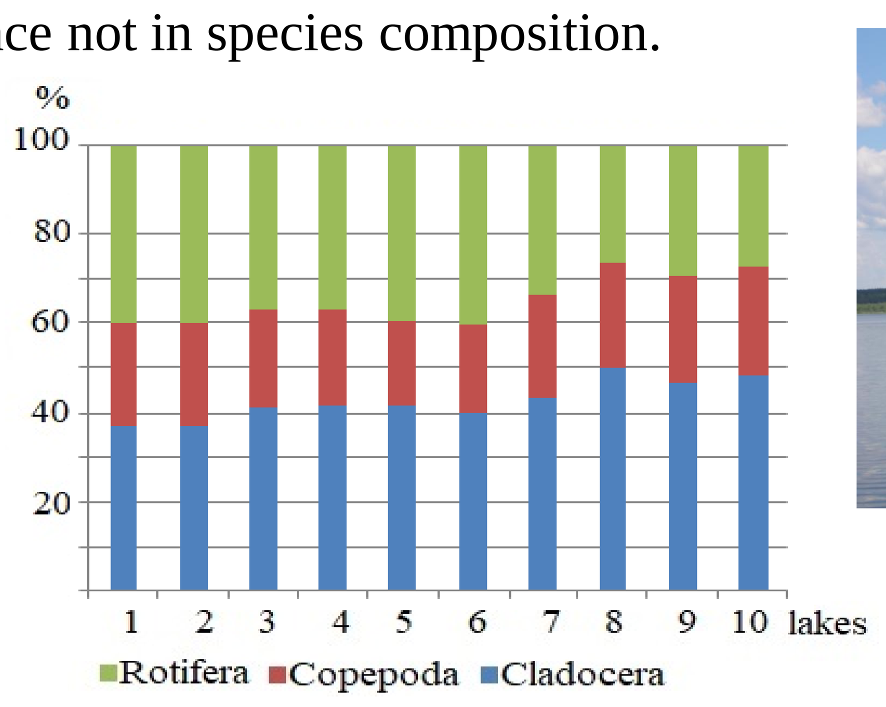

Figure 2. Proportion of species (%) of the main zooplankton groups in lakes: 1 - Sav; 2 - Bar; 3 - Arg; 4 - BM; 5 - BT; 6 - MM; 7 - Ishk; 8 - Ilm; 9 - BK; 10 - MK

The ranging of lakes with the help of non-metric multidimensional scaling (nMDS) on biodiversity and density does not always coincide with a trophic status of the studied lakes on clarity value. The analysis of the graph (figure 3), drawn in accordance with biodiversity and density, made the following ranging possible: the first group consists of Sav and Bar, which are oligotrophic according to the TSI; the second group comprises BM, MM, BT, which are mesotrophic according to the TSI; BK, Ilm, MK, Ishk belong to the third group (eutrophic lakes), although BK, Ilm are mesotrophic lakes according to the TSI (table 1).

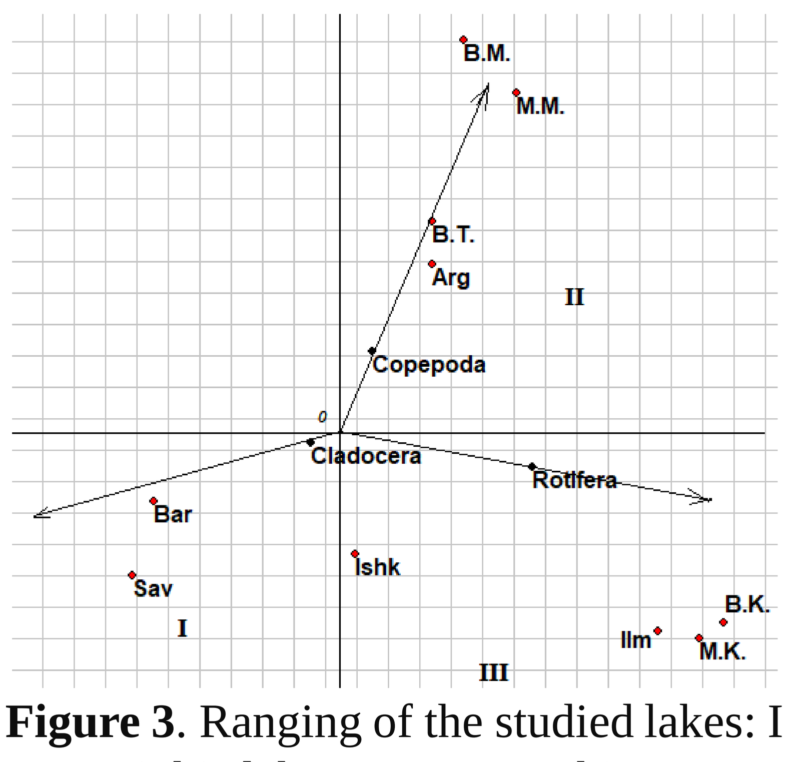

Figure 3. Ranging of the studied lakes: I - oligitrophic lakes; II - mesotriphic lakes; III - eutrophic.

Table 2 shows zooplankton population according to the taxonomic groups. The proportion of zooplankton population of the studied groups Cladocera - Rotifera - Copepoda in lakes different in trophicity appeared to be different.

Figure 4 shows the correlation between the main zooplankton groups and their trophic status. In oligotrophic lakes this proportion is 89:2:9 (%). The proportion of Cladocera population decreases in mesotrophic lakes with the proportion of Rotifera and Copepoda population increasing 70:10:20 (%). In eutrophic lakes, the proportion of Rotifera increases and the proportion of Copepoda and Cladocera decreases 66:22:10 (%) (figure 4).

Table 2.The population of main taxa in zooplankton communities, ind·L^{-1}

Zooplankton taxa	Lakes									
	Arg	Sav	Bar	BM	MM	BT	Ishk	Ilm	BK	MK
Cladocera	96.47	362.03	295.42	98.12	87.77	84.04	37.34	69.92	66.43	71.69
Copepoda	26.03	31.86	34.01	33.89	28.78	24.78	4.90	12.67	13.62	13.63
Rotifera	15.20	7.01	6.97	9.10	8.96	13.42	4.03	23.47	26.10	26.60
Total	137.70	400.90	336.40	141.11	125.52	122.24	46.27	106.06	106.15	111.92

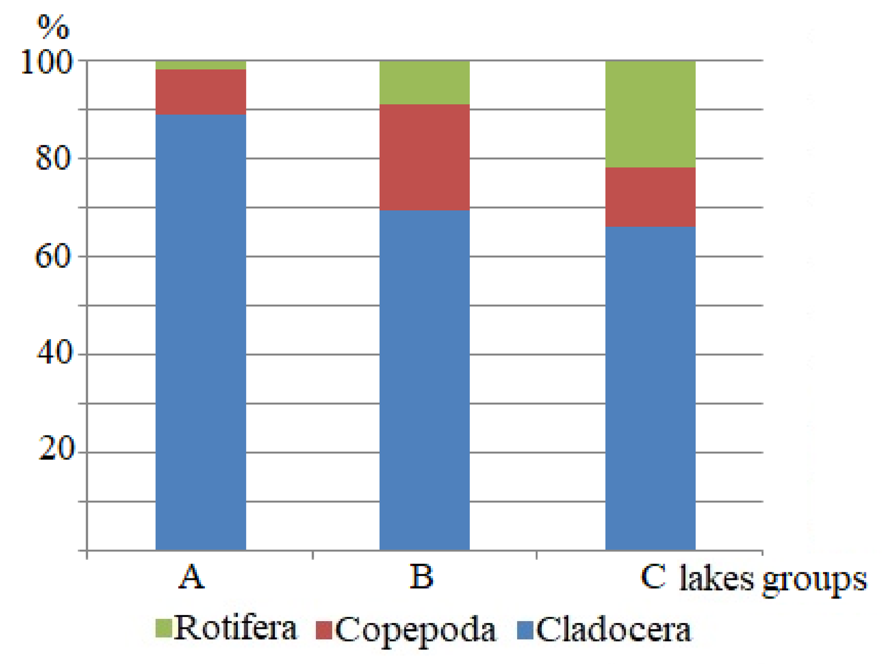

Figure 4. Proportion (%) of population of zooplankton main groups in lakes different in trophicity A - oligotrophic lakes; B - mesotrophic lakes; C - eutrophic lakes.

Besides, in oligotrophic lakes, Cladocera dominates in all water layers and the average weighted zooplankton population is high and accounts for 368.59± 32.31 ind•L^{-1} (figure 5). Unlike in oligotrophic, in mesotrophic lakes, the part of Copepoda is increasing (figure 5), the average weighted zooplankton population is 132.17 ± 8.50 ind•L^{-1}. In meso-eutrophic lakes, the population of Rotifera is growing (figure 5), and the average weighted zooplankton population is 92.60 ± 2.88 ind•L^{-1}.

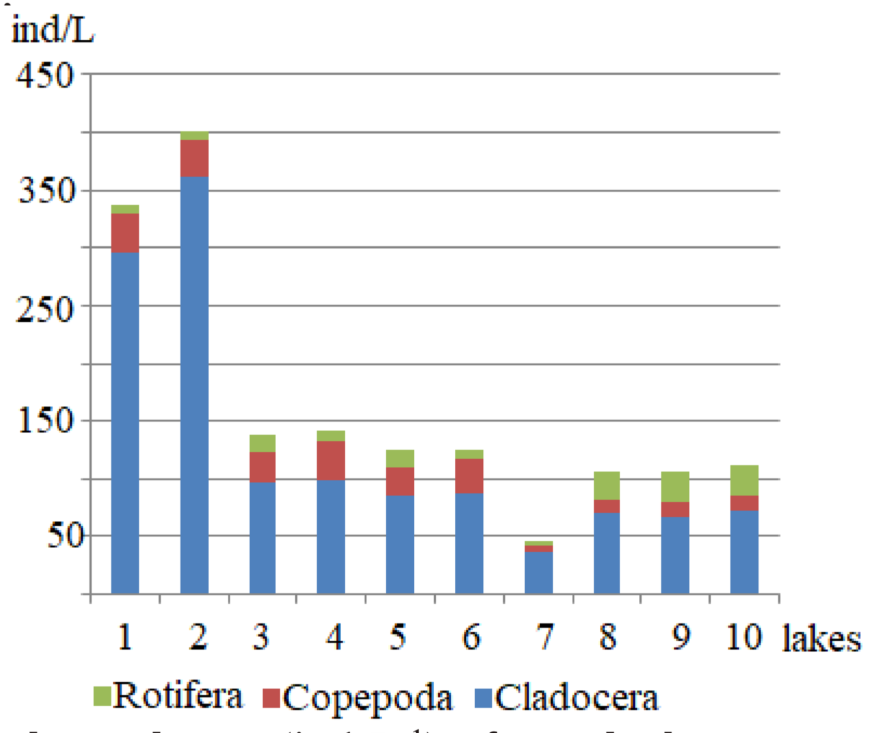

Figure 5. Average weighted population (ind·L^{-1}) of zooplankton main groups in lakes: 1 - Sav; 2 - Bar; 3 - Arg; 4 - BM; 5 - BT; 6 - MM; 7 - Ishk; 8 - Ilm; 9 - BK; 10 - MK

Conclusions

Ranging lakes according to biodiversity and density mostly coincides with the lakes trophicity according to SD value. Physical factors of shallow lakes might reflect trophic changes more quickly than biological ones. And for large lakes the situation is opposite. Arg, Ilm, BK could be referred to transitive (mesoeutrophic). When trophic status of lakes changes oligotrophic-mesotrophic-eutrophic, the total zooplankton community density decreases from 400.90 individuals per L^{-1} (Sav) to 106.06 individuals per L^{-1} (Ilm) (table 3). If trophic status is considered in separate groups, then, Cladocera fnd Copepoda is decreasing, and Rotifera is increasing.