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# Editorial: Zooplankton and nekton: gatekeepers of the biological pump, volume II

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Editorial on the Research Topic
Zooplankton and nekton: gatekeepers of the biological pump, volume II

Zooplankton and nekton organisms play multifaceted roles in marine ecosystems and are integral components of the ocean's food web. By consuming a wide range of planktonic organisms and detrital matter, they directly impact the size-distribution of particles in the ocean by breaking large aggregates down to smaller fragments and by repackaging single phytoplankton cells into dense fecal pellets. Many zooplankton and nekton organisms also conduct diel vertical migrations (DVM). They ascend to the surface layer of the ocean at dusk to feed during the dark hours and return to midwater depths at dawn to hide from visual predation. As they metabolize and excrete organic material in deeper waters, they contribute to an "active flux" of carbon and nutrients. This active flux can have a substantial impact on the functioning of the biological pump — the process responsible for the downward export of carbon and nutrients into the ocean's interior. In essence, zooplankton and nekton are gatekeepers of the biological pump via their diverse roles in particle dynamics, from consumption and fragmentation to the active transport of organic matter. Understanding these roles is critical for unraveling the complex mechanisms that govern the health and functioning of marine ecosystems, as well as for improving our models of global biogeochemical processes in the world's oceans.

Mooney et al. studied the seasonal impact of the 200 µm large copepod *Microsetella norvegica* on carbon export in a subarctic fjord. They determined the vertical distribution and abundance of *M. norvegica* and marine snow at different locations and seasons and then used previously observed feeding behavior of *M. norvegica* to estimate their potential contribution to flux attenuation. *M. norvegica* showed a shift in its feeding behavior, with a preference for diatoms during productive seasons and a preference for marine snow and detritus during the polar night. *M. norvegica* only had a modest contribution to the total carbon flux attenuation, but still fed on settling aggregates and detritus during periods with low productivity, thereby acting as a secondary producer, which converts detritus to eukaryotic biomass, making these tiny copepods an important part of the Arctic ecosystem.

Chawarski et al. used hydroacoustics to study the mesopelagic distribution of macrozooplankton and nekton across polar fronts in the Arctic and Southern Ocean. At low latitudes, the mesopelagic ocean (depths between 200 and 1000 m) hosts a diverse variety of fish and zooplankton. Many zooplankton and nekton organisms spend their day-time within a depth-layer of a few hundred meters, typically between 300 m and 600 m. This aggregation reflects hydroacoustic signals as deep-scattering layers. Chawarski et al. observed that these layers disappear when crossing the polar fronts towards the poles, suggesting a more even vertical distribution of zooplankton and fish at high latitudes. Furthermore, net sampling showed that polar oceans had lower biodiversity and biomass of zooplankton and fish in the mesopelagic. Chawarski et al. suggest that temperature differences associated with polar fronts are the driving factor to explain the distribution patterns and that warming of the polar oceans and shifts of the polar fronts may increase the habitat, biodiversity and abundance of mesopelagic fish and zooplankton.

Dias Fernandes de Oliveira et al. assessed how diversity, in its many forms, influences the biogeochemical role of zooplankton in the ocean. They visually identified and enumerated the calanoid copepods from two tows in the subtropical South Atlantic (0-800 m depth), then split them into different functional groups based on their diel migration depth and patterns. Using a novel approach, where they calculated the percentage of the total community associated with a functional group based on taxonomic clustering, they then calculated both the active and passive flux using allometric estimates of respiration, ingestion and egestion. Different migratory functional groups had substantially different ecological roles, some driving the recycling of near-surface nutrients, while others contributed to carbon sequestration via active transport. The authors emphasize the need for inclusion of functional groups, and a transition away from biomass based analyses of day/night epipelagic tows, to better understand the cycling of nutrients via zooplankton.

Observational biological oceanographers have long been realizing that quantitative sampling of pelagic organisms across a wide size range requires a combination of targeted gear. Kwong et al. compared three relatively similar nets, all targeting micronekton, and based upon these catches estimated carbon flux contribution by the different taxa. Estimates of total active carbon transport were significantly lower when using the Hokkaido University frame trawl (HUFT) compared to the Isaacs–Kidd midwater trawl (IKMT), and differences in active carbon transport across gears were primarily driven by size-based sampling biases. The authors emphasize the challenges of using a single micronekton sampling gear to estimate active carbon transport, and suggest overlapping gear to quantitatively sample even across the micronekton group (adding to the already identified need for different observational methods for micro-, meso-, and macrozooplankton).

A general theme from all contributions to volume I and volume II of the "Gatekeepers" Research Topics is the need for size- and/or weight-specific parameterizations to estimate biomass, gut flux, mortality, predation potential, excretion, respiration or flux-interception potential. Efforts should be strengthened to collect, synthesize and compare these parameters. Another focus of the research community needs to be on the further adoption of the FAIR principles for data publication (Findable, Accessible, Interoperable, Reusable) and the subsequent aggregation of zooplankton and nekton distribution data across studies. Such efforts will enable modeling studies and model assessments, which could yield a more comprehensive understanding of the role of zooplankton and nekton as essential components of the biological pump.

## Author contributions

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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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