融氷期に海氷から放出されたアイスアルジーは生存することができるか?

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Does the ice algae released from the melting sea ice survive or die?

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Introduction

Algal communities found in sea ice, known as ice algae, play an important role in primary production in the sea ice ecosystem. Ice algal community is predominated by diatoms. Snow coverage and thick ice force ice algae acclimating to extreme low light condition. When cells are released from retreating sea ice, some ice algal cells might be exposed suddenly to high light. Although light is an essential resource for the survive of ice algae in the sea ice, light can be also harmful at supraoptimal irradiance such as surface water column, leading to a damage of photosystem II (PSII). One of the most important protection mechanisms against high light intensity is the thermal dissipation of excess energy by xanthophyll cycle pigments in the de-epoxidated state. The photoprotection through non-photochemical quenching (NPQ) of chlorophyll (Chl) fluorescence is linearly dependent on the presence of the de-epoxidated diatoxanthin (DT) for many marine diatoms (Lavaud et al. 2004). In this study, we investigated the photoprotective responses of the ice algal community to natural irradiance when released from sea ice, and whether they can survive under dark condition.

Materials and Methods

Our sampling was conducted at the station off the eastern shore of Saroma-Ko Lagoon, Hokkaido (44 °N, 143 °E) in February 2013. The ice algal samples, collected from undersurface of sea ice, were exposed to sun light. Subsamples were collected from 1 to 120 min after light exposure to measure pigments and variable Chl fluorescence of the ice algae. Chlorophyll fluorescence are employed to estimate NPQ and maximum quantum efficiency (Fv/Fm) of PSII. The degree of damage and recovery of PSII can be examined by variation in Fv/Fm. At the end of exposure experiments, for 120 min, the cells were incubated further in the darkness for 2 days.

Results and Discussion

Diatoms dominated the ice algal communities, and the most numerous diatoms were the centric *Detonula confervacea*, *Chaetoceros* sp., and the pennate *Achnanthes taeniata*. After the ice algal community was exposed to sun light, de-epoxidation of diadinoxanthin (DD) to DT occurred rapidly and NPQ showed dynamic changes. Activation of xanthophyll cycle and induction of NPQ suggested that ice algal community could perform photoprotection as thermal dissipation against higher light intensity. The linear relationship between the ratio of DT to Chl *a* and NPQ observed in this study suggests that NPQ is dependent on the size of the DT pool in ice algal communities. Despite the ice algal communities could dissipate excess heat by activation of the xanthophyll cycle, the significant decrease in Fv/Fm due to high light intensity may suggest that the reaction centers of PSII in the ice algae could be severely damaged by high light conditions. When the light-exposed cells were stored in the darkness within 2 days, the Fv/Fm values were recovered. Therefore, the possibility of survive for ice algae within the water column could be predicted if the released ice algae from the sea ice settle rapidly to the sea floor in near- or complete darkness.

References

Lavaud, J. Rousseau, B., Etiennpe, A.-L. General features of photoprotection by energy dissipation in planktonic diatoms (Bacillariophyceae). Journal of Phycology 40, 130‑137, 2004.