

Photosynthetic responses to water and light of five Arctic lichens and their photobionts

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Lichens are important primary producers which life is thought to be limited by water availability in polar terrestrial ecosystems. We investigated structural features and photosynthetic responses to the water and light of five lichen species (*Cetrariella delisei*, *Flavocetraria nivalis*, *Cladonia arbuscula* ssp. *mitis*, *Cladonia pleurota* and *Ochrolechia frigida*) that dominated in the Arctic glacier foreland. Using the isolated photobionts cells (algal partner of lichens), the responsibility to these environmental parameters of lichens' were experimentally tested focusing on symbiotic effects that enable to perform the photosynthetic production under Arctic summer condition.

Photobionts of *C. delisei*, *F. nivalis* and *O. frigida* were allocated in medulla which is covered by cortical layer of the thallus. In contrast, photobionts of *C. arbuscula* ssp. *mitis* and *C. pleurota* were randomly colonized on external part of the thallus. Light curves of isolated photobionts photosynthesis of *C. delisei*, *C. arbuscula* ssp. *mitis* and *C. pleurota* were showed differences when they were in the lichen thallus symbiotically; the saturation light intensity was lower. In contrast, the light curves of thallus and photobionts of *O. frigida* and *F. nivalis* were not shown significant difference.

Photosynthetic activity of all photobionts were similarly slowed by the water shortage when their water contents decreased to <40%, however, responsibility of their water content to the changes in environmental water condition showed great difference between naked photobionts and thallus, and also among tested thallus; quicker dessication for naked photobionts, rapider acquirement of water from wet atmosphere, etc. These differences of water condition for photobionts, that were induced by each symbiotic relation with host fungi, may affect the photosynthetic activity, and cause the difference of the photosynthetic active period of each lichen species.