北海道サロマ湖におけるアイスアルジーの光保護とキサントフィルサイクルの応答

片山智代、滝本香代子、本川正三、小幡光子、田口哲
創価大学工学部

Photoprotection and xanthophyll cycle activity of ice algae in Saroma-Ko Lagoon, Hokkaido, Japan

Tomoyo Katayama, Kayoko Takimoto, Shozo Motokawa, Mitsuko Obata and Satoru Taguchi
Soka University, Faculty of Engineering

Introduction

One of the most important protection mechanisms against high light intensity is the thermal dissipation of excess energy by xanthophyll cycle pigments in their de-epoxidated state. The photoprotection through non-photochemical quenching (NPQ) of chlorophyll fluorescence is linearly dependent on the presence of the de-epoxidated diatoxanthin (DT) for most marine diatoms (Lavaud et al. 2004). Diatoms dominate the bottom surface of sea ice in polar seas. Snow cover and thick surface ice forces phytoplankton acclimating to extreme low light condition of surface irradiance. The ice algal communities may be exposed to the high light intensity by releasing from melting sea ice. In this study, we investigated the photoprotective responses of a seasonally well-developed ice algal community in sea ice at Saroma-Ko Lagoon on March 2012, by examining NPQ and xanthophyll pigments in shade adapted ice algae after exposure to sun light.

Materials and Methods

Our sampling was located at a station off the eastern shore of Saroma-Ko Lagoon, Hokkaido (44 °N, 143 °E). The ice algal samples were exposed to sun light between the light intensity of 520 and 1145 µmol photons m^{-2} s^{-1} on 7 March 2012. Subsamples were collected from 1 to 120 min after light exposure to measure variable chlorophyll (Chl) fluorescence and pigments of the ice algae.

Results and Discussion

The irradiance at the bottom surface of ice algae was 13% of irradiance in air. The amount of diadinoxanthin (DD) and DT in the bottom surface of ice algae were 9.8 mol DD (100 mol Chl *a*)$^{-1}$ and 0.58 mol DT (100 mol Chl *a*)$^{-1}$, respectively. After the ice algae community was exposed to sun light, de-epoxidation of DD to DT occurred rapidly, and after 10 min DD reached a minimal value of 7.8 mol DD [100 mol Chl *a*]$^{-1}$. Non-photochemical quenching (NPQ) showed dynamic changes within 10 min on exposure to high light intensity while the maximum quantum efficiency (F_v/F_m) of photosystem II was decreased exponentially from 0.63 to 0.082. Activation of xanthophyll cycle and induction of NPQ in the present study suggested that ice algae could perform photoprotection as thermal dissipation against higher light intensity. Photoprotective ability of ice algae released from the melting sea ice may contribute to seeding of ice edge bloom.

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.