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Editorial: Changing Plankton Communities: Causes, Effects and Consequences

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Editorial on the Research Topic

Changing Plankton Communities: Causes, Effects and Consequences

Marine ecosystems are changing in response to multiple stressors such as global warming, increasing carbon dioxide (CO_2) and decreasing oxygen (O_2) concentrations and eutrophication of coastal waters, among others. The direct effects of these changes on plankton physiology have been studied for decades; less are known about possible effects these changes might have on the composition of plankton communities, and even less about what effects any such shift in plankton community composition will have on marine ecosystems. The plankton community makes up the base of the marine food web (i.e., primary producers, decomposers, and primary consumers) and plays a pivotal role in global biogeochemical cycles (e.g., Falkowski and Raven, 2013). Any change of the plankton community structure, driven by natural or human induced changes, may consequently have indirect effects on marine ecosystem functioning.

This Research Topic focused on causes, effects and consequences of changing composition of plankton communities. The 12 contributions to this volume include seven original research papers, one method paper, and four reviews; all touching the state-of-the-art in current plankton research, and each from a complementary angle.

Several of the original research papers deal with changing phytoplankton communities, environmental drivers and ecosystem effects. Fernández-Méndez et al. analyzed sea-ice ridges and the snow-ice interface, which are algal hotspots in the Arctic Ocean. Both sea-ice ridges and the snow-ice interface are projected to increase due to thinning of the ice, and Fernández-Méndez et al. described the algal communities, mostly dominated by different diatoms, in these habitats in the Arctic. von Scheibner et al. examined the phytoplankton and bacterioplankton response to short-term warming. Warming increased carbon availability for the bacterial community, but the ratio between bacterial and primary production was still relatively low, suggesting it is not much changed by short-term warming events. Cohen et al. described diatom transcriptional and physiological responses to changes in iron availability in the open Northeast Pacific Ocean and in the California upwelling system. They found species specific differences in gene expression to changes in nutrient availability and taxa specific strategies for coping with Fe stress. Ajani et al. investigated the realized niches of phytoplankton using a long-term data set collected off Eastern Australia. They demonstrated that the ecological niches can be dynamic and that climate change models cannot use fixed niches when forecasting the phytoplankton community composition.

There are three original research papers on zooplankton dynamics. Lips and Lips investigated the increasing importance of the mixotrophic ciliate *Mesodinium rubrum* in the Baltic Sea. The abundance of this species was higher in years of earlier warming and the authors suggest that it plays an important role in shaping the inorganic nutrient pools at the start of the summer (Lips and Lips). Haraguchi et al. studied the coupling between phytoplankton and ciliates in Danish waters over 2 years, and demonstrated a close coupling between these communities, suggesting top down control of the phytoplankton community by the ciliates. Karlsson and Winder examined ecosystem effects of two locally adapted populations of the filter feeding copepod *Eurytemora affinis* that differed in size. They demonstrated that morphologically divergent populations of the same species can perform different ecosystem functions through differences in quantitative and qualitative feeding, and by having different population response to changes in resource supply and the phytoplankton community composition.

In the method paper by Engel et al., they tested three different ways to manipulate species loss in natural phytoplankton communities. Dilution, filtration, and heat stress was used to remove rare, large and sensitive species, respectively, and this can be used as a method for non-random species manipulation in experiments. The majority of research on species loss has used the approach of random species removal, which may not be a suitable approach for studies of fragile species. The method development and standardization of approaches suggested by Engel et al. are essential for more realistic species loss modeling.

The review papers covered different aspects of plankton dynamics and trait-based approaches. Lindh and Pinhassi presented a comprehensive review of bacterioplankton communities in the Baltic Sea and environmental drivers for community changes based on field and experimental studies. Bartoli et al. reviewed the drivers of cyanobacterial blooms in the Curonian Lagoon (Baltic Sea), where cyanobacteria has benefitted from long term increase in the temperature and reduction in the inorganic N:P ratio. A comparison of the differences between freshwater and marine studies of phytoplankton traits and community assembly is presented by Weithoff and Beisner. Finally, Spilling et al. reviewed and synthesize state-of-the-art knowledge on the observed, long-term increase in dinoflagellate abundance in the Baltic Sea during spring bloom and the consequences the shift from diatom to dinoflagellate dominance has for biogeochemical cycles.

The topics of the papers published in this Research Topic ranged from heterotrophic bacteria, phytoplankton to zooplankton and covered different marine ecosystems. The potential shift in community composition may have dramatic effects on ecosystem functioning, for example on trophic transfer, and on biogeochemical fluxes through changes in export of organic material, i.e., the biological pump. One of the key challenges for predicting changes to the plankton community is to understand the various functional groups and their niche separation in combination with individual taxa's ability to acclimate, adapt and compete in a changing environment. This trait-based community ecology of plankton has started to gain traction (Litchman and Klausmeier, 2008; Litchman et al., 2013), and is a useful framework to investigate potential effects of environmental change on plankton community structure. In order to disentangle the potential consequences of shifts in plankton communities, more empirical studies of ecological interactions and export are needed. Hence, we consider the research papers in this Research Topic will be a valuable addition to the accumulating empirical evidence of how plankton communities are modulated by natural and human induced changes and the indirect effect this has on marine ecosystems.

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All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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