

EXPERIMENTAL ARTICLES

Diversity of Prokaryotes in Planktonic Communities of Saline Sol-Iletsk lakes (Orenburg Oblast, Russia)

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Abstract—Prokaryotic diversity was studied in the planktonic communities of six Sol-Iletsk lakes (Orenburg oblast, Russia) varying in salinity level using the Illumina technology of high-throughput sequencing. The extremely halophilic archaea of the phyla *Euryarchaeota* and *Nanohaloarchaeota*, as well as the bacterial phylum *Bacteroidetes* predominated in the communities of lakes with salinity of 285–300‰. Representatives of the phyla *Bacteroidetes* and *Actinobacteria*, as well as of the class *Gammaproteobacteria* were predominant in the lakes with salinity 110–180‰. A bloom of *Cyanobacteria* was observed in Bol'shoe Gorodskoe Lake (10‰ salinity). The dominant OTUs in the lakes with high salinity were represented by archaea *Halonotius* sp., uncultured *Nanohaloarchaea*, and bacteria *Salinibacter* sp. In the lakes with medium salinity level the dominants included gammaproteobacteria *Spiribacter* sp., alphaproteobacteria *Roseovarius* sp., flavobacteria *Psychroflexus* sp., unidentified archaea of the family *Haloferacaceae*, actinobacteria *Pontimonas* sp. and *Rhodoluna* sp. In the lake with low salinity level cyanobacteria of the genus *Planktothrix* were predominant. Effect of salinity on prokaryotic taxonomic richness, composition, and diversity in planktonic communities of the studied lakes was demonstrated.

Keywords: saline lakes, biodiversity, prokaryotes, halophilic bacteria, archaea, planktonic communities, high-throughput sequencing, Illumina, 16S rRNA gene

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Sol-Iletsk lakes are located in the Orenburg oblast, at the border between Russia and Kazakhstan. The lakes were formed at the surface of the Iletsk salt dome, which developed in the end of Permian period over 200 Ma ago, and are of karst-anthropogenic origin (Petrishchev, 2010). Rock salt has been recovered from the Iletsk deposit for over 200 years, and the deposit's surface is presently a large depression with the lake system surrounded at the outer side with the remnants of the core salt cylinder (Tuz-Tyube mountain). The lakes are in the area of semiarid climate in the Southern Ural region and are characterized by an unstable hydrogeological regimen (Petrishchev, 2015). Sol-Iletsk karst lakes are of recreational and balneal importance as a regional resort center. Some of the lakes are objects of natural heritage for the Orenburg near-Ural zone.

While some microbiological research of Sol-Iletsk lakes, including study of microalgae, was carried out in the mid-20th century (Blyumina, 1958), active ecological, hydrobiological, and hydrochemical investigation commenced in the 1990s and was associated mostly with their balneological application (Pavlov, 1993; Abdrakhmanov, 2001; Abdrakhmanov et al.,

2005). For many years, microbial communities of Sol-Iletsk lakes have been studied using traditional culture-based techniques, which revealed members of the basic domains *Archaea*, *Bacteria*, and *Eukarya* (Abdrakhmanov, 2001; Shabanov, 2001; Plotnikov, 2002). The structure of lake microbiocenoses was found to depend on salinity and trophic status of the lakes (Selivanova, 2007). The cultures of some prokaryotes (Selivanova and Nemtseva, 2013) and eukaryotes (Plotnikov et al., 2013, 2015) were isolated, identified and investigated. New species of protozoa were described (Harding et al., 2013; Myl'nikov, 2015), and biotechnological value of local strains of *Dunaliella* green algae was established (Nemtseva et al., 2013; Solovchenko et al., 2015). The structure and diversity of prokaryotic communities of closely located Sol-Iletsk lakes with different salinity levels has not, however, been studied using up-to-date metagenomic approach.

The known thesis that species richness and diversity decreases sharply with increasing salinity is true for many highly saline lakes. However, recent application of genetic techniques for diversity assessment in hyperhaline lakes revealed high prokaryotic diversity