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A Time Series Observation of Coastal Fast Ice in Barrow ; Ice Algae Production Processes (Extended Abstract)

KYUNG-HOON SHIN[1], NORIYUKI TANAKA[1], TOMOYUKI TANAKA[1] and TERRY WHITLEDGE[2]

[1]Frontier Observational Research System for Global Change/International Arctic Research Center, University of Alaska Fairbanks, 930 Koyukuk Dr. Fairbanks, AK 99775-7335, USA
[2]Institute of Marine Science, University of Alaska Fairbanks

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1. Introduction

Recent investigations in the Arctic Ocean have revealed larger biological communities, higher levels of primary productivity and more active dynamics of organic carbon (Cota *et al.*, 1996; Wheeler *et al.*, 1996; Gosselin *et al.*, 1997; Rich *et al.*, 1997). However, there is still much uncertainty regarding to sea-ice algae production and its energy flux in the Arctic Ocean. Therefore, to investigate ice algae production processes and its related carbon flux, is important and urgent research subject in the Arctic Ocean. There are three objectives in this study as follows: 1) to clarify ice algal production processes in the coastal fast ice, 2) to evaluate ice algal contribution to carbon cycle in the Arctic, 3) to provide the quantitative data for the Arctic biogeochemical model related to climate change. In the present study, time series sea-ice observations and in situ ice algae incubation experiments were conducted off Pt Barrow in the northern Alaska during the last two spring seasons in 2001-2002.

Method and material

Ice core samples were collected at an observational station (71°19.6′N 156°42.2′W) in the coastal fast ice of Chukchi Sea. The ice core was drilled with a 9 cm diameter corer (Kovacs, Mark II). The water samples from the sub-ice water column were collected through ice holes with a plastic tube connected to a handy pump. The bottom 3 cm (ice algae assemblage) of ice core was cut and transferred into the incubation bottles. ^{13}C $NaHCO_3$ (99 at. % of ^{13}C), as a tracer, was added to the bottle to carry out the ^{13}C assimilation experiments for primary production and fatty acids production rates. Chl. *a* concentration was determined with a fluorescence spectrometer (Turner Design, 10 AU) after extraction with 90% acetone (Welshmeyer, 1994). Inorganic nutrients were measured with an autoanalyzer (Bran+Luebbe, TRAACS 800) according to Parsons *et al.* (1984). The concentration and stable isotope ratios of particulate organic carbon (POC) were determined by mass spectrometer (Fignnigan MAT) combined with an elemental analyzer. The individual concentrations of each fatty acid were determined

using a gas chromatograph (Shimadzu GC 17A) equipped with a flame ionization detector. The ^{13}C atomic percent of each fatty acids methyl ester (FAME) was estimated by using the relative intensities of ions corresponding to both isotopes for the quasimolecular ion measured at the chromatographic peak maximum (Hama *et al.*, 1987).

Results and discussion

Chl. *a* and POC concentrations were extremely high in the bottom layer of sea-ice with the development of brown colouration depending on light availability. The Chl. *a* concentration in the bottom ice algal layer (bottom 10 cm) was the highest in early May in 2001-2002, showing the large annual variation which might be attributed to the development of ice thickness.

The stable isotope ratio ($\delta^{13}C$) of POC indicates that terrestrial organic matter may be the main source of POC in the entire ice core except bottom 10 cm, exhibiting comparatively lighter isotopic values (around -28‰). The $\delta^{13}C$ ratios of POC were heavier in the bottom 10 cm (reflecting ice algal origin), showing up to ca. −18.3 in June. POC production rate was higher in May rather than in June 2001, indicating faster POC turnover rate in May. In particular, particulate fatty acids turnover rate was remarkably faster, resulting from their large production and consumption rates. Additionally, as an indicator for ecophysiological state of marine diatoms population (Shin *et al.*, 2000), C_{16}-PUFA index (a measure of the percentage of C_{16} fatty acids that are polyunsaturated) suggests ice algae population was in a nutrient-limited condition.

Comparing Chl. a concentrations in the bottom 10 cm of ice algal biomass between 2001 and 2002, Chl. a concentration on April 3, 2002 was approximately 2 fold higher than on April 5, 2001, and the maximum Chl. a concentration was around 2 fold larger on May 1, 2002 than on May 5, 2001 in Fig. 1. This observational result suggests that ice algal biomass have a large annual variation between 2001 and 2002. However, we still don't know what causes the variability of ice algal biomass because it may be related to various environmental conditions such as ice thickness, cloudiness and nutrients supply and physical events. Therefore, more thorough investigation should be necessary to

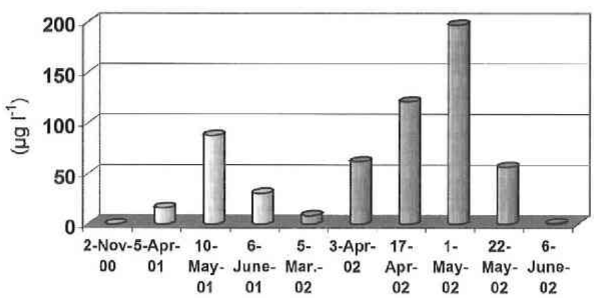

Figure 1. Chl. a concentration in the bottom 10 cm of ice core at the coastal sea-ice off Barrow in 2001 and 2002.

understand the ice algal biomass variability. Furthermore, to clarify the fate of organic carbon that produced by ice algae, we have to plan to carry out more comprehensive research on the ice algal carbon cycle including dissolved organic carbon, sinking organic matter and sediment as well as microbial and food web carbon fluxes.

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