Factors leading to differences in water availability and photosynthetic activity of High Arctic lichens

T. Inouea, S. Kudoh[1,2], M. Uchida[1,2], Y. Tanabe[1,3], M. Inoue[4], H. Kanda[1]
[1]National Institute of Polar Research, 10-3 Midori-cho, Tachikawa-shi, Tokyo 190-8518, Japan
[2]Department of Polar Science (Sokendai-NIPR), The Graduate University for Advanced Studies, 10-3 Midori-cho, Tachikawa-shi, Tokyo 190-8518, Japan
[3]Institute for Advanced Study, Waseda University, 1-6-1, Nishi Waseda, Shinjuku-ku, Tokyo 169-8050, Japan
[4]Faculty of Education and Human Studies, Akita University, 1-1 Tegata-Gakuenmachi, Akita-shi, Akita 010-8502, Japan

The lichen symbiosis comprises a successful nutritional strategy that leads to lichen distributions of High Arctic ecosystems. However, in situ contributions of mycobionts to photosynthesis and water availability of photobionts remain unclear. We investigated factors that lead to differences in water availability and photosynthesis of High Arctic lichens were investigated in observational and experimental analyses of substrates and thallus morphology in the High Arctic, Ny-Ålesund, Svalbard (79°N) during the snow-free season in 2010. Five lichens were found on the five substrate types moss litter, vascular plant litter, mixed litter, biological soil crust (BSC) and gravel in the study area. The BSC substrate had significantly higher water content than the other substrates, and large amount of water was evaporated from their surface while they conveyed much more water from the ground. Moreover, the structure of BSC exhibited higher water retention ability than the other four substrates, thus providing the most moist environment for lichens in our study. The surface area of *Ochrolechia frigida* in contact with substrate was about four times larger than for the four fruticose lichens, with about 60% *O. frigida* thallus in contact with the substrate. The four fruticose lichens had greater surface areas than *O. frigida*, with about 90% exposure to the air. Initial rates of absorption and evaporation increased with greater thallus surface areas, suggesting that water availability for photosynthetic partners (photobionts) is strongly affected by both morphological characteristics (surface area in contact with the surrounding environment) and water properties of substrates, which are both dependent on fungal partners (mycobionts). We conclude that lichens show harmonisation of morphology and substrate preferences for autotrophic nutrition in the water-limited glacier foreland of the High Arctic region.

References

Takeshi Inoue, Sakae Kudoh, Masaki Uchida, Yukiko Tanabe, Masakane Inoue, and Hiroshi Kanda, Factors leading to differences in water availability and photosynthetic activity of High Arctic lichens, Polar Biology, (submitted).