Temporal changes in protist fluxes during sea ice melt off Wilkes land, East Antarctica

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Seasonal Ice Zone (SIZ) is one of the most important area of the Southern Ocean ecosystem. Sea ice, which regulate environmental conditions (e.g. light penetration and iron supply) in SIZ, strongly affect primary production (Smith and Nelson 1985; Lancelot et al. 2009) and material cycling through the food web. The relationships between surface environments and the biological pump has usually been investigated by using sediment traps attached to a mooring. However, in the Southern Ocean, mooring observation could not cover the surface environment due to the existence of icebergs. In this study, we conducted a drifter observation using a newly developed ice-resistant GPS buoy to understand the relationship between surface environment and the protist composition in sinking particles during sea ice melt.

Deployment (December 9, 2019) and retrieval (February 16, 2020) of the drifter were conducted from the icebreaker *Shirase* under the 61st Japanese Antarctic Expedition. Sinking particles were collected at depths of 60 m and 150 m by time-series sediment traps. Water temperature, salinity, Photosynthetically Active Radiation (PAR), and chlorophyll fluorescence were measured using sensors placed at multiple depths (0, 10, 20, 30, 40 m). CTD observations were made when the drifter was deployed and retrieved, and seawater samples at each depth were collected by a bucket and Niskin bottles. Sea ice around the vessel was collected when the drifter was deployed. A similar observation was also conducted near the path of the drifter on January 22, 2020 during the *Umitaka-maru* cruise (Takahashi et al. 2022). Samples of seawater, sea ice, and sinking particles were fixed using neutral Lugol-iodine solution. Composition and flux of protist were analyzed using an inverted microscope.

Sea ice concentration was almost 100% when the buoy was deployed, then rapidly decreased from December 27 to January 5, finally reaching 0% on January 12. PAR increased with decreasing sea ice concentration. During the period, a peak of chlorophyll fluorescence was found at 20 m, and then, shifted to deeper depths. The chlorophyll fluorescence peaks were always found in pycnocline, which existed below the euphotic layer, suggesting that they were caused by phytoplankton accumulation rather than their production at the pycnocline. Nanoflagellates (mainly *Phaeocystis antarctica*) and *Fragilariopsis cylindrus* were dominant protists in sinking particles. Cluster analysis using the protist composition of sinking particles, seawater, and sea ice showed that the composition in sinking particles was divided into two clusters, one similar to seawater and the other similar to sea ice. Cluster A is a cluster whose protist composition is similar to sea ice, and Cluster B is a cluster whose protist composition is similar to seawater. Of the clusters in Cluster B, those that resemble seawater were classified as Cluster B1. The composition in sinking particles was similar to that of seawater before the sea ice melted and became similar to that of sea ice during the period of rapid sea ice melting. Therefore, organisms released from sea ice settle faster and are expected to contribute to the flux during the period of sea ice melting.

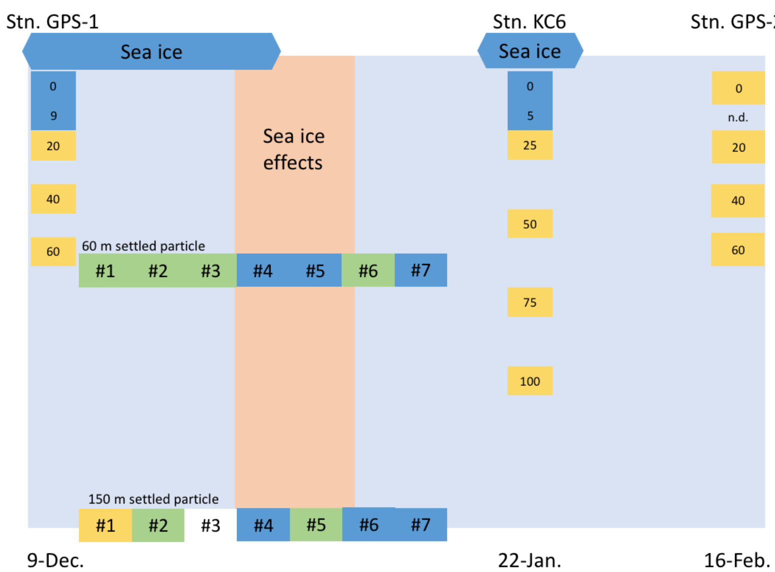

Fig.1. Schematic diagram of results of cluster analysis.

Cluster A: Clusters similar to the protist composition in sea ice

Cluster B: Clusters similar to the protist composition in sea water

B1: Groups with composition similar to seawater, especially

B2: Groups of similar composition to seawater that are common in settled particles

Stn. GPS-1: GPS buoy deployment point

Stn. GPS-2: GPS buoy retrieval point

Stn. KC6: Observation point by *umitaka_maru*

Cluster A

Cluster B1

Cluster B2