Particulate organic matters in sea ice floe in the Indian sector of the Southern Ocean

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The Seasonal Ice Zone (SIZ) covers broad area in the Southern Ocean. Various organisms live in this area have a life cycle strategies closely related with sea ice dynamics. For example, sea ice is the important habitat for protozoans and small metazoans, and ice algal production accounting ca. 10% of total primary production in this area. Ice edge blooms are also important event not only for primary producer but also various consumers whose growth and/or reproduction largely depend on this event. On the other hand, occurrence of the ice edge bloom is quite heterogeneous compared to that of filter feeding consumers mainly depend on primary production. We hypothesize, therefore, alternative food sources other than ice edge production, e.g. particulate organic matters (POM) in the sea ice, could explain the gap. POM contents in sea ice have been investigated by a number of previous studies, but most of them conducted using ice cores collected from large ice floes or fast ice mainly in coastal area.

Field samplings were conducted in Indian sector of the Southern Ocean during the Antarctic cruises of the training vessel (TV) *Umitaka-maru* of the Tokyo University of Marine Science and Technology (2015/16, 2016/17, 2017/18, 2018/19 and 2019/20), the cruise of the icebreaker *Shirase* (2015/16, 2017/18, and 2019/20), and the cruses of *RV Hakuho-maru* (2018/19 and 2019/20). Sea ice floes in the marginal ice zone were collected by using a stainless steel basket (50 × 60 × 20 cm) or a large ring net frame (1.6 m diameter) with an attached canvas. In most case, surrounding water was also collected for measuring chlorophyll *a*, macro-nutrients and particulate organic carbon and nitrogen using the pump-underway ship intake system (intakes were located 5-9 m depth). Sea ice samples were kept in freezer, and then melted at 4°C in dark. For measuring chlorophyll *a*, sea ice was melted with addition of filtered sea water (sea ice:filtered sea water = 1:9, w/w).

Particulate organic carbon (POC), particulate organic nitrogen (PON) and Chl. *a* in sea ice was 1368±1008 mg C m^{-3} (n = 155), 121±125 mg N m^{-3} and 17±41 mg m^{-3}, respectively (Fig. 1). The carbon:chlorophyll ratio usually quite high compared to the traditional of phytoplankton (Fig. 2). In addition, C/N ratio was also high (14.1±5.8). These results suggest that high carbon contents in the sea ice floes were mainly caused by detrital materials rather than living organisms, such as ice algae and the other microorganisms. The high POC contents with low variability compared to Chl. *a* implies that such detrital POC input from sea ice to upper water column could contribute as stable food source for zooplankton community in MIZ.

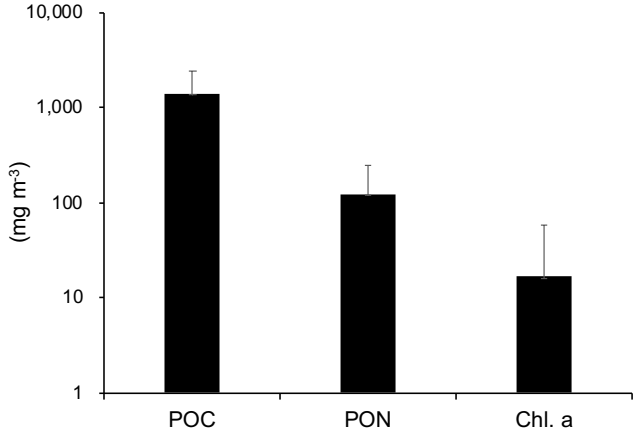

Fig. 1. Mean particulate organic carbon (POC) , nitrogen (PON), and Chlorophyll *a* (Chl. *a*) in collected sea ice flows. error bars show standard deviation.

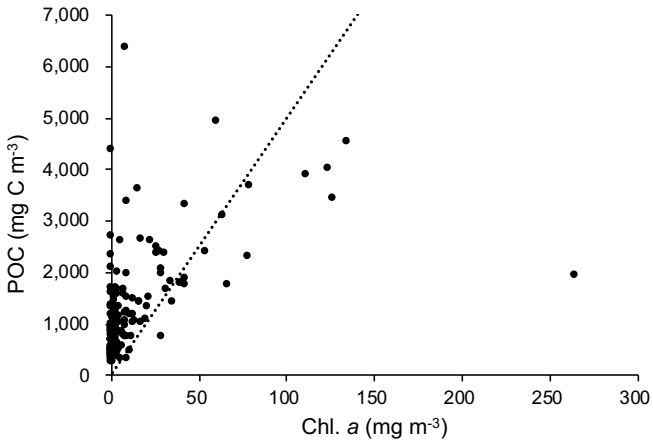

Fig. 2. Chlorophyll *a* (Chl. *a*) and particulate organic carbon (POC) in sea ice flows. A dashed line shows carbon:chlorophyll ratio = 50.