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ABSTRACT Subject :

Shifts in microbe-mediated organic matter degradation patterns in relation to sea-ice dynamics in a coastal area of the Ross Sea

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The Ross Sea is one of the most productive areas of the Southern Ocean and plays an important role in biogeochemical cycles. Significant yet variable changes in sea-ice cover extent have been observed in the recent past and these are expected to continue in the light of the ongoing and future global climate scenarios. The consequences of such sea-ice dynamics have been mainly focused on phytoplankton with cross-food web links from krill to large vertebrates, neglecting the response of microbial food webs. Aiming to fill this gap in the framework of a multidisciplinary investigation, we assessed microbially mediated hydrolysis rates of carbohydrates, lipids, sulphate esters and proteins, along a three-station coast-offshore transect in Tethys Bay (Terra Nova Bay) from early November 2022 to late January 2023. Sampling was carried out on a quasi-weekly basis, aiming to cover a wide array of physical-chemical, as well as trophic, conditions in relation to sea-ice dynamics. In early November, at the beginning of the sampling period, all three stations were covered by sea-ice and characterized by generally low carbohydrate, lipid and protein hydrolysis rates (<2 nM h-1, <20 nM h-1 and <15 nM h-1, respectively). Following sea-ice fragmentation, lipase and aminopeptidase activities abruptly increased (>200 nM h-1 and >70 nM h-1, respectively), while carbohydrates degradation rates remained relatively slower, suggesting that carbon mobilization following sea-ice melting occurred primarily through lipid rather than polysaccharide pools. By late January, lipase activity was comparable to values measured during the sea-ice cover period, while carbohydrate degradation rates increased. This pattern may be explained by the development of a massive Phaeocystis sp. bloom in late December which represented a source of freshly produced carbohydrates for the heterotrophic microbial assemblages. Sulphatase activity was a notable exception to the general pattern observed for the other exoenzymes, with higher rates under sea-ice cover conditions and a barely detectable signal during and after sea-ice fragmentation and algal bloom development. While data on sulphate esters degradation assessed through fluorogenic substrate analogues are scarce in pelagic ecosystems, there is evidence of the inducibility of this enzyme under low sulphur concentrations. Considering that Phaeocystis sp. copiously produces S-rich molecules during bloom conditions, it is plausible that sulphatase expression may have been reduced in response to this readily available sulphur source. These preliminary data shine a light on organic matter degradation dynamics under different regimes of sea-ice cover, providing insights into the functioning of the microbial food webs during the transition between sea-ice fragmentation and algal bloom development.