ISSN 1691-5402
ISBN 978-9984-44-028-6
Environment. Technology. Resources
Proceedings of the 7th International Scientific and Practical Conference. Volume I1

ECOLOGICAL EVALUATION OF ZOOPLANKTON GROUPS IN LAKE GERANIMOVAS-ILZAS AND LAKE GARAIS

ZOOPLANKTONA GRUPU EKOLOĢISKAIS NOVĒRTĒJUMS GERAŅIMOVAS-ILZAS UN GARAJĀ EZERĀ

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Abstract. *Lake Garais is the second deepest lake in Latvia. Its maximum depth is 56.0 meters, but its average depth is 16.5 meters. Lake Geranimovas-Ilzas is the fifth deepest lake in Latvia. Its maximum depth is 46.0 meters, but its average depth is 9.8 meters [13]. During the research of Lake Gernimovas-Ilzas and Lake Garais three zooplankton groups have been found, i.e. Rotatoria, Cladocera and Copepoda. Having analysed the quality composition of species the authors have concluded that the pollution level of these lakes is low, because there are such olygosoprobic zooplankton species as Keratella cochlearis, Keratella quadrata, Filinia longiseta, that die from lack of oxygen in few hours.*

Key words: *Lake Geranimovas-Ilzas, Lake Garais, Sorensen index, Renkonen index, physical and chemical parameters.*

Introduction

Lakes are natural bodies of water that occupy inland basins. They are widely distributed terrain feature in Latvia. There are approximately 40% of all Latvian lakes on Latgale Hills [4]. Lake Geranimovas-Ilzas and Lake Garais are also located on Latgale Hills and they are in the top ten deepest lakes of Latvia [13].

Lake Geranimovas-Ilzas is located on Feimanu hilltop at 150.3 m above sea level, in Kastulini self –governing territory in Kraslava District. Its area is 3.28 sq.km and its length is 8.1 km (ZR-A). Average depth of the lake is 9.8 m, while its maximum depth is 46.0 meters [3]. Lake Geranimova-Ilzas is the fifth deepest lake in Latvia [13]. It is in the transition stage between the mesotrophic and eutrophic lake classes [3].

Lake Garais is located at subglacial trench on the edge of Latgale Hills at 130.2 m above sea level, between Indra and Piedruja in Kraslava District. Its area is 71.2 and its length is 3.4 km (DR-ZA), while its largest width is 0.3 km. Average depth of the lake is 16.5 m, while its maximum depth is 56.0 meters [2]. Lake Garais is the second deepest lake in Latvia [13]. Lake Garais is a meso-eutrophic lake, it is deep along its shores and it is not overgrown. (~5% of its area) [2].

Lakes are continuously developing and changing all the time from its origin and up to nowadays. Any lake has kept its original form, content, because as soon as its basin has been filled with water they both start their interaction.

All organisms living in lakes are also in the interaction with each other and with their environment. They play particular roles in the circulation of substances and energies. Besides these organisms interact with environmental factors in their own unique ways depending on their distinctive biological characteristics that help them to resist the changes in these environmental factors. Zooplankton plays an essential role in the transformation of substances and energy in bodies of water. Zooplankton is a very convenient object for the assessment of biocenosis diversity, because it is represented not only with different taxonomic groups, but it is also represented at different trophic levels.

Materials and methods

For the ecological assessment of Lake Geranimovas-Ilzas and Lake Garais zooplankton samples were collected on July 12 and 13, August 1 and 31 in 2007. The sampling in Lake Geranimovas-Ilzas was carried out on three different localities that have different depth; however the sampling in Lake Garais was carried out on four different localities that also have different depth. The authors of the research performed the following studies on the lakes:

- determined the zooplankton species composition in Lake Geranimovas-Ilzas and Lake Garais;
- determined physical and chemical parameters of Lake Geranimovas-Ilzas and Lake Garais;
- conducted statistical and graphical computing of the results received during the field studies using the software Microsoft® Excel 2000.

Hydrometric measurements for the topographic map were performed with a GPS (satellite navigation) device - GPS Scout Master®. The precision of the site (location) in the Acute Locate regime is ±2 meters. The BioSonics DT-X Digital Echosounder System was used for the measurement of the depth and the bottom relief of Lake Geranimovas-Ilzas and Lake Garais. The sonde HYDROLAB "Minisonde 4 Multiprobe" was used to measure water temperature, pH, conductivity, dissolved substances, dissolved oxygen, dissolved oxygen percent saturation, chlorophyll-α, turbidity, oxidation-reduction potential per one imagined line. During the study the Minisonde was lowered to the bottom of the water bodies. When the physical and chemical parameters became stabilize on the Minisonde display, they were saved to the HYDROLAB memory. Then the Minisonde was moved to one meter up. The activities were repeated until the Minisonde reached the water surface. The final measurements were taken at depths of one meter and half a meter.

The collection of zooplankton samples and their quantitative and qualitative analysis was performed using the APHA standard methods procedure for the analysis water and wastewater.

Apshtein and Gedi plankton nets were used for collecting the samples. Using the Apshtein plankton net (85 μm meshes) the zooplankton samples were taken from 0.5 – 1 meter depth and 100 l of water were filtered. The column of water was filtered through the Gedi plankton net. For our research we used the zooplankton samples which we collected on Lake Geranimovas-Ilzas from the following depths:

- Locality No 1 – 9 m – the volume of filtered water is 100l;
- Locality No 2 – 44 m – the volume of filtered water is 940l and 100l;
- Locality No 3 – 19.5 m – the volume of filtered water is 416l and 100l.

At the localities No 2 and No 3 we also determined physical and chemical parameters of the water.

The zooplankton samples of Lake Garais were collected from the following depths:

- Locality No 1 – 18 m - the volume of filtered water is 100l;
- Locality No 2 – 47 m - the volume of filtered water is 1004l and 100l;
- Locality No 3 – 36 m - the volume of filtered water is 769l and 100l;
- Locality No 4 – 6.6 m - the volume of filtered water is 100l.

At the localities No 2 and No 3 we also determined physical and chemical parameters of the water.

Zooplankton samples are usually stored in 0.33l bottles. The collected samples are fixed with 37-40% formaldehyde solution. One part of formaldehyde solution is added to nine parts of samples. As a result the sample is preserved with 4% formalin.

Then 2 ml of samples, which have been carefully mixed, are taken from the bottle with a Hensen-Stempel pipette and then analysed in a counting chamber, i.e. Bogorov's counting chamber. The samples are studied in the light microscope Ampival (Carl Zeiss Jena) with a magnification of 16x10 (160). Each sample is studied three times. Having studied the samples in the light microscope the zooplankton organisms are calculated and identified as species or families. We used the following zooplankton key-books [5;6;7;8;10;12].

The following formula was used to calculate the number of organisms in a sample:

$$N = (a \times b \times 1000) / (c \times d), \quad (1)$$

where a – is a calculated number of organisms (average);
b – is a volume of concentrated sample;
c – is a sample volume;
d – is a volume of filtered water;
N – is a number of organisms per $1m^3$.
The similarity of the qualitative composition of the zooplankton was verified using the Sorensen coefficient.

$$S_s = \frac{2a}{2a + b = c}, \quad (2)$$

where S_s – is a Sorensen Similarity Coefficient;
a – is a number of species in the sample A and sample B (the frequency of occurrence);
b – is a number of species which are present in the sample B, but are absent in the sample A;
c – is a number of species which are present in the sample A, but are absent in the sample B.
This coefficient is a very important indicator of the species composition similarity.
The similarity of the zooplankton quantitative composition was verified using the percentage similarity Renkonen index.

$$P = \sum \text{minimum } (p_{1i}, p_{2i}), \quad (3)$$

where P – Percentage ratio between the samples 1 and 2;
p_{1i} – the percentage number of species in the sample 1;
p_{2i} – the percentage number of species in the sample 2.
The software Microsoft® Excel 2000 was used to calculate the number of organisms and to analyse physical and chemical parameters.

Results and discussion

During the research on Lake Geranimovas-Ilzas and Lake Garais 3 zooplankton groups were identified, i.e. *Rotatoria*, *Cladocera* and *Copepoda* (see Tables 1, 2). The highest species diversity was registered in *Rotatoria* group, followed by *Cladocera* and *Copepoda* groups. A considerable number of young cyclopses were registered in the *Copepoda* group in both lakes, i.e. *Copepodite cyclopoid* and *Nauplii*. The determined total number of the zooplankton species in each lake is 30 species (see Tables 1, 2). In Lake Geranimovas-Ilzas *Rotatoria* were the most dominant group consisting of 17 species, followed by *Cladocera* with 11 species and *Copepoda* with 2 species. Similar situation is in Lake Garais, where *Rotatoria* group had 16 species, *Cladocera* group – 12 species and *Copepoda* group – 2 species. *Polyarthra vulgaris, Polyarthra major, Keratella cochlearis and Pompholux sulcata* were dominant species in the *Rotatoria* group in all localities of the sampling on both lakes, i.e. on Lake Geranimovas-Ilzas and Lake Garais. In its turn, *Daphnia cucullata* and *Diaphanosoma brachyurum* were dominant species in the *Cladocera* group, but *Cyclops sp.* and *Eudiaptomus gracilis* in the *Copepoda* group. The species number in the samples varied depending on the locality of sampling and the volume of filtered water. The largest species diversity was observed in the samples which were collected by Gedi plankton net, because these samples were collected from the bigger depth and accordingly the biggest volume of water was filtered through this net.

Table1.

Zooplankton community composition of Lake Geranimovas-Ilzas

Species (taxon)	*Occurrence of species (taxa) in sampling place*			
	Nr 1 (9m)	*Nr 2 (44m)*	*Nr 3 (19,5m)*	*Common species*
Rotatoria				
Trichocerca capucina	+	+	+	+
Ascomorpha ecaudis	+	+	+	+
Polyarthra major	+	+	+	+
Polyarthra vulgaris	+	+	+	+
Asplancha priodonta	+	+	+	+
Keratella cochlearis	+	+	+	+
Keratella quadrata	+	+	+	+
Kellicotia longispina	+	+	+	+
Conochilus unicornis		+	+	
Pompholux sulcata	+	+	+	+
Filinia longiseta	+	+	+	+
Trichocerca tigris	+	+	+	+
Conochilus hippocrepis	+	+	+	+
Testudinella truncata	+	+	+	+
Ascomorpha minima		+		
Ascomorpha saltans	+	+	+	+
Lecane sp.	+			
Cladocera				
Diaphanosoma brachyurum	+	+	+	+
Daphnia cucullata	+	+	+	+
Daphnia longispina		+	+	
Bosmina longirostris	+	+	+	+
Bosmina coregoni	+	+	+	+
Chydorus sphaericus		+	+	
Bosmina crassicornis	+	+	+	+
Bosmina longispina	+	+	+	+
Ceriodaphnia affinis	+	+	+	+
Bosmina reflexa		+		
Daphnia cristata		+		
Copepoda				
Cyclops sp.	+	+	+	+
Copepodite	+	+	+	+
Nauplii	+	+	+	+
Eudiaptomus gracilis	+	+	+	+
Sum:	**24**	**28**	**26**	**23**

Having analysed the qualitative composition of the zooplankton species it may be concluded that the level of pollution in these lakes is low, because there are such oligosaprobic species in these lakes as, *Keratella cochlearis*, *Keratella quadrata, Filinia longiseta*, that die out from lack of oxygen in few hours. Having compared the results of research with the literature sources [1]., it may be concluded that the qualitative composition of the zooplankton species in Lake Geranimovas-Ilzas and Lake Garais is similar to the composition of the zooplankton in other Latvian eutrophic lakes.

Table 2.

Zooplankton community composition of Lake Garais

Species (taxon)	*Occurrence of species (taxa) in sampling place*				
	Nr 1 (18m)	*Nr 2 (47m)*	*Nr 3 (36m)*	*Nr 4 (6,6m)*	*Common species*
Rotatoria					
Trichocerca capucina	+	+	+	+	+
Trichocerca tigris	+	+	+	+	+
Ascomorpha ecaudis	+	+	+	+	+
Ascomorpha saltans	+	+	+	+	+
Polyarthra major	+	+	+	+	+
Polyarthra vulgaris	+	+	+	+	+
Asplancha priodonta	+	+	+	+	+
Keratella cochlearis	+	+	+	+	+
Keratella quadrata	+	+	+	+	+
Kellicotia longispina	+	+	+	+	+
Testudinella truncata	+	+	+	+	+
Pompholux sulcata	+	+	+	+	+
Filinia longiseta	+	+	+	+	+
Lecane luna		+		+	
Conochilus hippocerpis	+	+	+	+	+
Synchaeta tremula				+	
Cladocera					
Diaphanosoma brachyurum	+	+	+	+	+
Daphnia cucullata	+	+	+	+	+
Ceriodaphnia affinis	+	+	+	+	+
Bosmina longirostris		+	+	+	
Bosmina longispina	+	+	+	+	+
Bosmina coregoni	+	+	+	+	+
Ceriodaphnia reticulata	+		+		
Chydorus sphaericus			+		
Kurzia latissima			+		
Bosmina crassicornis	+	+	+	+	+
Daphnia longispina	+	+	+		
Alona affinis		+			
Copepoda					
Cyclops sp.	+	+	+	+	+
Copepodite	+	+	+	+	+
Nauplii	+	+	+	+	+
Eudiaptomus gracilis	+	+	+	+	+
Sum:	**26**	**28**	**29**	**27**	**24**

Having studied the zooplankton quality indices (Sorensen index) (see Tables 3, 4) we have found that they are a bit different in these two lakes. The similarity of the localities of sampling in Lake Garais is between 0.89 and 0.94, it proves that they are very similar.

The locality 1 and the locality 3 show the greatest similarity – 0.94, as well as the locality 2 and locality 4 (see Table 3). The localities of sampling in Lake Geranimovas-Ilzas are also similar, where the similarity between the localities of sampling is between 0.87 and 0.94. The greatest similarity is between the locality No 2 and the locality No 3 -0.94 (see Table 4).

Table 3.

Sorensen index (Lake Garais)

Sampling place	*Nr 1*	*Nr 2*	*Nr 3*	*Nr 4*
Nr 1				
Nr 2	0,92			
Nr 3	0,94	0,89		
Nr 4	0,90	0,94	0,90	

Table 4.

Sorensen index (Lake Geranimovas-Ilzas)

Sampling place	*Nr 1*	*Nr 2*	*Nr 3*
Nr 1			
Nr 2	0,87		
Nr 3	0,92	0,94	

Having studied the quantitative comparison indices (Renkonen index) (see Tables 5, 6) we have found that the similarity between the localities of sampling in lake Garais is between 8% and 72% (see Table 5). The greatest similarity is between the locality No 1 and the locality No 4 – 72%, the locality No 2 and the locality No 4 – 27%, while the lowest similarity is between the locality 2 the locality 3 – 8%. However, the Renkonen indices of similarity between the localities of sampling are low, i.e. it is between 10% and 22% (see Table 6). The greatest similarity is between the locality No 2 and the locality No 3 – 22%.

Table 5.

Renkonen index (Lake Garais)

Sampling place	*Nr 1*	*Nr 2*	*Nr 3*	*Nr 4*
Nr 1				
Nr 2	26			
Nr 3	11	8		
Nr 4	72	27	10	

Table 6.

Renkonen index (Lake Geranimovas-Ilzas)

Sampling place	*Nr 1*	*Nr 2*	*Nr 3*
Nr 1			
Nr 2	11		
Nr 3	10	22	

Having studied and analysed physical and chemical parameters of these lakes we can say that they have not essentially changed for months when the research was conducted. For example, on the 13 July 2007 the temperature of water in Lake Geranimovas-Ilzas (locality No 2) ranged from 21.17 ºC at 0.5m depth to 5.74 ºC at 41m depth (see Figure 1). In its turn, on the 13 July 2007 the temperature of water in Lake Garais (locality No 2) ranged from 18.99 ºC at 0.5m depth to 4.79 ºC at 46m depth (see Figure 2). It can be concluded that water temperature tends to decrease with depth. The characteristic stratification of these lakes is in the metalimnion, i.e. at 4-9 m depth. The concentration of dissolved oxygen mg/l decreases with depth. The concentration of dissolved oxygen in Lake Geranimovas-Ilzas is between 8.71 mg/l at 0.5 m depth and 6.55 mg/l at 41 m depth (see Figure 2). The concentration of dissolved oxygen in Lake Garais is between 8.02 mg/l at 0.5 m depth and 3.51 mg/l at 46 m depth (see Figure 1). The highest concentration of dissolved oxygen in Lake Geranimovas-Ilzas is at 7 m depth, but the highest concentration of dissolved oxygen in Lake Garais is at 4 m depth. Then the concentration decreases. The concentration of dissolved oxygen mg/l in water is connected with biological and chemical processes. For example, high concentration of dissolved oxygen in upper water layers may be a result of the plants photosynthesis when oxygen is evolved r it may be washed away from the atmosphere with waves.

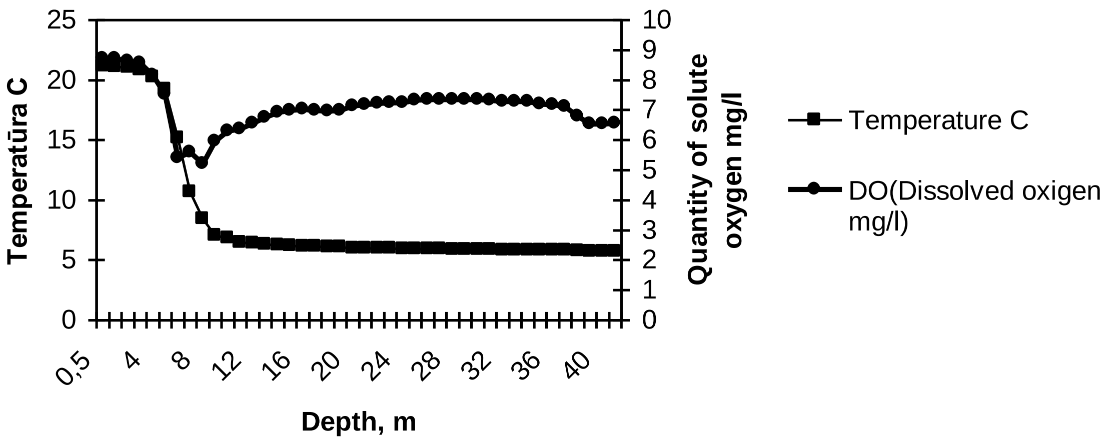

Fig.1. **Comparison of physically chemical parameters of water in Lake Geranimovas-Ilzas on 13th July, 2007**

The concentration of dissolved substances g/l in lake Geranimovas-Ilzas ranges from 0.194 g/l to 0.208 g/l, but in Lake Garais – 0.21 g/l.

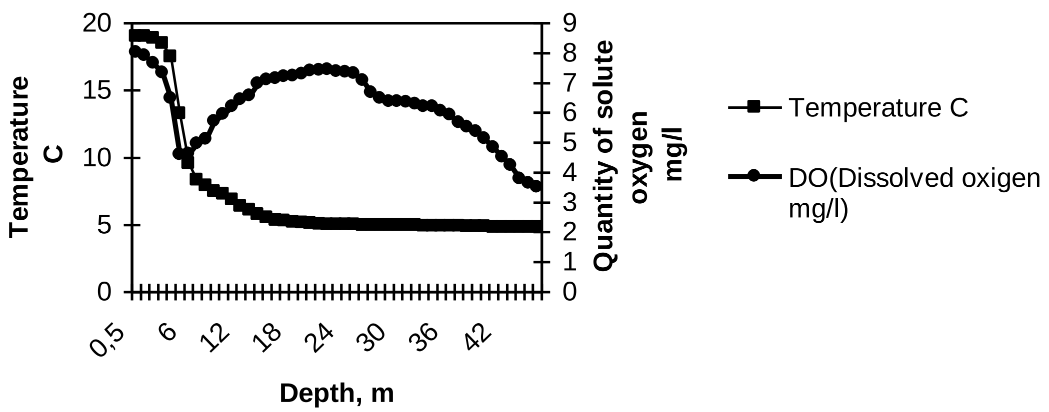

Fig.2. **Comparison of physically chemical parameters of water in Lake Garais on 12th July, 2007**

The other localities of sampling shared very similar physical and chemical parameters.

Conclusions

Based on the data received in the research, the following conclusions can be made:

1. Three zooplankton groups, i.e. *Rotatoria*, *Cladocera* and *Copepoda* groups were identified in Lake Geranimovas-Ilzas and Lake Garais. The total amount of the zooplankton species in both lakes is 30.
2. The level of pollution in Lake Geranimovas-Ilzas and Lake Garais is low, because there are oligosaprobic species in these lakes.

3. The qualitative zooplankton analysis (Sorensen index) showed that the similarity between the samples from Lake Geranimovas-Ilzas is within 0.87-0.84, while the similarity between the samples from Lake Garais is within 0.89-0.94.
4. The quantitative zooplankton analysis (Renkonen index) showed that the similarity between the samples from Lake Geranimovas-Ilzas is within 10%-22%, while the similarity between the samples from Lake Garais is within 8%-72%.
5. The physical and chemical parameters of Lake Geranimovas-Ilzas and Lake Garais have not been essentially changed for months. Water temperature decreases with depth, and the concentration of dissolved oxygen decreases with depth.

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