G6–P1

PHOTOPROTECTIVE RESPONSES OF ICE ALGAE AFTER LIGHT EXPOSURE IN SAROMA-KO LAGOON, HOKKAIDO, JAPAN

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The ice algal communities may be exposed to the high light intensity by releasing from melting sea ice. An important protection mechanism 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. 20014). In the previous studies, the weak shade adaptation of ice algae at Saroma-Ko Lagoon in Hokkaido, Japan, may have the advantage of avoiding photoinhibition by exposure high light intensity when cells are released into a water column (Obata and Taguchi 2009). 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. De-epoxidation of diadinoxanthin (DD) to diatoxanthin (DT) occurred rapidly and NPQ showed dynamic changes. These NPQ and DT concentration were linearly related. The regression coefficient of the linear relationship was higher compared to that of mesophilic diatoms (Lavaud et al. 2004). These results suggest that ice algae possess a relatively effective photoprotection as thermal dissipation against higher light intensity. The further study needs to exam other factors that may affect the enhancement of NPQ in the ice algae.

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G6–P2

PHYSIOLOGICAL AND MORPHOMETRICAL RESPONSES OF SUBARCTIC COCCOLITHOPHORE, *EMILIANIA HUXLEYI,* TO TEMPERATURE

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The coccolithophore *Emiliania huxleyi* is one of the major phytoplankton species widely appeared from equator to subarctic present oceans with the formation of calcified scales, named coccoliths (e.g., Beaufort et al., 2011). Since greenhouse gases including CO_2 are accumulated in present atmosphere, the global warming and the sea-ice melting become major concerns for the polar region and, eventually, the sustainable global environments (e.g., Harada et al., 2012). In order to understand physiological responses of the coccolithophore due to the upward shift in ocean temperature, two *E. huxleyi* strains, MR57N and MR70N, isolated by MIRAI subarctic expedition in 2010 (for isolation of the strains, see M. Satoh et al. Another presentation in this conference) were investigated by their culture experiments at 5, 10, 15 and 20˚C. Both strains showed the similar growth properties: their growth was still maintained high at 5˚C at ca. 1/3 of the maximum rate, although the growth rates increased with raising the temperature. According to SEM observations and the morphometric analyses, both size (length of distal shield: LDS) and the numbers of distal shield elements of the coccolith decreased with raising the temperature. The central area of the coccoliths was also changed from grill structures to completely calcified structures. Concurrently, the cell size of *E. huxleyi* decreased with raising the temperature. Thus, the subarctic *E. huxleyi* stains showed the correlations between cell sizes and coccolith morphometic parameters with variable central area morphology depending on the growth temperatures. These results imply that the subarctic coccolithophore strains can maintain enough to grow in the arctic region and that the coccolith morphologies can be used as a potential indicator of the growth temperature. As the subarctic strains can grow faster even at 20˚C, such property will be advantageous for producing easier occurrence of coccolithophore blooms in the Arctic Ocean when temperature increases in future.
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G6–P3

ANALYSIS OF THE CHARACTERISTICS IN THE COCCOLITHOPHORE, *EMILIANIA HUXLEYI* ISOLATED FROM ARCTIC SEA

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The coccolithophore *Emiliania huxleyi* widely distributes from subtropical to high latitude oceans and is known as the most abundant bloom-forming unicellular calcifying alga. It is supposed that there may be various kinds of strains which are adapting to various environmental conditions. To investigate such speculation, we tried to isolate *E. huxleyi* from the Arctic Sea and investigate difference in photosynthetic characteristics between strains isolated from subarctic and tropical oceans.

We selected one strain isolated from Arctic sea, MR67N (Lat. 67˚30'N.) and another strain isolated from tropical region, NIES 837 isolated from the Great Barrier Reef (site data not available). To investigate the effect of growth temperature on the photosynthetic activities, we grew both cells at 20˚C or 10˚C. Although the growth rate of NIES 837 markedly decreased and failed to grow at 10˚C, MR67N could acclimate to such low temperature within ca. 3 days and maintain high growth rate. How could MR67N grow at such low temperature? When MR67N was transferred from 20˚C to 10˚C, the activity of non-photochemical quenching (NPQ), determined by chlorophyll fluorescence method, markedly increased although no significant changes in the photosystem (PS) II activity, determined as Fv/Fm. In contrary, no NPQ change was observed in NIES837. The increase in NPQ by low temperature functions to maintain photosynthetic electron transport usual by reducing high light stress. The Arctic strain MR67N seemed to develop higher ability to regulate NPQ activity but not the tropical strain NIES 837. This study clearly showed that such ability is essential for the acclimation of *E. huxleyi* in Arctic sea strain.

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G6–P4

HORIZONTAL DISTRIBUTION OF BACTERIAL ASSEMBLAGES ON SURFACE SEDIMENTS IN THE ARCTIC OCEAN

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The Arctic Ocean is globally important as a key indicator and driver of climate change. However, there are not much documented reports concerned in microbes in response to climate change although the polar region contains diverse microbes and microbial habitats and allow microbes to keep activities. The expedition for the R/V *ARAON* to the Arctic Ocean was progressed from August to September in 2012. Total ten sampling sites were occupied to monitor benthic bacterial assemblages in the Arctic Ocean related to the global warming issue. From these sampling sites, ten sediment cores were collected by the box corer or multicorer equipped in the *ARAON*, and their surface layers were respectively transferred into sterile tubes for the further analyses of pyrosequencing and sediment properties. In this study, pyrosequencing approach using a 454 GS FLX Titanium Sequencing System (Roche) is applied for bacterial diversity, taxonomic classification and phylogenetic analysis. To estimate the physiochemical properties of sediment samples, ICP-MS (Inductively Coupled Plasma-Mass Spectrometry), pH, and salinity are measured in further analysis at Gwangju Institute of Science and Technology (GIST). The data of sedimentary properties in samples is used for statistical analysis to confirm the correlation with bacterial properties in sediments. The primary aim of this study is to determine whether bacterial assemblages are described on the basis of the substratum that they occupied in the benthic ecosystem, and further to understand the effects of environmental factors on the spatial distribution of benthic bacteria by monitoring distributions of major phylotypes in bacterial assemblages in the Arctic Ocean.

G6–P5

SPATIAL DISTRIBUTIONS OF BACTERIO- AND VIRIOPLANKTON IN THE CHUKCHI SEA DURING SUMMER 2012

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Bacteria and viruses are at the bottom of the marine food web and play important roles in biogeochemical cycles of organic matters and nutrients. In the Chukchi Sea, there are 4 distinct water masses during summer; surface mixed layer water, Pacific summer water, Pacific winter water and Atlantic water. These water masses can be distinguished by its unique hydrographical properties, hypothesizing that spatial distributions of bacteria and viruses may be reflected by these different ecological regimes. To test this hypothesis, we investigated 35 depth-profiles of bacterial (BA) and viral abundances (VA) in an area covering ca. 900x400 km^2 in the Chukchi Sea (73-82°N, 173°E-153°W) during the icebreaker R/V Araon expedition (Aug 1 to Sep 10 in 2012). To avoid loss of microbes due to long-term storage, bacteria and viruses were counted within a day of sampling on aboard using an epifluorescence microscope isolated from the vibrations of the research vessel. BA ranged from 0.1×10^5 cells ml^{-1} to 16.4×10^5 cells ml^{-1} in the study area. In most stations, BA showed the maximum value at the surface or at the subsurface chlorophyll maximum depth, and tended to decrease with depth in water column. VA was on average 19-fold higher than BA, but depth profiles of VA showed similar patterns to those of BA. Our results showed that there was spatial heterogeneity in bacterial and viral abundances among stations, probably influenced by physiochemical and biological conditions in the study area. Results for in-depth analyses of relationships between microbial variables and environmental variables will be discussed in the poster presentation.

G6–P6

Macromolecular compositions of phytoplankton in the Northern Chukchi Sea

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Macromolecular compositions of phytoplankton were investigated in the Arctic Ocean. Samples for macromolecular compositions were obtained from the three light depths (100%, 30%, and 1%) at 31 different stations in the Northern Chukchi Sea, 2011. Samples were filtered on 0.7μm Whatman GF/F filters (47mm) and the filters were immediately frozen and preserved for colorimetric measurements. Extractions of different macromolecular classes (lipids, proteins, polysaccharides) were performed using the methods in Lowry et al. (1951), Dubois et al. (1956), Blighr and Dyer(1959), and Marsh and Weinstein (1966) and the concentrations were determined by the optical density measured with a spectrophotometer. The contents of lipids, proteins and polysaccharides of phytoplankton in the water column ranged from 58.62 mgL^{-1} to 105.55 mgL^{-1} (average ± S.D. = 81.76 ± 11.87 mgL^{-1}), from 5.47 mgL^{-1} to 93.31 mgL^{-1} (average ± S.D. = 47.82 ± 38.10 mgL^{-1}) and from 27.79 mgL^{-1} to 85.25 mgL^{-1} (average ± S.D. = 59.82 ± 29.90 mgL^{-1}), respectively. In our study, lipid concentrations were highest among all different macromolecular classes (p<0.05, t–test). The compositions and ambient environmental factors (nutrients, salinity, light, temperature, and Chlorophyll-a concentration) were examined for relationships. Among different macromolecular classes, only protein concentrations had strong linear relationships with ambient environmental factors.

G6–P7

DISTRIBUTION OF PHYTOPLANKTON COMMUNITIES IN THE BERING, CHUKCHI SEA AND CANADIAN BASIN DURING SUMMER

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Recent studies have shown that photosynthetic eukaryotes are an active and often dominant component of Arctic phytoplankton assemblages. In order to explore this notion at a large scale, samples were collected to investigate the community structure of phytoplankton in the Western Arctic Ocean. The 97 stations (165 samples) at the surface and subsurface chlorophyll-a maximum (SCM) depths in the Western Arctic Ocean from 2006 to 2009 during summer. Phytoplankton (>2 μm) were identified and counted. Phytoplankton communities were composed of 116 taxa representing Dinophyceae, Cryptophyceae, Bacillariophyceae, Chrysophyceae, Dictyochophyceae, Prasinophyceae and Prymnesiophyceae. In Bering Sea, diatoms were most diverse with 69 species (69.7%), followed by the dinophyceae with 22 species (22.2%). Chukchi Sea was similar to Bering Sea however Canadian Basin was showed lower diversity than other study area by other environmental and physiological factors that determine structure of phytoplankton, such as temperature. The most abundant species were of pico- to nano- size at the surface and SCM depths at most stations. From the Western Bering Sea to the Bering Strait, the abundance, and species diversity of phytoplankton provided a marked latitudinal gradient towards the central Arctic. Although pico- and nano-sized phytoplankton contributed most to cell abundance, their chlorophyll a contents and biovolumes were less than those of the larger micro-sized taxa. Micro-sized phytoplankton contributed most to the biovolume in the largely ice-free waters of the Western Arctic Ocean during summer.

G6–P8

DISTRIBUTION OF MESOZOOPLANKTON RELATED TO THE ENVIRONMENTAL FACTORS IN THE CHUKCHI SEA, 2011

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The Chukchi Sea is one of the major gateways into the Arctic where large quantities of Pacific heat, nutrients, phytoplankton and mesozooplankton enter the region through the shallow Bering Strait in a complicated mixture of water masses. Mesozooplankton abundance and biomass generally have been considered to be low in this region. Nevertheless, mesozooplankton is numerically important element and plays a major role in the food webs. We examined the distributions of mesozooplankton related to the environmental factors in the Chukchi Sea during August 2 to 16 in 2011. Mesozooplankton samples were collected with a Bong net (330 and 505 μm) at selected 10 stations. The net was towed vertically within the upper 200 m of water column. A total of 28 mesozooplankton taxa were identified, including 17 copepod species. Copepods contributed 65% of total mesozooplankton abundance, followed by a Cirripedia larvae (19%). The chaetognath *Sagitta* spp. and the tunicate *Oikopleura* spp. represented 5% and 6% of total mesozooplankton abundance, respectively. The total mesozooplankton abundance was very high at St. 1, with *Calanus glacialis*, *Pseudocalanus* spp., and *Cirripedia* larvae were more abundant than other regions. *Metridia longa*, *Calanus hyperboreus*, and *Paraeuchaeta barbata* dominated in the western part. *C. glacialis*, *Pseudocalanus* spp., and *Oithona* spp. were high at St. 1 of the southern part. With St. 1 excluded, mesozooplankton abundance was not significantly correlated with environmental factors (seawater temperature, salinity, and chlorophyll a concentration).

SEASONAL CHANGES IN MESOZOOPLANKTON SWIMMERS COLLECTED BY SEDIMENT TRAP MOORED IN THE WESTERN ARCTIC OCEAN

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In the Arctic Ocean, because of the seasonal ice coverage, little information is available for seasonal changes in zooplankton community structure and their life cycles. In the present study, we analyzed seasonal changes in zooplankton swimmer collected by sediment trap rotated with 13−15 day intervals moored at 180 m in Northwind Abyssal Plain during October 2010 to September 2011. Zooplankton flux ranged at 5−44 ind. m^{-2} day^{-1}, and was greater in September to October. Copepods were the most dominant taxa and composed 18−94% of number, followed by amphipods. Based on the zooplankton flux, cluster analysis (Bray-Curtis dissimilarity connected with unweighted pair group method using arithmetic mean) classified samples into three groups (A−C). Occurrence of each group showed clear seasonality: group A was observed during July to October, group B was seen in November to January and group C was at March to June. Each group was characterized with the dominance of different species. Thus, group A was characterized with *Gaidius brevispinus*, *Paraeuchaeta glacialis*, *Themisto libellula* and Barnacle larva, group B with *Mimonectes* sp. and group C with *Calanus hyperboreus* and Polychaeta. For the four dominant copepods (*C. hyperboreus*, *Metridia longa*, *Heterorhabdus norvegicus* and *P. glacialis*), their population structures varied with species. *C. hyperboreus* was predominated by C6F throughout the year, and their gonad development and mature specimen were only observed during February to May. These facts suggest that their reproduction is restricted at that season. For *M. longa* and *P. glacialis*, C6F dominated during January to May, and late copepodid stages (C4−C5) were abundant during June to October. *H. norvegicus* was dominated by C5 during November to February, C6F/M during March to May, and their early copepodid stages were seen in June and July. Such seasonality in population structure of the dominant copepods is considered to be a reflection of their life cycles. For the other special character, the Pacific copepod *Neocalanus cristatus* C5 occurred throughout the year, and was abundant especially during June to September, when the sea ice coverage area was the least. Through the analysis on zooplankton swimmer collected by sediment trap, this study revealed that the zooplankton community and their population structure in the western Arctic Ocean had clear seasonality, which would be related with the seasonal changes in sea ice coverage and their food.