QUANTITATIVE BENTHIC DISTRIBUTION IN KISLO-SLADKOYE LAKE

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ABSTRACT

Water bodies separating from the sea have recently been an object of increasing interest among specialists in various fields. Kislo-Sladkoye Lake situated near the White Sea Biological Station of Moscow State University is one of the model separating water reservoirs. The lake is under monitoring for hydrological, hydrochemical, and microbiological characteristics. Bacterial and phytoplankton communities are also a focus of attention. However, some aspects are still poorly understood. In this work first results of a quantitative survey of macrobenthos are presented.

The work is dedicated to the quantitative evaluation of the macrobenthic community of Kislo-Sladkoye Lake. Thirty samples were taken from 16 stations at the following depths: 0.5, 1, 1.5, 2, 2.5, 3, 4 m. Ten species of macrobenthic invertebrates were found in the dredge samples: Insecta: Diptera - 4 taxa (larvae and adults); Mollusca: Gastropoda - 2 taxa; Oligochaeta - 1 taxon, there were also Nematoda, Chironomidae as well as houses of *Pectinaria koreni* and debris of *Dynamena pumila*. The largest quantities are reached by *Hydrobia ulvae* and *Chironomus salinarius*; nematodes, oligochaetes, chironomids and other beetles are sufficient, too. Benthic biomass in this lake varies from 0.59 to 202.62 g/m^2 with the highest amount of *Hydrobia ulvae*, *Chironomus salinarius*, Oligochaeta (at greater depths) and *Ephydridae gen. sp.*

INTRODUCTION

Recently, ponds separating from the sea have been an object of increasing interest among specialists in various fields (1,2). Kislo-Sladkoye Lake is one of the models of separating water reservoirs, which are monitored in order to define hydrological, hydrochemical, and microbiological characteristics. Bacterial and phytoplankton communities are also a focus of attention (3). Lately, collaboration with students from Moscow State University (MSU) becomes a tradition at the Nikolai Pertsov White Sea Biological Station (WSBS)[1]. Students already have done quite a few works on physical-chemical water properties and optical absorption spectra (4). However, some aspects are still poorly understood. In this work, first results of a quantitative survey of macrobenthos are presented. The current work is dedicated to quantitative evaluation of the macrobenthic community of Kislo-Sladkoye Lake by a group of students from the Biophysics Department, MSU.

Objectives

1) Kislo-Sladkoye Lake bottom surface study; planning and laying transects for quantitative collection of benthos samples in the lake based on the data of bathymetry and hydrology studies;

2) collection of quantitative sampling and species identification of macroorganisms;

3) quantitative and mass evaluation of macrobenthic organisms, calculation of the total biomass in the layers of the lake;

4) definition of mass forms of macrobenthic organisms and their distribution across the pond.

[1] http://en.wsbs-msu.ru/

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METHODS

For bottom relief studies two sonars were used: FishFinder 140 Garmin and Lowrance LMS 522.

According to the bathymetry and hydrology data three transects were laid for sample collection, linking the most interesting zones with contrasting conditions according to the previous work on benthos composition in the coastal zone. Transect 1 connects the lake threshold with the centre; transect 2 goes from the muddy shallow northern part to the centre; transect 3 goes to the southern shallows, Figure 1.

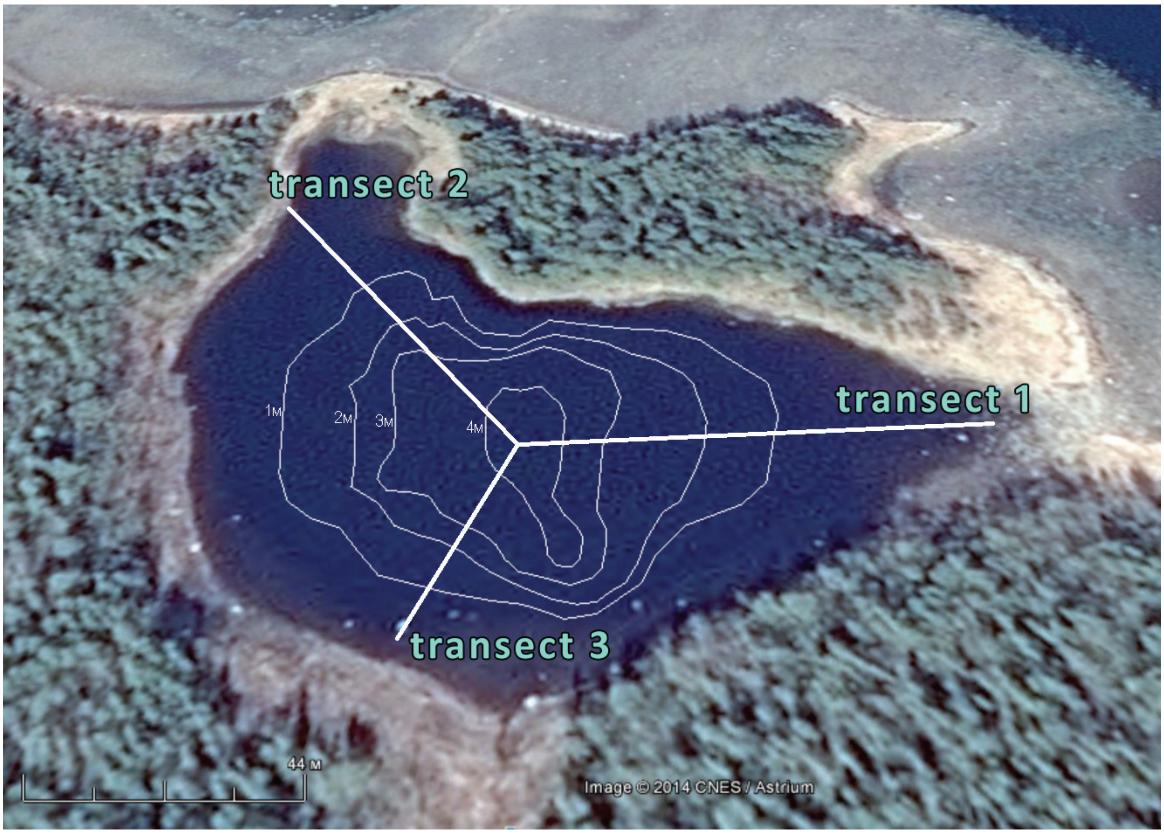

Figure 1: Transect map of Kislo-Sladkoye Lake.

Thirty samples were taken on 16 stations on the three transects crossing the half metre-fold isobaths (1 m, 1.5 m, 2 m, 2.5 m, 3 m, 4 m, and also 0.5 m as a control zone studied by the other group a few days earlier). Sample collection was carried out from a boat using an Ekman-Bergey dredger (area 210.25 cm^2). Dredger samples were sieved through a 1 mm mesh; then animals and residues were taken out with tweezers and placed in clean sea water of intermediate salinity (12.5 psu); when predators were found, samples were fixed with 50% ethanol. For species identification, MBI-1 binocular and Micmed-1 microscope and corresponding keys were used (5,6,7,8,9,10,11). The samples were weighed on an electronic scale with an accuracy of about 0.01 g.

RESULTS

An echogram was received by the sonar signal, Figure 2. Besides the bottom surface, another boundary was caught by the sonar signal. According to the depth (1.7-2.2 m) and signal appearance, we assume that it is the upper part of the red water layer with high *Rhodomonas* content at the chemocline, where a sharp redox potential jump is recorded. The layer is not flat: At depths of around 2 m, it is located at 1.4-1.9 m; then goes 0.3 m lower and becomes flat at the lake depths over 3 m. However, there are some doubts that the signal is connected with the red layer. Further research is needed for signal examination.

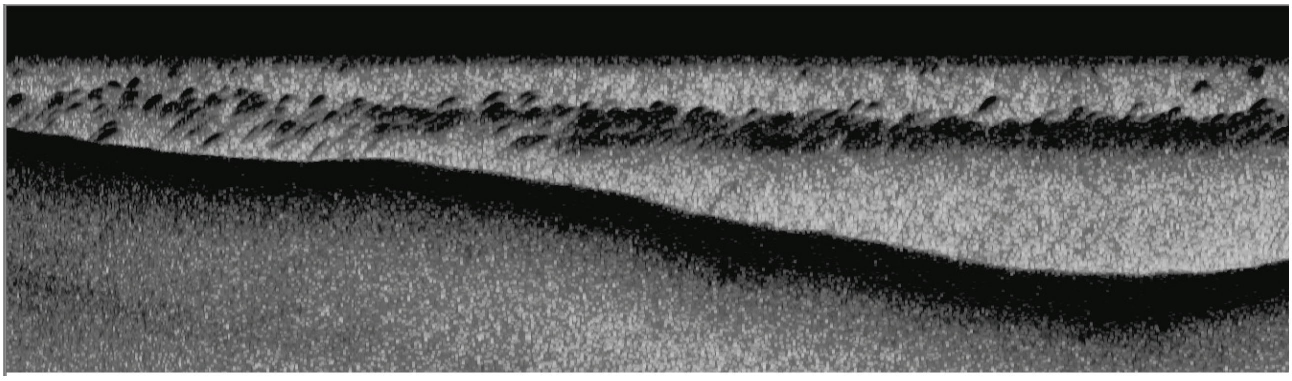

Figure 2: A sonar echogram of Kislo-Sladkoye Lake. The dark stripe at the bottom corresponds to the lake bottom surface. The dark fitful line in the water mass shows another boundary that might be connected with the red layer location.

A 3-D visualisation model of the bottom surface was derived, shown in Figure 3.

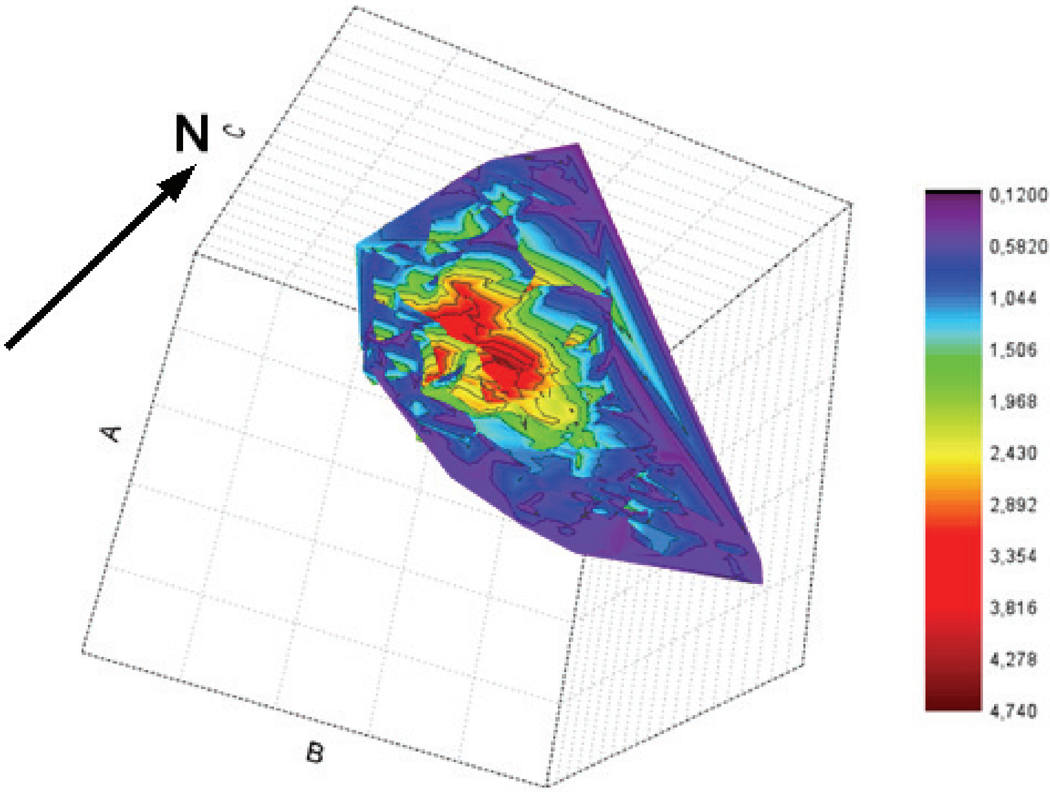

Figure 3: 3-D visualisation of the bottom relief in Kislo-Sladkoye Lake, with colour coded water depths given in m. Red colour shows the deepest parts of the lake.

Ten species of macrobenthic organisms were found in Kislo-Sladkoye Lake: Insecta: Diptera - 4 taxa (larvae and adults); Mollusca: Gastropoda - 2 taxa; Oligochaeta - 1 taxon, there were also Nematoda and Chironomidae as well as houses of *Pectinaria koreni* and debris of *Dynamena pumila*. The 30 received histograms reflect the quantitative distribution of benthic depending on the depth. Figure 4 shows one of them.

Furthermore, we have obtained graphs showing the contribution of the different types of biomass. The most massive form - *Hydrobia ulvae* and *Chironomus salinarius* - represent more than 60% of the total benthic biomass, Figure 5.

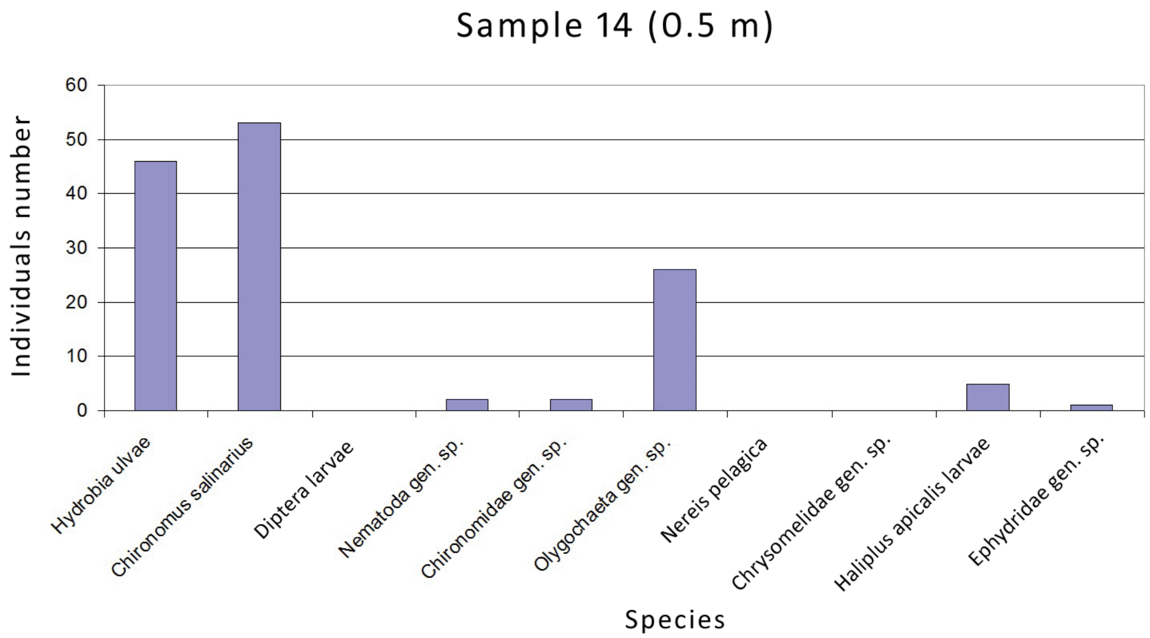

Figure 4. Quantitative distribution of benthos at a depth of 0.5 m (transect 3). This sample is dominated by Chironomus salinarius. In addition, Hydrobia ulvae and Olygochaeta occur in large numbers. Also Nematoda, Chironomidae, Haliplus apicalis and Ephydridae are present.

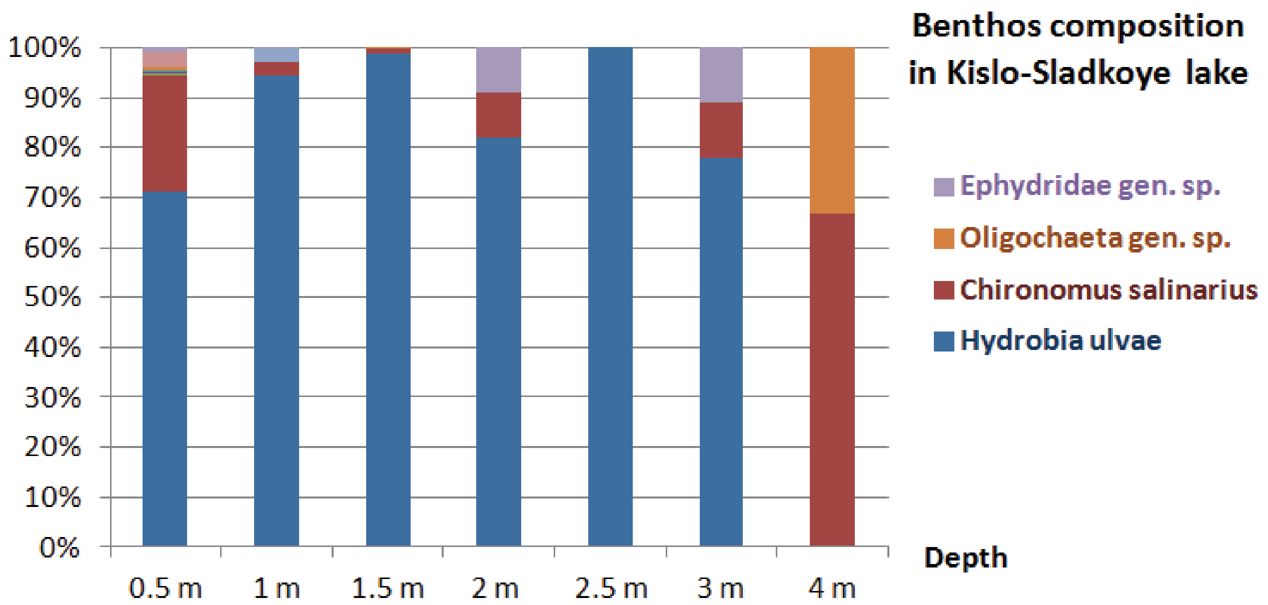

Figure 5: Contribution of macrozoobenthos species in biomass at different depths (0.5 m, 1 m, 1.5 m, 2 m, 2.5 m, 3 m, 4 m). Blue colour shows Hydrobia ulvae, red - Chironomus salinarius, orange - Oligochaeta, purple - Ephydridae.

The largest quantities are reached by *Hydrobia ulvae* and *Chironomus salinarius*; nematodes, oligochaetes, chironomids and other beetles are sufficient, too. The map of distribution of the most common species in the lake is shown in Figures 6, 7 and 8.

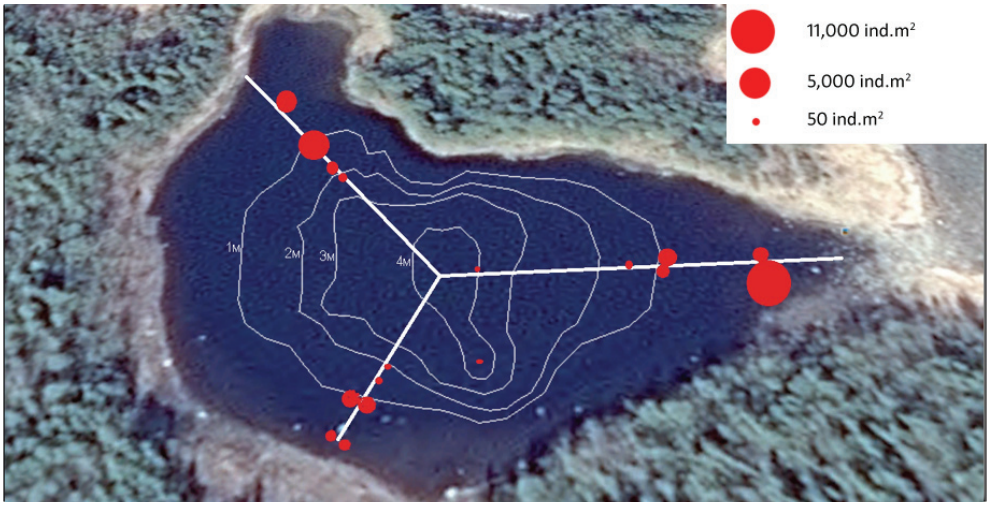

Figure 6: Red dots indicate locations of sample collection, in which Chironomus salinarius was registered. Point size is proportional to the number of living organisms of the species.

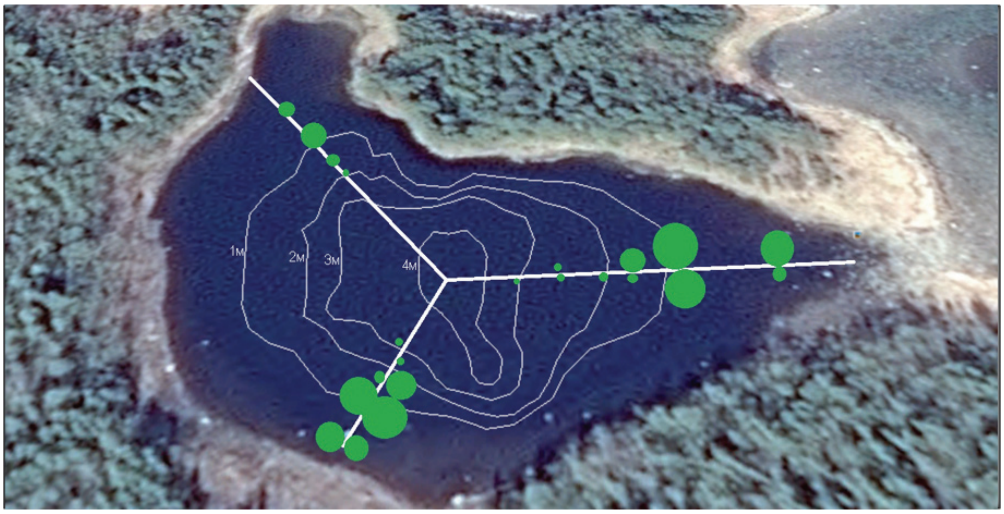

Figure 7: Green dots indicate locations of sample collection, in which Hydrobia ulvae was found. Point size is proportional to the number of living organisms of the species.

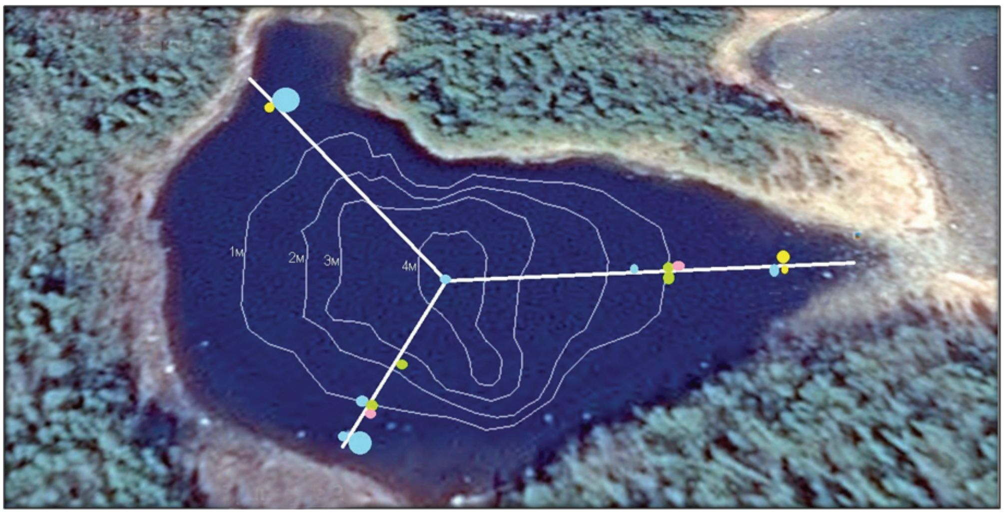

Figure 8: Blue dots indicate locations of sample collection, in which Oligochaeta were found, yellow ones indicate Nematoda, pink ones indicate Nereidae and bright green dots indicate Chrysomelidae. Point size is proportional to the number of living organisms of the species.

CONCLUSIONS

Transects were chosen in order to cover all biotopes. Due to this choice the benthic variety of the lake threshold, its centre and the muddy shallows were studied. Moreover, all depths from 0.5 to 4 m were explored.

Benthic biomass in this lake varies from 0.59 to 202.62 g/m^2, which is comparable with the data on the White Sea varying from 9 to 279 g/m^2 (12). According to the biomass valuation, bivalves prevail in the sea (82%), just as gastropods prevail in the sea (85%). According to the number valuation, polychaetes prevail in the sea (81%), so do gastropods in the lake (68%). A total of ten species were noted in the lake.

There is a transparent layer of water at the depth from 0.5 to 1.5 m, water is saturated with oxygen at depths from 1 to 1.5 m maximally. These layers combine a halocline. Most of the biomass is concentrated within these layers.

There is a so-called thermocline within the layer from 1.5 to 3 m. From 1.5 m depth, the salinity of the lake complies with marine waters - 25 psu (at a depth of 0.5 m the salinity is 12 psu). It is the turning point, where the biomass reaches its maximum value and then begins to decline. The green layer begins from the depth of 2 m, the layer from 2.2 to 2.3 m is red; the layer from 2.3 to 3 m is yellow. At the boundary of the red and yellow layers, a slight increase of biomass (3 g/m^2) appears due to *Hydrobia ulvae*. From the depth of 3 m, the water is clear and saturated with hydrogen sulphide. Biomass and abundance of living organisms gradually decrease proportionally to the depth to a minimum value at the bottom of the deepest pit.

Such a pattern of biomass distribution by the depth is typical of marine waters. At the sea, the maximum value of biomass was found in a flat part of the bottom in front of the stall, and then the biomass gradually reduces (13). By contrast, there is no such a manifest gradient of biomass at comparable depths in freshwater reservoirs (14).

In freshwater lakes, the most numerous groups dominant by biomass comprise chironomids and Oliochaeta (15). In Kislo-Sladkoye Lake, these two groups are well represented, but give way to Hydrobia ulvae. Molluscs are typically dominant in marine communities. Thus, Kislo-Sladkoye Lake shows features of both types and might be considered an in-between water body.

Summary

- Ten species of invertebrates were found in the samples;
- *Hydrobia ulvae* and *Chironomus salinarius* are mass species, and they were most commonly found at depths of 0.5 and 1 m;
- The number of organisms varies from 0 to 11767 per 1 m^2; average value is 240 ind./m^2;
- Biomass varies from 0.59 g/m^2 to 202.62 g/m^2; average value is 44.98 g/m^2;
- The highest number of organisms is found at a depth of 0.5 m, the lowest one is found at a depth of 4 m;
- The biomass maximum is found at a depth of 1 m, the lowest value is found at a depth of 3-4 m.

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