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Genetic diversity and community dynamics of *Synechococcus* spp. in the northern basin of Lake Biwa

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Synechococcus is a unicellular cyanobacterium and its cell size is from 0.8 to 2.0 micrometers in diameter. Comparably sized photosynthetic planktons, including *Synechococcus*, other picocyanobacteria and picoeukaryotic algae, are called as picophytoplanktons (0.2-2.0 micrometers) and they are known to be the important primary producers in various aquatic ecosystems. Picophytoplanktons in lakes are mainly comprised of *Synechococcus* spp., which are assigned to the "picophytoplankton-clade" (*sensu* Urbach et al. 1998) in molecular phylogenetic trees. In the northern basin of Lake Biwa, it was reported that the abundance of picocyanobacteria reached to 10^5 - 10^6 cells/ml level, and the chlorophyll abundance of them made up about 45% of total chlorophyll in summer (Nagata 1986). Although the abundance of *Synechococcus* in Lake Biwa is seasonally changing, it's always more than 10^3 cells/ml. So, they are thought to significantly affect the material cycles and the ecosystems in Lake Biwa. Three strains of *Synechococcus* spp. (clones Pink, Green and Brown) have been isolated from Lake Biwa (Maeda et al. 1992), and they were thought to be major components of picophytoplanktons in the lake. However, it's difficult to make out the differences of them by microscopy because of these small and simple shaped cells. So the diversity and community dynamics of *Synechococcus* in Lake Biwa were unclear. In this study, we investigated the genetic diversity of *Synechococcus* spp., and analyzed vertical distribution and seasonal changing of their community structures in the northern basin of Lake Biwa by using a molecular method.

We monthly collected water at a point in Lake Biwa (35°22'44"N, 136°5'43"E), which is near to the deepest point of the lake, from April 2009 to March 2010. Water samples were collected every 10 meters in depth by using the Niskin bottle from surface to 90 m in depth. One liter of water from each sample was filtered with GF/F glass-fiber filter (25 mm in diameter), and we prepared total DNAs from them. By using these DNAs as template, PCR were performed by using the unicellular cyanobacteria specific primer set (GC-CYA353F/CYA781R(b)), followed by denaturing gradient gel electrophoresis (DGGE). Bands were excised from DGGE gels and the base sequences of these bands were determined. These sequences were phylogenetically compared to known sequences derived from *Synechococcus* spp.

All of the obtained base sequences, which were derived from *Synechococcus* spp., were assigned to the "picophytoplankton-clade", and they were divided into 14 phylogenetic groups. The phylotypes, which were identical to or closely related to the clone Pink, were detected from samples collected in April to August 2009, and in January to March 2010, and they were thought to be the major components of picocyanobacteria in those months, because of the density of DGGE bands. On the other hand, the phylotype closely related to the isolates Green and Brown was only detected from the 0-10 m samples collected in August 2009. Therefore, it was suggested that this phylotype affected to the increase of picocyanobacteria in summer. In other season, the phylotypes, which had not been discovered in Lake Biwa, were mainly detected. During the months of June to September, the compositions of phylotypes varied with depth; single or two phylotypes were dominant in surface layer (0-20 m), but some other phylotypes were dominant in deeper layer. On the contrary, community structures of *Synechococcus* spp. were almost same from surface to bottom in other months. From these results, it was revealed that there were many phylotypes of *Synechococcus*, which were phylogenetically different from already known ones, in Lake Biwa. Additionally, it was also revealed that not only the abundance of *Synechococcus* cells, but also the dominant phylotypes and community structure of them were seasonally changing in Lake Biwa.

Keywords: cyanobacteria, picoplankton, *Synechococcus*, Lake Biwa, community dynamics