低温適応したアイスアルジー群集の光合成電子伝達速度について

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Cold-Adapted High Electron Transport Rate in the Photosynthesis of Ice Algal Community

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The traditional P versus I curve experiments based on the ^{14}C method for example provide the photoadaptive response of microalgae. The dark-adapted cells tend to indicate the steep initial slope and low saturated-photosynthetic rates, whereas the light-adapted cells indicate the gentle initial slope and high-saturated photosynthetic rates (MacIyntyre et al. 2002). The initial slope may not depend on temperature, whereas the saturated value indicates temperature dependency (Steemann-Nielsen and Jørgensen 1969). From those observations, the ice algal community is predicted to indicate the steep initial slope and low saturated value of photosynthesis. Recently chlorophyll fluorescence has been employed to study the electron transport rate of photosynthesis (Genty et al. 1989). The chlorophyll fluorescence method is applied to study the photoadaptive strategy of ice algal community which has been kept in the laboratory.

Materials and Methods

Ice algal community was collected at the experimental station off Sakae-Ura, Saroma-ko Lagoon on February 2011. Once the ice core was collected at the field, ice core was transferred immediately to the land-based laboratory in dark condition. The bottom 3 cm portion was sliced to the filtered sea water enriched with f/2 medium. The culture in f/2 medium was transferred to the laboratory in Tokyo. The culture was maintained at 0°C under 12h light and 12 h dark cycle of 60 µmol photons m^{-2} s^{-1} in the temperature-light controlled incubator. The photon density flux, *PDF*, was measured by using the 4π irradiance meter (QSL-100). Cell density was determined daily to follow the growth of cells in a batch culture mode. Once culture became saturated, it was diluted with a new f/2 medium several times for 6 months. The cell density and chlorophyll fluorescence were determined daily and chlorophyll *a* concentration and light absorption were measured every two days.

Results and Discussion

The ice algal community showed the logarithmic growth during the period from day 0 to day 7 of growth based on both cell number and chlorophyll *a* concentration. Five dominant species such as *Odontella* sp., *Entomoneis* sp., *Nitzchia* sp., *Detonula* sp., and *Thalassiosira* sp. in order of cell abundance were identified during the experiment. *Odontella* sp. was the largest cell volume (45×10^3 μm^3), dominated also in the cell volume. Chlorophyll *a* specific absorption coefficient (a_{ph}*) indicated 0.0154±0.0026 m^2 (mg Chl *a*)$^{-1}$. The red light absorption efficiency was estimated as 77.7±14.8%, indicating a moderate package effect occurred during the present enrichment experiment.

Maximum photosynthetic efficiency, *Fv*/*Fm* was 0.736±0.019, indicating possibly the highest value of the ice algal community. The initial slope and saturated value of the electron transport rate were 0.332±0.017 (*e* µmol photons^{-1}) and 52.6±8.1 (*e* m^{-2} s^{-1}), respectively. The adaptation index, E_K, was 25±18 µmol photons m^{-2} s^{-1}, indicating well-dark adapted cells. The saturated values of the electron transport rate were similar to those of mesophilic diatoms. This may strongly suggest that the ice algal community do indeed adapt to low temperature with similar high saturated value of photosynthesis to those of mesophilic diatoms under low irradiance with ample nutrients.

References

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