Contribution of biological soil crusts to the terrestrial carbon cycle in a High Arctic glacier foreland in Ny-Alesund, Svalbard

Shinpei Yoshitake[1]; Masaki Uchida[2]; Hiroshi Koizumi[3]; Hiroshi Kanda[2]; Takayuki Nakatsubo[4]

[1] Advanced Science and Engineering, Waseda Univ.; [2] NIPR; [3] Education, Waseda Univ.; [4] Biosphere Science, Hiroshima Univ.

Biological soil crust is a soil-surface community which consists of cyanobacteria, algae, lichen, moss, fungi etc. They are known to perform a key role in stabilizing otherwise mobile surfaces and protecting soil from both wind and water erosion and cryoturbation. Furthermore, since they are typically the pioneer organisms to colonize the soil surface and subsurface, they can be the very important primary producers and thus represent the trophic base on which heterotrophic organisms depend. However, there is little information about the effect of biological soil crusts on carbon cycle in the Arctic region. In this study, we aimed to clarify the photosynthetic characteristics of the biological soil crusts to estimate the production and the effect of temperature increase on it.

Biological soil crusts were collected from a High Arctic glacier foreland in Ny-Alesund, Svalbard (79 N) in early August 2008. Net photosynthetic (Pn) and dark respiration (R) rates at various temperature (0-20 C), water (20-100% of water holding capacity (WHC)), and light (PPFD; 0-709 umol photons m^{-2} s^{-1}) condition were determined by CO_2 exchange measurement.

The maximum values of Pn and R were observed at about 50%WHC. Both the Pn and R dropped below the detectable limit in a range below about 20%WHC. The Pn decreased with increasing temperature and showed negative values in a range over about 13 C. In contrast, the R increased with increasing temperature and the Q_{10} value of R was 3.1. We constructed a model for estimating the production of biological soil crusts and the effect of temperature increase on it based on the relationships between abiotic factors and Pn and R. The daily net production of biological soil crusts in the growing season of 2008, estimated using temperature, water content, and light condition in the field, was about 0-50 mg CO_2-C m^{-2} day^{-1}. It was much smaller than those of mosses and lichens in this area (0-751 and 0.95-72 mg CO_2-C m^{-2} day^{-1}, respectively) reported in the previous studies. However, since the soil carbon pool and the primary production per area were very small in the early stage of primary succession in the High Arctic glacier foreland, it is likely that the production of the biological soil crusts have great effect on the terrestrial carbon cycle. Model estimation showed that temperature increase caused a remarkable decrease in the net primary production of the biological soil crusts. These results suggest that temperature increase by the global warming might have fatal damage on the biological soil crusts.