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INFORMATION

Multidisciplinary Studies of the Separating Lakes at Different Stage of Isolation from the White Sea Performed in March 2012

E. D. Krasnova[a], A. N. Pantyulin[b], T. A. Belevich[a], D. A. Voronov[c, d], N. A. Demidenko[e], L. S. Zhitina[a], L. V. Ilyash[a], N. M. Kokryatskaya[f], O. N. Lunina[g], M. V. Mardashova[a], A. A. Prudkovsky[a], A. S. Savvichev[g], A. S. Filippov[h], and V. P. Shevchenko[h]

[a] *Moscow State University, Biological Faculty, Moscow, Russia*
[b] *Moscow State University, Geographical Faculty, Moscow, Russia*
[c] *Institute for Information Transmission Problems (Kharkevich Institute), Russian Academy of Sciences, Moscow, Russia*
[d] *Belozersky Institute of Physico-Chemical Biology, Lomonosov Moscow State University, Moscow, Russia*
[e] *Zubov State Oceanographical Institute, Moscow, Russia*
[f] *Institute of Ecological Problems of the North, Urals Branch, Russian Academy of Sciences, Arkhangelsk, Russia*
[g] *Winogradsky Institute of Microbiology, Russian Academy of Sciences, Moscow, Russia*
[h] *Shirshov Institute of Oceanology, Russian Academy of Sciences, Moscow, Russia*
e-mail: e_d_krasnova@wsbs-msu.ru

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The multidisciplinary expedition was performed from March 20 to April 2, 2012, on the Kindo Peninsula in Kandalaksha Bay of the White Sea. The expedition was aimed to study the salty waterbodies that appeared due to the separating of the sea inlets from the sea by the isostatic lifting of the seashore. The scientists from the Biological and Geographical Faculties and the Belozersky Institute of Physico-Chemical Biology of Lomonosov Moscow State University, the Shirshov Institute of Oceanology, the Winogradsky Institute of Microbiology, Zubov State Oceanographical Institute, the Institute for Information Transmission Problems (the Kharkevich Institute), and the Institute of Ecological Problems of the North (Urals Branch of the Russian Academy of Sciences) participated in the expedition. The work was performed at the N.A. Pertsov White Sea Biological Station of Lomonosov Moscow State University.

The functioning of the ecosystem of the White Sea is inseparably linked with the processes that take part in the watershed area. The forming of meromictic lakes is one of the least studied processes. These lakes form after the separation of small inlets from the sea. For the studied separating waterbodies (SW), we have only data on the summer period; winter data are absent so far.

The study was aimed to perform multidisciplinary research in the waterbodies of different stages of their isolation from the White Sea in the Velikaya Salma Strait and the Rugoserskaya and Chernorechenskaya inlets, including studies of the biota related to the ice coverage and to the permanent polynya in the Velikaya Salma Strait.

The study's aims include the following: (1) studies of the hydrophysical and hydrochemical characteristics of the SW; (2) studies of the peculiarities of the hydrogen sulphide contamination of the SW; (3) studies of the species composition and the assessment of the zooplankton and phytoplankton abundance in the SW; (4) studies of the biodiversity of the anaerobic bacteria, while measuring the anoxygenic and oxygenic photosynthesis rates and the bacterial production in the surface and near-bottom water masses of the SW; (5) the assessment of the species composition and abundance of the cryogenic flora, the analysis of the vertical profile of the flora in the ice cores, and the analysis of the spatial heterogeneity in the SW and in the sea areas; (6) assessing the carbon isotope composition in the organic matter in the suspended particles (seston) sampled from the different water layers; (7) studies of the sediment deposition and performing lithological and geochemical studies of the bottom sediments; (8) collecting data on the composition, flux, and major directions of the aeolian transport; (9) organizing and performing observations concerning the counting of the sea ducks during their wintering in the polynya system of the Rugozerskaya Inlet together with the Kandalaksha Natural Reserve, the Polar Circle Diving Center, and the Basin Committee of the Northern Karelian Coast.

Five lakes were studied during the expedition: the Kislo-Sladkoe, the Trekhtsvetnoe, the Verkhnee Ershovskoe, the Nizhnee Ershovskoe, and the lagoon (lake) on Zelenyi Cape (figure). Studies of the ice, the bottom sediments, the ice biota, and the snow were also performed at marine areas and the Ermolinskaya and Rugozerskaya inlets.

The studied waterbodies differ by their separation degree from the sea. According to the summer observations, Verkhnee Ershovskoe Lake is a totally freshwater reservoir, and, in Nizhnee Ershovskoe Lake, brackish water (9 psu) is registered only in the bottom hollows. Trekhtsvetnoe Lake is assessed as totally isolated from the sea, but the upper 2-m water layer is fresh; similarly, the surface water layer is freshened in Kislo-Sladkoe Lake. The lake on the Zelenyi Cape has permanent water exchange with the sea, and the water level varies by 10 cm in accordance with the tide events in the sea.

The temperature, salinity, pH, and Eh were measured throughout the water column. The zooplankton and phytoplankton were sampled; water samples were obtained for the chemical and microbiological analyses and measuring the seston concentration, the organic carbon, the lipids, the particulate matter analysis under a scanning electron microscope, the atomic-absorption analysis, the mass spectrometry with inductively coupled plasma, and the analysis of the carbon and oxygen isotope composition. Cores of the bottom sediments were taken to analyze the granulometric, mineral, and chemical composition of the different sediment layers and the radioactivity of the ^{210}Pb and ^{137}Cs isotopes; samples of fresh snow and samples, integrated over the whole snow depth, were obtained to measure the composition of the dissolved matter (the organic carbon and metals) and the insoluble particles (the element composition and concentration of the black carbon) and to assess the flux of insoluble particles from the atmosphere in the period of the snow accumulation. The ice cores were sampled to be analyzed for the concentration of the sedimentary material; the organic carbon; the granulometric, mineral, and chemical composition; and the species composition and the abundance of the ice flora and fauna.

Preliminary results. The stratification of the water column in regard to the thermohaline profiles was found in all the studied SW, which was very unusual for the shallow water bodies in the end of the winter period. The vertical thermohaline structure of the water column allows us to conclude about the advection of the seawater into the SW during the winter period. The surface water layer in the Trekhtsvetnoe and Nizhnee Ershovskoe lakes was brackish (1.1–5.0 psu) but not fresh. In Kislo-Sladkoe Lake, the surface water layer was characterized by marine salinity (26.2 psu), and this parameter even reached 28.8 psu in the waters of the lake on the Zelenyi Cape, which was even higher than the seawater's surface salinity (25.9 psu). Only Verkhee Ershovskoe Lake was totally fresh, as was also observed during the summer period.

The phenomenon of the salty water characterized by the temperatures above zero in the end of the winter period was registered for the first time in the Trekhtsvetnoe and Nizhnee Ershovskoe lakes at a depth of only 1 m below the water's surface.

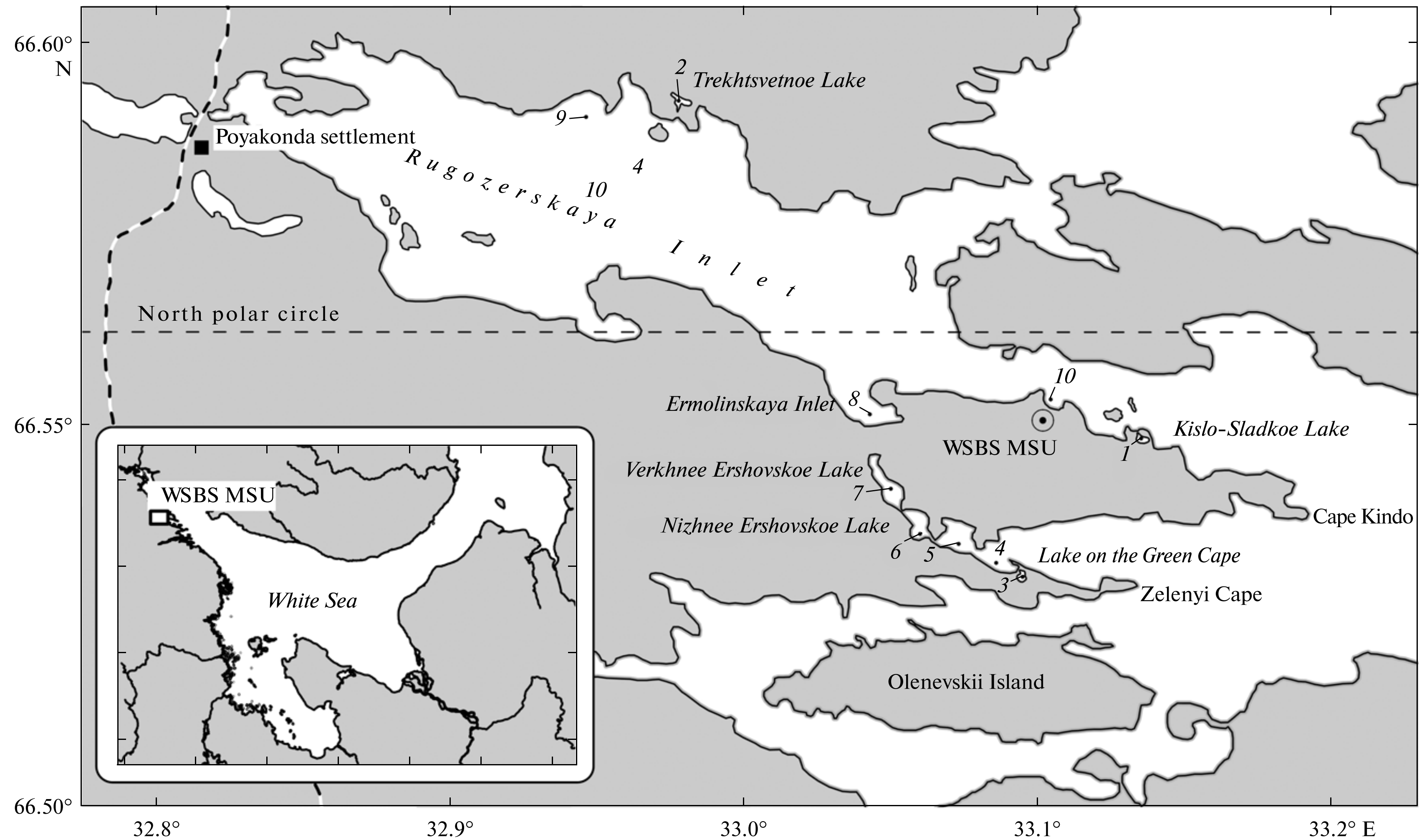
In all the studied SW, the concentration of hydrogen sulphide increased according to the depth. The maximal concentration was found in the Trekhtsvetnoe Lake, while the lowest in Nizhnee Ershovskoe Lake. In the Kislo-Sladkoe Lake, in the near bottom layer, the concentration of hydrogen sulphide was significantly lower (down to the values observed in the summer and autumn). The highest concentration of the dissolved reactive iron was registered in Verkhee Ershovskoe Lake.

The microbiological analysis of the water of all studied lakes provided evidence of live anaerobic phototrophic bacteria and general sceneries were very similar. As a rule morphophyslogically alike green and/or brown forms of green sulfur bacteria dominated and one or several spices of purple sulfur bacteria presented as minor component of anoxygenic bacterial community.

The zooplankton's abundance in the Kislo-Sladkoe Lake was significantly lower compared to the marine zooplankton's abundance observed for the adjacent areas. The zooplankton in the Lake on Zelenyi Cape was the most abundant and diverse. The copepods *Acartia longiremis* and *Pseudocalanus minutus* dominated.

The ice's structure was studied for the separating waterbodies for the first time. The ice cover's thickness varied from 12 to 35 cm. The upper layer of 15–20 cm was represented by interlayers of opaque ice and the liquid ice mass, while the lower layer was characterized by the common structure of the sea ice (an opaque layer, a crystallized transparent layer, and the lowest one was porous). In the Trekhtsvetnoe Lake, the lowest porous layer was absent and the lowest layer was represented by transparent fresh ice 5-cm thickness.

Diatoms typical for the marine ice communities dominated in the upper ice layers of snow and water origin in Kislo-Sladkoe Lake. The large cryptophyte *Cryptomonas* sp. (20- to 33-μm in length) dominated in the lower ice layers characterized by their crystalline and columnar structure. The dominating of cryptophyte algae is typical neither for the White Sea nor for the Arctic. The active development (blooming) of cryoflora was registered at two stations: nos. 8 and 9. In the Ermolinskaya Inlet, the blooming was typically marine; i.e., diatoms dominated in the ice flora: *Nitzschia frigida, Navicula gelida, Pauliella teniata, Entomoneis paludosa, E. kjellmanii*, etc. The composition of the cryoflora was totally different in the Rugozer-



Sampling sites in the vicinity of the White Sea Biological Station of Moscow State University (WSBS MSU) in March of 2012. *1–10*—stations of multidisciplinary samplings: *1*—Kislo-Sladkoe Lake; *2*—Trekhtsvetnoe Lake; *3*—a salty lagoon (lake) on the Zelenyi Cape; *4*—station in the open sea after the lake rift on Zelenyi Cape; *5*—inner part of the Kislaya Inlet; *6*—Nizhnee Ershovskoe Lake (two stations); *7*—Verkhnee Ershovskoe Lake; *8*—Ermolinskaya Inlet (two stations); *9*—Rugozerskaya Inlet; *10*—WSBS MSU Inlet.

skaya Inlet, where the green algae *Chloromonas nivalis* (preliminary taxonomic definition) grew en masse in the lower ice layer, which was colored pink. The algae *C. nivalis* usually develop in the snow cover, and its growth in the lower ice layer and in the under-ice water was registered in the Arctic ice for the first time.

The concentration of insoluble particles in the snow was comparable to the background concentrations for the Arctic region. The concentration of insoluble particles in the ice of the SW and in the marine areas did not differ significantly, although it was higher in the under-ice water in the SW.

The number of common eider increased compared to March 2011, but the number of long-tailed ducks stayed the same, as was observed during the counting of the sea ducks during the winter gathering.

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