南極湖沼生態系を支える湖底の栄養塩

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Nutrients in sediments as driving force behind Antarctic lake ecosystems

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One of the most productive ecosystems in continental Antarctica is found in freshwater lakes, where benthic microbes with mosses form thick mats can flourish on the lakebeds of the Sôya Coast. This is despite low nutrient levels, low temperatures, and seasonally limited solar radiation. In previous studies, we examined the detailed light environment in the water columns (Tanabe et al. 2008), and light usage and protection of the phytobenthos in Antarctic lakes (Tanabe et al. 2010), and have revealed that the phytobenthos allowed the growth and survival by using the possible light energy while preventing from death during a short but strong light summer, and discussed the ecological implications of microbial communities in terrestrial ecosystem including Antarctic lake (Tanabe & Kudoh 2012). Because the Sôya Coast lakes are oligotrophic and have sparse phytoplankton, the flux through the water column to the sediments of detrital, algal-derived organic material may be much lower. A question arise where can the phytobenthos obtain nutrients from in such oligotrophic lake ecosystems? In the oligotrophic Antarctic lake water, although the benthic organisms have been thought to obtain nitrogen through N_2 fixation of cyanobacteria (Fernández-Valiente et al. 2001) and also guessed to utilize from inside the lakebed, the quantity and utilization of nutrients are not clear yet. To dissolve this question, we measured the nutrients in gap water and bioelements such as C, N, P of Antarctic lake sediments with the vertical profiles which remain to be defined. Then, as compared to the sediment gap water and C/N ratio, and the lake water that collected from over a wide range of Syowa Oasis, the present study aimed to reveal the nutrients utilization of the phytobenthos. From this, in terms of matter cycle, we approach to the mystery for success and formation of the benthic vegetations in Antarctic lakes that have their own and diverse ecosystem by each lake.

As a result of nutrients analysis, 3-220 times of DIN (dissolved inorganic nitrogen) and 2-102 times of DIP (dissolved inorganic phosphate) were contained in gap water of the lake sediments surface, but the nutrient concentrations in gap water were disaggregated in each lake even though the concentrations were similar levels in the lake waters. The profile of nutrient concentrations in sediment cores drastically changed the gradient in the sediments surface. Comparing with DIN concentration in 20 cm depth and DIN difference in the surface of sediments, indicates that the more DIN accumulation in sediments, the larger DIN decrease in the surface. Also comparing with DIN difference and C/N ratio of the sediments surface, indicates that the larger DIN decrease in the surface, the lower C/N ratio in living phytophentos. These results suggest that nutrients are utilized by phytobenthos from the lakebeds, and low nutrients in the lakebeds lead the phytobenthos to nitrogen deficiency, in addition, there are any mechanisms that nutrients are hardly discharged from lakebeds to lake water column. The scenario previously thought in Antarctic lake ecosystem is that the benthic organisms obtain nutrients through N_2 fixation ability of cyanobacteria, however, the present study raised the new hypothesis that the nitrogen fixation of cyanobacteria is not so important and the benthic organisms can obtain nutrients from lakebed in the present stage of lake ecosystem.

References

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