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ORIGINAL ARTICLE

Plankton community and the relationship with the environment in saline lakes of Onon-Torey plain, Northeastern Mongolia

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Abstract The plankton community of sixteen saline lakes located on Onon-Torey plain (Northeastern Mongolia) during the filling phase and the raising of the water level was investigated in July 2011. Thirty-five taxa of phytoplankton and thirty-one species of zooplankton were found. For phytoplankton, blue-green algae (*Merismopedia elegans*, *Anabaenopsis elenkinii*, *Arthrospora fusiformis*, *Spirulina major*, *Lyngbya* sp., *Oscillatoria* sp.) and green algae (*Monoraphidium minutum*, *Tetrastrum komarekii*, *Ankyra ocellata*, *Oocystis* sp.) were dominant. For zooplankton, *Filinia longiseta, Brachionus plicatilis*, *B. variabilis*, *Hexarthra mira* (Rotifera), *Daphnia magna*, *Moina brachiata*, *M. mongolica* (Cladocera), *Arctodiaptomus bacillifer*, *Mixodiaptomus incrassatus*, *Metadiaptomus asiaticus* (Copepoda) dominated. Mineralization, active hydrogen ratio, dissolved oxygen and water temperature were the main factors influencing the diversity, structure and distribution of plankton organisms in the steppe lakes during low water level. The RDA analysis for phytoplankton and zooplankton from different lakes was carried out for selected two groups which included lakes and a subset related species. The first group is of oligohaline and mesohaline lakes in which mostly green algae, rotifers and copepods inhabit. The second group is of mesohaline and polyhaline lakes with mainly blue-green algae, some crustaceans and rotifers inhabiting. High abundance and biomass of *Spirulina major*, *Oscillatoria* sp. and *Brachionus variabilis* were observed in lakes with high mineralization, pH and temperature.

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1. Introduction

Naturally mineralized lakes with high pH value are unique ecosystems, they become the objects of many studies. Researches are connected with different aspects of the ecosystem's structural–functional organization and ecological

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changes caused by external influence (Williams, 2002; Balushkina et al., 2007).

There are over 900 natural lake basins in the territory of Eastern Mongolia, 72% of them belong to the Onon, the Uldza and the Khalkhin river basins (Sevastyanov and Tserensodnom, 2014). Semi-arid climate conducive to the evaporative concentration of surface water, and hummocky terrain with many closed depressions favors the formation of saline lakes in this area (Dzyuba and Kulagina, 2005). Most of water-bodies belong to the Eastern Mongolia system of small lakes (Sklyarov et al., 2011). High amplitudes of long-term fluctuations of water level are characteristic of these lakes. These amplitudes result in the variability of morphometric, hydrochemical and hydrological parameters of lakes. From the scientific point of view, lakes of northeastern Mongolia are natural laboratories for adaptations of saltwater lake organisms to extreme environmental conditions. In this respect studies of plankton communities as one of the most import functional components of lacustrine ecosystems are especially topical.

During various periods, the amplitude of fluctuations of depths in small lakes is quite high. Sometimes the lakes dry out fully. Climate change causes changes in water level, area, mineralization, active hydrogen ratio, nutrients and others. Fluctuations in environmental factors lead to changes in species diversity and structure characteristics in communities of aquatic organisms. During low water dry years (2008), when compared to high water 1966 and 1993, the lake depths decreased and water mineralization increased (Itigilova et al., 2014). Information on the changes in the ecological conditions in the lakes is presented in the published papers (Dulmaa, 1966; Sheveleva et al., 2009; Dorofeyuk and Tsetsegma, 2014.). The beginning of the filling in ones lakes and the raising of the water level in others were recorded in 2011. But data from these periods of recovery of ecosystem functioning in the saline lakes of northeastern Mongolia are virtually absent.

Our main goal was to study hydrobiological characteristics (species composition, abundance, biomass of algae and zooplankton) of some saline lakes in the northeastern Mongolia to determine the relationship between plankton community structure and environmental factors during low water level. The main questions were: (1) What environmental factors are main in the saline lakes during the low water level? (2) How do these factors affect the plankton species composition and structure? (3) How do taxonomic groups of phytoplankton and zooplankton respond to changes in environmental factors?

2. Materials and methods

2.1. Description of the study lakes

All studied lakes are located on the territories of steppe Mongolia in the Uldza-Gol and Kerulen rivers basins (Fig. 1).

Almost all lakes are shallow (except Khukh), so waters are stirred by the wind well. Mainly soils are clay, so the water is very turbid. Lakes Sumiyn, Teeliyn and Yakh' were at the stage of flooding with water after full drying in previous years. Its waters were desalinated owing to the new flooding of the lake depressions. The strong smell of hydrogen sulfide was felt from the Lake Khaichiyn Tsaydam.

Dissolved oxygen concentration ranged from 1.2 to 17.5 mg l^{-1}. The pH value ranged 9.2–9.9, describing water as alkaline. The water temperature varied from 19.5 to 35.2 °C. In terms of water mineralization, the studied lakes may be divided into three groups: oligohaline lakes having water mineralization of 0.7–4.2 g l^{-1}, mesohaline lakes with water mineralization of 5.0–16.2 g l^{-1}, and polyhaline lakes with mineralization over 20 g l^{-1} (Itigilova et al., 2014). The dominant cation was sodium, hydrocarbonate was the dominant anion, chloride was the sub-dominant anion with increasing mineralization (Sklyarov et al., 2011) (Table 1).

In the most deep water Lake Khukh, no clear vertical stratification was found either in temperature (temperature at surface 21.6 °C; at bottom, 19.5 °C) or in water salinity (2.6–3.8 g l^{-1}). The content of oxygen varied with depth from 12.9 mg l^{-1} at the surface to 1.2 mg l^{-1} near the bottom. The values of pH ranged from 9.2 to 9.3. The water transparency varied from 0.5 m to 4.5 m (Itigilova et al., 2014).

2.2. Sampling methods and data collection

Our studies of the plankton community (algae and invertebrates) in 16 saline lakes were carried out in July 2011. Some abiotic environmental parameters (temperature, pH, dissolved oxygen, mineralization) were measured using an AQUA-METER 200TM device (Itigilova et al., 2014). Water transparency was measured by Secchi disk. The viscous clay soils were not allowed to fully carry out the study of lakes. Due to the shallowness of the lakes subsuperficial samples were taken.

For phytoplankton, from each lake (except Khukh), a 1 liter sample was taken. Each sample consisted of subprobe selected in two to four different parts of the lake. Subprobes were mixed, and then one integrated sample of required volume was selected. On Huh Lake a phytoplankton samples were taken from surface, middle and bottom layers by Patalas bathometer (6 l). Thirty-eight of phytoplankton samples fixed in 4% formalin were collected. The sedimentation method was used to concentrate phytoplankton. Cell calculation was made in a counting plate (0.01 ml volume) using the Hansen method. Algae biomass was determined with geometric figures method (Sadchikov, 2003). Taxonomic identification is given by Guides to the Identification of the Freshwater Algae ... (1962, 1980), Tsarenko (1990); Komárek and Anagnostidis (1986, 1989, 1998, 2005); Genkal and Trifonov (2009); Popovskaya et al. (2011); Guiry and Guiry (2014).

Zooplankton was sampled quantitatively using a Judy net with a filtering cone made of Capron mesh (125 μm) on four lakes (Ikh Dalay, Baga Dalay, Gurmiyn, Khukh). Samples were taken from the whole water column (bottom-to-surface). From other lakes from 10 to 60 l of water was filtered through the net during sampling. These samples were collected using the same principle as for phytoplankton. For qualitative sampling, a hand net was used. A total of 32 quantitative and 18 qualitative samples were collected and processed. The samples were preserved in a 4% formalin solution following standard routine and counted in the Bogorov chamber (Guidelines ..., 1982). Abundance (ind. m^{-3}) and biomass (g m^{-3}) were calculated for each species in each sample. The biomass of zooplankton was determined considering the size of zooplankters

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