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## Results of subfossil Cladocera (Branchiopoda, Crustacea) analyses from bottom deposits of Lake Antyukh-Lambina (Kola Peninsula, Murmansk region).

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### ABSTRACT

The research is executed for restoration of climatic and ecological conditions of the past in the territory of the Kola Peninsula. The lake Antyukh-Lambina was once a part of the large lake Kolvitskoye and consequently, its ground "archives" contain information on its development, change of natural situations on a reservoir, change of climatic conditions of the region in general. The analysis the subfossil cladocera of communities of ground deposits of the Kola Peninsula was not carried out and is of special interest itself in connection with the accruing anthropogenous loading in the region. In work results of the paleobiologic analysis of communities Cladocera in ground deposits of the lake Antyukh-Lambina are presented. It is established that in a reservoir palaeartic and holarctic taxons prevail, cosmopolitan distribution is peculiar to only 15% of the revealed taxons. Comparison of results with data of the hironomidny analysis is carried out. Information on researches of planktonic communities of lakes of the Kola Peninsula and its comparison with the data received during the analysis of the remains of Cladocera in ground deposits of the lake Antyukh-Lambina is provided. In work the indexes defining degree of specific wealth, variety and domination of communities the Crustacea are used, statistical and stratigraphic analyses are made. Results of the lithostratigraphic analysis are presented.

**Keywords:** Kola Peninsula, subfossil Cladocera, paleoclimatology, paleolimnology

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## INTRODUCTION

The Kola Peninsula — one of key areas when studying postglacier development of the European North. The subarctic water ecosystems investigated by us differ in low degree of resistance to anthropogenous influence and extremely slow speed of restoration [Frolova, 2013]. Industrial pollution leads to degradation of various components of fresh-water ecosystems, violation of power-supply circuits. Similar changes are registered even in regions of the Kola North, rather remote from sources of anthropogenous influence, that especially make streams collection of information about a condition of water objects of the region for assessment of level of pollution and rationing of anthropogenous load of them [Valkova, 2015].

Extent of anthropogenous impact on water ecosystems can be estimated, as on the basis of monitoring ecological researches, and relying on results paleoecological and the paleoclimatologic researches. The fullest information on history of development of reservoirs contains in its ground deposits representing the original chronicle of the major processes which happened over their history [Kalesnik, 1967]. In them with the good permission climate changes, the geomagnetic field and other events of evolution of the environment in general for the last millennia are written down [Nazarova, Nurgaliyev, 2011]. Several previous researches show that the structure and structure of communities of water organisms undergo quite considerable changes, reflecting changes along climatic and ecological gradients [Lotter et al., 1997; Frolova et al., 2013, 2014, 2016]. Throughout the long period of time as the main bioindicators diatomic seaweed, pollen, the remains of insects (chironomids, culicids) which siliceous and chitinous structures have high degree of safety in ground deposits were used [Nazarova, Nurgaliyev, 2011]. Recently the increasing popularity is gained by the analysis of ground deposits on the basis of the remains of Crustacea. Chitinous parts of an exoskeleton of Cladocera (carapaces, postabdomenae, postabdomenal claws, upper jaws, head boards and so forth) allow to identify the remains to various taxonomical ranks [Frolova, 2016]. Bioindication is carried out on the basis of a confinedness of types to various biotopes, manifestations of different degree of tolerance to biotic and abiotic factors of the environment [Frolova, 2011].

## DATA AND METHODS

The Kola Peninsula is characterized by very high lakeness and well developed hydrographic network. Small lakes less than 1,0 sq.km prevail. The relief of the Kola Peninsula bears the impress, imposed by a glacial cover of quaternary time: the river erosion and frosty aeration in polar conditions, characteristic to the postglacial period, "made the contribution" in a modern image of the Kola Peninsula [Lavrova, 1947].

The severe climate of the Kola Peninsula is under the influence of position of the region in the extreme northwest of Russia. Average temperature of July makes 10 — 12 °, the average temperature of January near — 9,5 °. The annual sum of rainfall is 350 — 400 mm [Milkov, Gvozdetsky, 1986].

The last decades are characterized by noticeable warming on the Kola Peninsula. Average annual air temperature in Murmansk for the period of 1881-1990 made 0 °C. From 1991 to 2013 average annual air temperature increased to 1 °C, and in a decade 2004-2013 it increased on 1.4 °C. Changes of climatic conditions cannot be written off only for anthropogenous influence. Observed warming covers all region and practically does not depend on density of population and the nature of economic activity [Dyomin, etc., 2014]. The lake Antyukh-Lambina is chosen as an object of a research (67°06'52" N, 33°31'36" E; height above sea level - 59,4 m, the area - 200 sq.m), located in the southern part of the Kola Peninsula, to the east of Kandalaksha, on the southern coast of the lake Kolvitskoye (the area of a mirror - 121 sq.km) to which it is connected by the narrow passage (Fig. 1).

In the summer of 2015 the domestic piston drill made selection of a column of ground deposits of the lake Antyukh-Lambina 3 m long which was used for radio-carbon, lithologic and paleobiologic analyses (diatomic, spore-pollen, chironomidae and cladocerae). Radio-carbon dating was carried out in laboratory geomorphological and the paleogeographic of researches of polar regions and the World Ocean of institute of Sciences about Earth of St.Petersburg State University of St. Petersburg.

Section stratigraphy: in the lower part green-gray clays (6,95-6,37 m), are presented by the accurate transitional zone created alevritic with gittia (6,37-6,1 m), and further a powerful layer of a gittia with a large number of the alevrit decreasing up a section with the distinct large macroremains which further are replaced.

In the lower part of a section (6,37-6,3 m) the sample on dating which age made ~ 9.3 thousand 14C years (10.5 thousand kcal was taken. years) [Grekov and Kolka, 2016].

On the cladoceric analysis from a column of soil 25 tests were selected. Processing of tests of ground rainfall was carried out by a standard technique [Szeroczydska, Sarmaja-Korjonen, 2007], definition was carried out on specialized determinants [Szeroczydska, Sarmaja-Korjonen, 2007; Korosi, Smol, 2012; Frolova, 2011].

The analysis of change of a variety of biotic groups is made with use of the indexes defining degree of specific wealth, variety and domination of communities the Crustacea: Shannon-Weaver's index [Shannon, Weaver, 1963], index of uniformity of ecological groups of Pielou [Pielou, 1966], index of a saprobity of R. Pantle and G. Buck [Pantle, Buck, 1955]. Statistical and stratigraphic analyses are made in the C2 program of S. Juggins [Juggins, 2007], faunistic zones are allocated by means of the cluster analysis of CONISS of the TILIA version 2.0.b.4 program [Grimm, 2004]. The stratigraphic analysis included taxons which relative number made not less than 1% of the total number of Cladocera in test.

## RESULTS AND DISCUSSION

As a part of subfossil cladoceric community of the lake Antyukh-Lambina 34 taxons are revealed. Dominantom of cladoceric community of the lake is the typical representative of an open pelagic part of reservoirs – *Bosmina* (*Eubosmina*) cf. *longispina* (66%) (Fig. 2) inhabiting small and large reservoirs of northern and middle latitudes. Considerable development in the lake is reached by types-philophil and types inhabitants of a littoral zone of a reservoir: representatives of the sort *Alona* (*A. affinis*, *A. quadrangularis*, *A. guttata/rectangula*, *A. rustica*), *Alonella* (*A. excisa*, *A. exigua*, *A. nana*) (Fig. 2) that demonstrates existence in it, along with well developed zone of open water, the shallow zones and sites which grew with makrophite.

On the basis of structure the subfossil of communities the Crustacea 4 main zones in which the number of copies of Cladocera, sufficient for the statistical analysis is noted were allocated (over 100).

Zone I (10800-8700 cal.l.n.). A rich taxonomical variety (78,2% of total number of taxons are presented in the allocated zone) is combined with quantitative representation of the remains of chitinous structures of Cladocera (Fig. 2). Representatives of the sort *Bosmina* sp dominate. (*Bosmina* (*Eubosmina*) cf. *longispina* (68,3%), *B. coregoni* (1%), *B. longirostris* (0,9%) that demonstrates existence of well developed pelagic part of a reservoir.

At this stage existence of a significant amount of the remains of the taxons preferring vegetable substrata is noted: representatives of the sort *Alona* (10,2%) and *Alonella* (7,3%). The quantity of the remains of *Alona rustica*, maximum in comparison with other paleozona (85,6% of total number of the subfossil of this taxon found on all column), *A. quadrangularis* (78,8%), *A. guttata/rectangula* (70,1%) is found. The Hironomid analysis confirms increase in the importance the philophil types during this period [Syrykh, 2016]. In tests views with different degree of tolerance to temperature conditions of the environment are found. So, *Acroperus harpae*, *Alona quadrangularis*, *Alonella nana* are typical northern types, and numerous representatives of the sort *Alona* and *Alonella* have cosmopolitan distribution [Sinev, 2002, 2009, 2014]. Average value of an index of Shannon makes  $2,1 \pm 0,18$ , an index of uniformity of Pileu – 0,4. The index of a saprobity makes 1,42, i.e. the trophic level of a reservoir is estimated as oligotrofny.

Zone II (8700-7470 cal. l. n). There is a reduction of relative number of *Bosmina* (*Eubosmina*) cf. *longispina* with further increase in the importance of a look up to 75%. Representation in comparison with the previous zone, at *Chydorus sphaericus*, *A. guttata/rectangula* decreases.; For *Alona quadrangularis* and *A. rustica* there is a gradual reduction of quantity of the found remains up to their total disappearance. The peak of development of northern types – *Camptocercus rectirostris* (70,7% of total number found), by *Eurycercus lamellatus* (54,3%), *Alonella nana* (28,1%) is fixed (percentage ratios are given concerning total of the found remains of a separate taxon in all tests). Change of qualitative structure of the found remains of Cladocera testifies to a climate cold snap. Value of an index of Shannon averages  $2,34 \pm 0,27$ , an index of uniformity of Pielou – 0,4. The index of a saprobity makes 1,58 that allows to refer the lake to category  $\beta$  - the mezosaprobic of reservoirs.

Zone III (7470 – 4400 cal. I. n). The number of the remains of northern types decreases, Ceriodaphnia sp remains are found. (1,2%) and Daphnia gr. longispina (0,8%). The described changes can demonstrate some warming from the middle of a specified period. Reduction of value of an index of Shannon to  $1,76 \pm 0,1$  is noted), the index of uniformity of Pielou averages 0,3. The index of a saprobity makes 1,36 that allows to classify the lake as oligosaprobic.



Fig. 1 Physiographic position of the lake Antyukh-Lambina

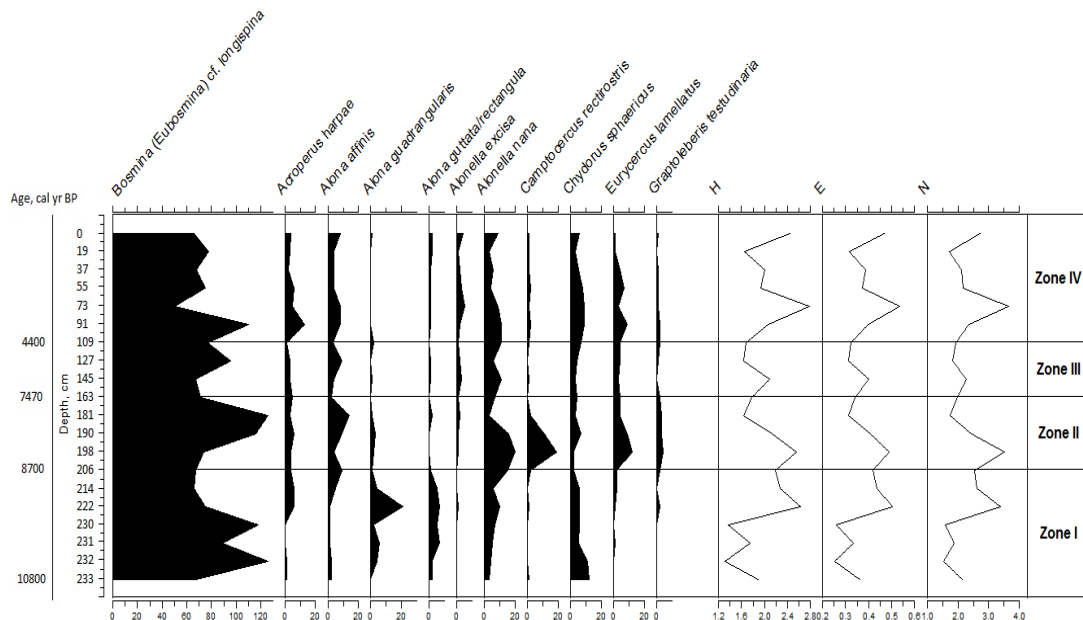


Fig. 2 Taxocenosis of ground deposits of the lake Antyukh-Lambina

Zone IV (4400 cal. l. n). There is a reduction of number of *Bosmina* (*Eubosmina*) cf. *longispina* (64%). Frequency of occurrence of fragments of an exoskeleton of *Eurycercus lamellatus* increases – 37% of number of the found look remains in all tests a Taxonomical variety are provided by Palearktiki's representatives. The Hironomidny analysis confirms domination of cold water types at the present stage of studying of the lake [Syrykh, 2016]. Increase in the importance of *Chydorus sphaericus* is noted that testifies to the initial stages of an eutrophication. Shannon's index fluctuates ranging from 1,65 to 2,79 (2,15±0,2), the average index of uniformity of Pielou makes 0,4. At the present stage the lake is  $\beta$ -mezosaprobny (1,59).

### CONCLUSION

The obtained data are confirmed by the researches of zooplankton of small lakes of the Kola Peninsula conducted during the period from 2007 to 2012 during which it is established that the majority of lakes are  $\beta$ -mezasaprobic, a class of quality of water – III ("moderate polluted") [Valkova, 2015]. On "a trophic scale" reservoirs can be carried to oligotrophic. Representatives of the sort *Bosmina*, *Daphnia* are distinguished from dominant of cladoceric community. Zooplankton of the explored lakes had colovratic-copepodic character with prevalence colovratic in a quantitative ratio. The index of a specific variety of Shannon varied within 1,08-2,51 bits/piece.

According to results of the paleobiologic analysis average value of an index of Shannon of the explored lake made 1,99±0,09 that allows to classify the lake as moderate polluted. Values of Pielou index varied ranging from 0,02 to 0,53 (on average – 0,31) that testifies to insufficiently steady and leveled structure of communities. Average value of an index of a saprobity makes 1,49 that characterizes the lake as transitional from oligosaprobic to a mezosaprobity reservoir.

### SUMMARY

The analysis of ground deposits of the lake Antyukh-Lambina on the basis of studying of recent cladoceric community is confirmed by the data obtained during the hironomidic analysis: during evolution of the lake there are changes of climatic situations twice. The tendency to increase in a trofnost of a reservoir at the present stage is noted.

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