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Editorial: Ecology of marine zooplankton and micronekton in polar and sub-polar areas

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Editorial on the Research Topic
Ecology of marine zooplankton and micronekton in polar and sub-polar areas

Introduction

As reported by Azam et al. (2017) the polar and subpolar regions are characterized by ecosystems with high biodiversity and species richness. Hunt et al. (2016) highlighted that the variability among polar ecosystems, such as sea ice cover and thickness, population structure, abundance, diversity and food web, from phytoplankton to marine mammals, is due to the different circulation patterns of water masses between north and south. Huge environmental changes have been induced in those areas by a high climate dynamic, which has generated loss of biodiversity and consequent reduction of ecosystem services provided to the entire planet (Laffoley and Baxter, 2016). In this context, much attention was paid to the effects of these environmental changes on zooplankton structure and dynamics, and consequently on the matter and energy cycling in polar ecosystems, as also demonstrated by the results of La et al. (2019) on how climate changes can alter the zooplankton vertical migration (DVM) in the Southern Ocean. The high vulnerability of these ecosystems, in the presence of pressures such as climate change and overfishing, jeopardizes the essential ecosystem services they provide, e.g. in terms of carbon storage and suitable habitats for nursing and feeding (Azam et al., 2017; Johnston et al., 2022). The polar ecosystem presents high spatial variability in terms of the rate and direction of change in temperature and sea ice, but little is known about the mechanisms through which the spatial distribution of planktonic species is influenced (Yang et al., 2021). These changes appear to impact circumpolar food webs involving krill and other zooplankton. It follows that knowledge of the density and distribution of zooplankton is crucial to correctly estimate the energy transfer within the food web of the continental shelf and its response to climate change (Minutoli et al., 2024). In turn, ocean warming can have a significant impact on the structure and functioning of zooplankton (Fraser et al., 2023; Swadling et al., 2023).

Summary of the topic papers

With this Research Topic, many researchers involved in the study of zooplankton and micronekton ecology have had the opportunity to provide updated data on their latest research in polar and subpolar environments. Therefore, their results will certainly contribute to improving the state of knowledge on polar ecology in these still poorly understood areas, which require urgent and significant operations to prevent and to mitigate, as soon as possible, the effects of climate change on ecosystems.

In this Research Topic, 11 papers by 74 authors collaboratively address issues related to the zooplankton and micronekton spatial distribution, biomass, production, diel vertical migration, trophic relationships, and effects of climate change both in Antarctica (5 papers) and in the Arctic (6 papers). Two papers carried out by echosurvey in the Ross Sea concerned the spatial distribution of the biomass both in the crystal (*E. crystallorophias*) and Antarctic krill (*E. superba*). In particular, the authors focused their study on the possible impact of water masses on the vertical krill structure in different sectors of the Ross Sea, from Terra Nova Bay to Cape Adare. Barra et al. also emphasized the need to carry out multidisciplinary research campaigns for a better and more complete interpretation of the results, while De Felice et al. gave significant importance to salinity and the predator-prey relationship. Attention to the water mass structure and to biotic and abiotic variables in determining the composition of zooplankton communities characterized the study by Liu et al. The authors compared the abundance and biodiversity data from the surface down to 1500 m among samples collected in the East Pacific and the Indian sectors of the Southern Ocean. The study on phytoplankton carried out by Liu et al. on a grid of stations located around the South Shetland Islands, along the Antarctic Peninsula, highlighted the importance of some environmental factors such as temperature and ice concentration, in determining the structure of phytoplankton communities. A direct relationship between pennate diatoms and krill was highlighted by multivariate analysis. The study by Chen et al. on the composition and diversity of heterotrophic flagellates in the western Cosmonaut Sea highlighted the remarkable abundance of this community in the euphotic zone and a strong correlation between environmental factors and taxonomic distribution. Most studies carried out in different areas of the Arctic have highlighted the effects of climate change on zooplankton, and in particular on copepods. Espinel-Velasco et al. focused on the potential implications that ocean acidification and warming may have on Arctic populations of calanoid copepods, with possible consequences on the entire food-web. The results of Gawinski et al. added among the climate variables also the reduction of Arctic sea ice as an effect on small-sized copepods, with cascading consequences on secondary production. Hop et al. studied the abundance of zooplankton communities at four glacier fronts in Kongsfjorden, Svalbard and concluded that under current conditions of global warming these glaciers could act as an "elevator effect" of prey (zooplankton) thus facilitating the feeding of predators, and particularly seabirds. The results of Ishihara et al. on the ecology, trophodynamics, and fatty acid composition of the copepod *C. glacialis/marshallae* in the Eastern and Northeastern Chukchi and Canadian basins, highlighted the adaptation of this species to climate changes in the Pacific Arctic Ocean. Kumagai et al., examining the zooplankton size spectra demonstrate that in the northern Bering Sea an optimal and efficient predator-prey relationship is established between zooplankton and fish larvae/juveniles. Kim et al. note the uncommon presence of ichthyoplankton species into the Chukchi Sea, attributing this "anomaly" to several climatic factors including freshwater inflow from the East Siberian Sea and the intrusion of warm Atlantic and Pacific waters.

Gaps and perspectives

The global importance of the rich, unique and valuable biodiversity in the polar and subpolar ecosystems on which it depends has been recognized internationally. Unfortunately, it has been established that these ecosystems have already been affected by the physical and chemical impacts due to global change. For this reason, the international scientific community has recently recognized that an integrated multidisciplinary approach is needed to better understand the functioning of these vulnerable ecosystems, with particular interest in the carbon cycle to clarify the response of zooplankton to climate change (e.g. Everett et al., 2017; Hill et al., 2024; Ratnarajah et al., 2023).The importance of considering biological interactions in planktonic studies has been highlighted, employing open access and machine learning for measurable and repeatable distribution modeling and providing crucial ecological insights for informed conservation strategies in the face of environmental change (Grillo et al., 2022, 2024).

Author contributions

LG: Writing – review & editing, Writing – original draft. AB: Writing – review & editing, Writing – original draft. GY: Writing – review & editing, Writing – original draft. AG: Writing – review & editing, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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