Role of sea-ice crack formation on biological productivity and transport of biogeochemical components into sea ice

D. NOMURA[1]*, S. AOKI[2] AND D. SIMIZU[3]

[1] Faculty of Fisheries Sciences, Hokkaido University, Hakodate, Japan (*correspondence: daiki.nomura@fish.hokudai.ac.jp)

[2] Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan (shigeru@lowtem.hokudai.ac.jp)

[3] National Institute of Polar Research, Tokyo, Japan (shimizu.daisuke@npir.ac.jp)

Most floating ice in the polar oceans contains numerous cracks, which are formed naturally and are common features of floating ice. In this study, a sea-ice crack in Antarctic land-fast sea ice was examined to assess its impact on biological productivity and the transport of biogeochemical components into the upper layers of neighboring sea ice. The water inside the crack and proximate ice were characterized by an intense brown color, an indication that a massive phytoplankton bloom had occurred within the crack water. Salinity and oxygen-isotopic-ratio measurements confirmed that 64–84% of the crack water consisted of snow meltwater supplied during the melting season. Measurements of biogeochemical components within the slush-layer pool (the flooded layer at the snow–ice interface) immediately above the sea ice revealed the intrusion of water from the crack, likely forced by mixing with underlying seawater during the tidal cycle. Our results suggest that sea-ice crack formation provides conditions favorable for phytoplankton blooms by directly exposing the crack water to sunlight, supplying nutrients from the under-ice water, and stratifying the water in the crack. Subsequently, components of the crack water modified by biological activity were transported into the upper layer of the sea ice, where they were preserved in the multi-year ice column formed by upward growth of sea ice caused by snow-ice formation in areas of significant snow accumulation.