The role of arctic melt ponds on primary productivity and macromolecular compositions

HO JUNG SONG AND SANG H. LEE[1]

[1]Department of Oceanography Pusan National University
strawpirate@pusan.ac.kr

The phytoplankton in melt ponds which are distinct features of summer Arctic sea ice provide an potential carbon source to marine ecosystems in the Arctic Ocean. Recently, global warming and thus sea ice changes might cause alterations in the spatial distribution as well as onset and termination of melt pond development. However, the ecological impacts of melt ponds according to these changes have rarely been studied in the Arctic Ocean. Using a ^{13}C-^{15}N dual stable isotope tracer technique, the carbon and nitrogen uptake rates of phytoplankton were measured at 36 total different melt ponds between 74-84 °N from three different cruises in 2005 (74-76 °N), 2008 (82-84 °N), and 2011 (77-78 °N) in the Arctic Ocean. To understand physiology of phytoplankton in melt ponds, the biochemical compositions (proteins, lipids, and carbohydrates) of particulate organic matters were analyzed at 10 different melt ponds during the 2011 cruise based on the methods of Lowry et al. (1951), Dubois et al. (1956), Blighr and Dyer (1959), and Marsh and Weinstein (1966). The average hourly carbon uptake rates of phytoplankton in melt ponds were 0.47 mg C m^{-3} h^{-1} (S.D. = ± 0.58 mg C m^{-3} h^{-1}), 0.09 mg C m^{-3} h^{-1} (S.D. = ± 0.11 mg C m^{-3} h^{-1}), and 0.18 mg C m^{-3} h^{-1} (S.D. = ± 0.31 mg C m^{-3} h^{-1}) for 2005, 2008, and 2011, respectively. The average hourly nitrogen uptake rates was highest in 2005 (mean ± S.D. = 0.27 ± 0.34 mg N m^{-3} h^{-1}) whereas lowest in 2008 (mean ± S.D. = 0.02 ± 0.02 mg N m^{-3} h^{-1}). Both carbon and nitrogen uptake rates in melt ponds showed a decreasing trend with increasing latitude. The most dominant components of phytoplankton in melt ponds were proteins which ranged from 20 to 61% (mean ± S.D. = 40 ± 13%), whereas the lowest contributions were carbohydrates ranging from 11 to 49% (mean ± S.D. = 25 ± 12%). Lipid composition of primary producer ranged from 25 to 46% (mean ± S.D. = 35 ± 8%). In comparison, the compositions of phytoplankton in adjacent water column ranged from 6 to 31% (mean ± S.D. = 15 ± 9%), from 37 to 62% (mean ± S.D. = 49 ± 8%), and from 22 to 53% (mean ± S.D. = 36 ± 9%), for proteins, lipids, and carbohydrates, respectively. The protein contributions of phytoplankton in the melt ponds were higher than those in the water column, which implies that melt ponds have a better nitrogen condition for phytoplankton growth.