Annuaire de l'Université de Sofia "St. Kliment Ohridski"
Faculte de Biologie
2016, volume 101, livre 4, pp. 94-100
Youth Scientific Conference "Kliment's Days", Sofia 2015

BIODIVERSITY OF ZOOPLANKTON IN RILA MOUNTAIN GLACIAL LAKES IN NATURA 2000 ZONES - BG 000495 AND BG 000496

GEORGICA ILIEVA[1*], MARIETA STANACHKOVA[1], DIMITAR KOZUHAROV[1]

1 – Department of General and Applied Hydrobiology, Faculty of Biology, Sofia University "St. Kliment Ohridski", Sofia, Bulgaria
** Corresponding author:georgica_ilieva@abv.bg*

Keywords: Mountain glacial lakes, relict species, zooplankton

Abstract: Rila mountain glacial lakes are included in protected area, according to Bulgarian legislation; they are part of the European ecological network Natura 2000. The management of the zones complies with the EU Directive for Conservation of Wild Birds (79/409/EEC), the Directive for Conservation of Natural Habitats and this of Wild Flora and Fauna (92/43/EEC), the Bern Convention (in effect since 1991), and the Biodiversity Convention (in effect since 1996). Assuredly, the mountain glacial lakes are characterized with high conservation significance. The conclusion is supported by the existence of some relicts and rare species. In the investigated lakes *Hexarthra bulgarica* (Wiszniewski, 1933), *Acroperus elongatus* (Sars, 1862), *Daphnia rosea* (Sars, 1862) and *Arctodiapthomus alpinus* (Imhof, 1885) were found. Despite of the considerable faunistic diversity, high mountain lakes are threatened by rapid eutrophication processes caused by a combination of anthropogenic impact and climate changes. Introduction of non-native fish species like *Phoxinus phoxinus* (Linnaeus, 1758), *Oncorhynchus mykiss* Walbaum, 1792 and *Salvelinus fontinalis* Mitchill, 1814 into previously fishless waters, altered zooplankton community too. Another sign of the lake's status is the composition and structure of zooplankton, which is used to assess the changes in trophic conditions in relation to water quality. Determination of trophic level was made based on RCC index (Kozuharov et al. 2013). Increasing of trophic state was observed according to 50 zooplankton samples from 23 lakes located in Natura 2000 zones - BG 000495 and BG 000496. The results are sufficient to evaluate the plankton diversity and conservation importance of glacial lakes in Rila Mountain. The presented new information also can be useful to update Rila National Park Management Plan.

INTRODUCTION

Eutrophication of glacial lakes is a natural process and it takes tens of thousands of years, but under the influence of human activity, this process decreases to a few decades. Unfavorable factors accelerating eutrophication are: continuously growing tourism, illegal fish stocking, intensive water supply, hydro-technical construction, fires and forest felling. Anthropogenic intervention, climate changes and low control of the protected area leads to destruction of natural ecosystem, biodiversity loss and even species extinction (Kozuharov, Ivanov 2011).The first known data on hydro biological exploration of lakes in the Rila mountains were published in the works of Valkanov (1934, 1938). Previously, Chichkoff (1906, 1909) reported on some lower crustacean inhabiting the glacial water ecosystem in Rila Mountain. Faunistic research on glacial lakes continues with systematic description of some cladocerans and copepoda species (Naidenow, 1975). In the same paper, the author published the development of evolutionary stages in glacial lakes. Naidenow (2000) summarized zooplankton data from the beginning of the last century and for the first time included quantitative data of the three main groups /Rotifera, Cladocera and Copepoda/. Composition and structure of the community are used as an indicator of the trophic state and often is evidence of changes in biodiversity and decreasing species richness of zooplankton, due to increased trophic level. The aim of the research was to determine species richness, diversity and ecological characteristic of zooplankton communities in glacial lakes of Rila Mountain in Natura 2000 zones - BG 000495 (Rila) and BG 000496 (Rila Monastery). In addition, some relicts and rare species were used as indicators to assess the state of the environment they inhabit. Preliminary data of zooplankton community are presented here, but detailed analysis is needed for the establishment of the actual lake status.

MATERIALS AND METHODS

The research was conducted in different regions of Rila Mountain (Figure 1). Twenty three glacial lakes with a variety of morphometric features, such as surface area, maximum depth and volume were investigated in the 2011 – 2015 period.

Zooplankton samples were collected and analyzed according to EN 15110:2006 (E) (http://www.bds-bg.org/). Digital interpretation of zooplankton community structure (Shannon-Weaver 1963, Simpson 1949, Pielou 1975) and trophic related RCC index (Kozuharov et al., 2013) was made according to web based software LIMNOS (www.limnoecology.com).The locations of indicators were represented with ArcGIS 10.

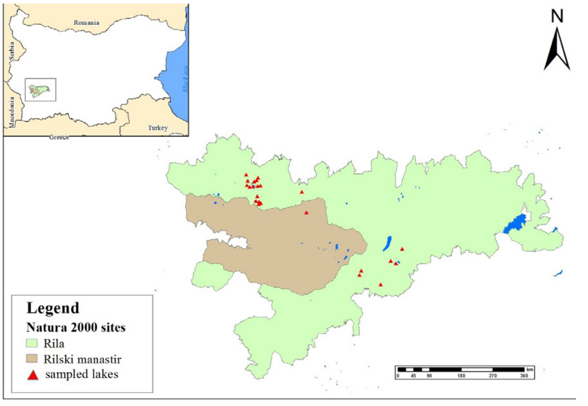

Figure 1. Map of the sampling area

RESULTS AND DISCUSSION

During the field research carried out, 85 zooplankton taxa were found. Only six of them are indicators of clear glacial waters which is illustrated in Fig. 2, 3 and 4. Location of indicators is represented according to the ratio of their quantities expressed by individuals per cubic meter. According to Deltshev et al., 1999, glacial relicts or indicator species are some crustaceans such as: *Acroperus elongatus*, *Arctodiaptomus alpinus*, *Mixodiaptomus tatricus*, *Arctodiaptomus niethammeri*, *Daphnia hyalina*, *Daphnia rosea*, *Chirocephalus diaphanus*. *Lecane (M.) latvica*, *Keratella hiemalis*, *Notholca labis*, *N. squamula* and *Hexarthra bulgarica* are rotifers inhabiting glacial lakes. Highest species richness of indicators was observed in the uppermost located Salzata and Okoto lakes from the Seven Rila Lakes. Most species can be characterized as being more commonly found in cold environments. Despite of the presence of rare species their populations are endangered. Some species were presented only by one individual per m^3 like *Daphnia rosea* and *Acroperus elongatus*. However, *A. elongatus* was the most frequent indicative species inhabiting seven of the sampled lakes, but was found with single individuals in the lakes Skakavitsa and Dolno Chanakgylsko Ezero (Fig. 2). Another species of the crustacean plankton *Arctodiaptomus alpinus* was recorded in the highest of the Seven Rila Lakes (Fig. 2). *Arctodiaptomus niethammeri* was not found in the investigated period.

Hexarthra bulgarica is extremely rare, *and* has so far been reported only for high altitude lakes in Pirin Mountain. The species inhabits lakes above 2500 m a.s.l. and was now registered in Nalbantsko Lake (Fig. 4). No Indicator species were found in six of the sampled lakes.

Alona affinis, *Chydorus sphaericus*, *Acroperus elongatus*, *Eucyclops serrulatus*, *Daphnia rosea*, *Mixodiaptomus tatricus*, *Keratella cochlearis, Polyarthra dolichoptera, Bosmina coregoni, Camptoceros rectirostris, Arctodiaptomus alpinus, Conochilus unicornis* dominated the zooplankton community in the past (Naidenow, 2000). The appearance of *Bosmina longirostris*, *Daphnia cucullata* and some rotifers is a sign of a change in the community structure of the lakes. At the same time the populations of the previously common species of glacial lakes decreased or completely disappeared.

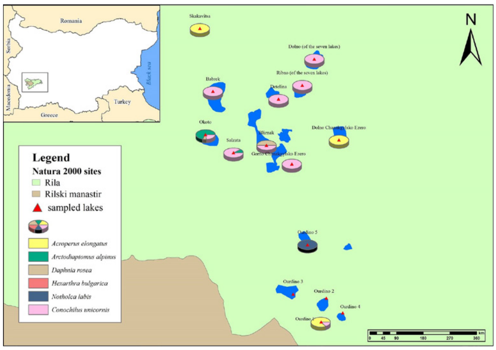

Figure 2. Location of indicator species

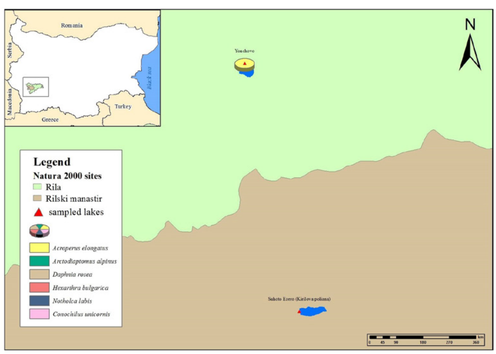

Figure 3. Location of indicator species

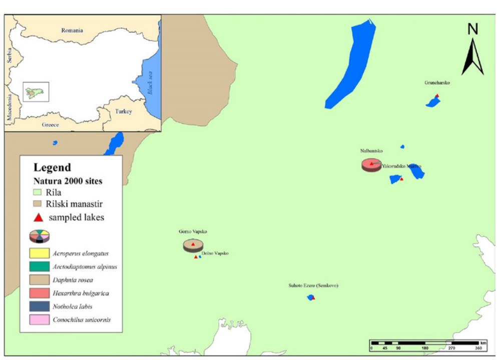

Figure 4. Location of indicator species

Quantitative data and structure of zooplankton community and RCC index

The quantitative parameters of the zooplankton in the studied lakes varied widely. The highest abundance (240200 ind.m^{-3}) was observed in Gruncharsko Lake due to *Keratella cochlearis*. The tendencies in the biomass did not follow these of the abundance. It was found that the minimum and maximum values of biomass are 0.53 mg.m^{-3} and 248.00 mg.m^{-3}, correspondingly. The zooplankton community structure was determined based on the quantitative evaluation of the samples. According to the results, maximum value of the Shannon-Weavers' diversity index (H =1.97) is in Skakavitsa Lake (Table 1), and the lowest value (H = 0.02) was calculated for Gruncharsko Lake.

Table 1. List of the sampled lakes; Legend: A – abundance /ind.m^{-3}/; B – biomass /mg.m^{-3}/; biodiversity index (H) by Shannon-Weaver 1963, (C) index of dominance by Simpson 1949, (E) index of evenness according to Pielou 1975; RCC trophic index

№	Lake	A	B	H	C	E	RCC
1	Salzata	21330	84,33	1,56	0,28	0,68	68
2	Okoto	812	25,63	1,53	0,31	0,60	66
3	Babreka	5932	4,53	1,66	0,21	0,85	25
4	Bliznak	5408	73,24	1,54	0,27	0,79	21
5	Detelina	24450	71,57	1,87	0,23	0,71	2
6	Ribno (of the seven lakes)	25108	50,14	1,36	0,36	0,59	2
7	Dolno (of the seven lakes)	2236	44,52	0,52	0,76	0,26	1
8	Gorno Chanakgylsko	15000	142,00	1,64	0,24	0,75	19
9	Dolno Chanakgylsko	19500	16,80	1,26	0,43	0,55	28
10	Skakavitsa	213	0,53	1,97	0,18	0,77	44
11	Nalbantsko	255	122	1,45	0,29	0,70	65
12	Gruncharsko	240800	49,00	0,02	1,00	0,01	0
13	Yakorudsko Murtvo	138	0,38	1,48	0,29	0,76	17
14	Gorno Vapsko	15147	6,34	0,40	0,83	0,21	7
15	Dolno Vapsko	10758	4,64	0,24	0,92	0,12	1
16	Yonchovo	5232	2,66	1,03	0,48	0,53	15
17	Ourdino 1	420	2,70	1,89	0,20	0,82	88
18	Ourdino 2	12000	248,00	0,75	0,55	0,54	2
19	Ourdino 3	1250	3,19	1,82	0,22	0,79	25
20	Ourdino 4	20700	86,90	1,35	0,39	0,61	74
21	Ourdino 5	12900	7,07	1,45	0,29	0,70	2
22	Suhoto Ezero (Semkovo)	1071	3,62	0,91	0,50	0,65	0
23	Suhoto Ezero (Kirilova polqna)	2990	155,00	1,41	0,28	0,79	97

The highest RCC Index values were recorded in Suhoto Ezero Lake as well as in some of the Seven Rila lakes, Nalbantsko, Ourdino 1 and 4. All of these water bodies are high altitude and isolated lakes. The presence of relict species is another evidence for the evolutionary state of the lakes. Evidences of advanced eutrophication process are observed in nine of the studied lakes. In regards to the obtained results conservation measures should be taken as soon as possible.

CONCLUSIONS

The obtained results are consequence of many factors: climate changes, anthropogenic impact, fish stocking witch influenced the environment and have cumulative effect on the zooplankton community. The results are sufficient to assess the current state of the plankton diversity and conservation importance of glacial lakes from Rila Mountain. The presented new information also can be useful to updating Rila National Park Management Plan. Preliminary data of zooplankton community is presented here but detailed analysis is needed for the establishment of the actual lake status.

Acknowledgment: The authors are grateful to the members of working teams of the projects: №DIR-59318-1-2 „Mapping and identify the conservation status of habitats and species - Phase I“ and № DIR 5113325-18-116“Sustainable management of Rila National Park-Phase I“.

REFERENCES

1. Deltshev C., P. Beron, G. Blagoev, V. Golemanski, V. Najdenow, V. Peneva P. Stoev, M. Todorov, Z. Hubenov 1999 Faunistic diversity of Invertrebates (non Insecta) of the Rila National Park. USAID: 249-284
2. Kozuharov D., M. Stanachkova, P. Yanev, S. Stanachkov 2013 Introduction of RCC Index for Stand Water Bodies Comptes endus de l‘Académie bulgare des Sciences, 66, No 11, 2013, 1563-1570.
3. Kozuharov D., P. Ivanov 2011. Oligotrophic mountain lakes In: Red book of Republic of Bulgaria /digital edition/ http://e ecodb.bas.bg/rdb/bg/vol3/01C1.html
4. Naidenow W. 1975 Experience of biological classification of mountain lakes. Hydrobiology, Sofia, 2: 46-65. (In Bulgarian, Russian and German summaries)
5. Naidenow 2000 Quantitative Development and Vertical Distribution of Plankton in Sedemte Ezera Lakes (the Rila Mauntains, Bulgaria) In: Golemanski, V., W. Naidenow (eds). Biodiversity and Evolution of Glacial Water Ecosystems in Rila Mauntains. Sofia, Inst. of Zool., 89-104.
6. Valkanov A. 1932. Notitzen über das Leben in den Hochgbirgssen Bulgariens. Trud na B. Prirodoizp. D-vo. Book 15, 16 (In Bulgarian and German summaries) (In Bulgarian)

7. Valkanov 1938 Hydrobiological survey on some Rila mountain lakes. Ann. Sofia University 34(4), 101-145. (In Bulgarian)
8. Shannon C., W. Weaver 1963 The Mathematical Theory of Communication. University of Illinois Press, Urbana, 117
9. Simpson, E. H. Measurement of diversity. Nature, Vol 163, 1949, 688. http://dx.doi.org/10.1038/163688a0
10. Pielou E. 1975 Ecological Diversity J. Wiley & Sons NY, L., S., T. 165 pp.