Theme Session O Report 2024

From microbes to zooplankton: Forecasting ecosystem dynamics in a changing ocean

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Introduction

Marine microbes and plankton play a crucial role in regulating oceanic ecological processes. The biodiversity of plankton can influence ecological functions and services across various spatial and temporal scales. Although our understanding of marine ecosystems has improved over the past decade, research remains skewed toward charismatic species and those of economic significance. As climate change and human activities push many species toward their tolerance limits, the lack of baseline data for much of marine microbial life leaves these organisms vulnerable and under-researched at a critical juncture. Shifts in the range and composition of microscopic life often serve as indicators of the responses of larger organisms, highlighting the importance of monitoring these often-overlooked microbial communities and plankton.

This theme session provided an opportunity to discuss diverse aspects of research on the smallest life forms in our oceans. The focus was to explore the latest research on marine microbes and plankton in the context of ecosystem dynamics. Key objectives included reviewing methods for identifying and quantifying uncertainty in microbial communities, assessing phyto-/zooplankton distribution patterns, discussing best practices for time series data, and comparing models to better forecast potential changes in ecosystem dynamics. Topics covered included the adaptations and acclimatization of microbial and plankton communities in response to changing ocean variables; the impacts of marine microbes and plankton on ecological processes, such as biogeochemical recycling, the biological carbon pump, biophysical interactions, and trophic level interactions; and the monitoring of biodiversity and community dynamics in microbial and plankton communities through time series and environmental data.

Session synopsis

Our theme session provided a platform to discuss recent research on marine microbes and plankton within ecosystem dynamics. Topics covered included the drivers of zooplankton distribution, such as food supply (plankton availability), prey size, predation, and environmental factors like light and temperature.

Presentations underscored the importance of the rate of environmental change in determining zooplankton survival in changing oceans. For example, predation pressure on large, lipid-rich copepods was examined through mechanistic modelling combined with analyses of extensive copepod and fish stomach data, revealing the impact of predation on copepod distribution. Presentations also illustrated the roles of topography and light structures in influencing predation risk. The survival and growth of another commercially important species, bluefin tuna, were further explored, with findings showing how successful exploitation of rare food sources in oligotrophic spawning areas supports rapid growth, though this may change under high temperatures.

Changes in coastal environments, such as the impacts of coastal darkening on food webs, were also highlighted. Long-term time series and environmental monitoring were discussed as valuable tools for tracking zooplankton biodiversity and community dynamics, with effects on higher trophic levels revealed. While the session addressed zooplankton adaptations and acclimatization to changing ocean conditions, as well as biophysical and trophic interactions, it gave less attention to the roles of marine microbes and phytoplankton in ecological processes like biogeochemical recycling and the biological

carbon pump. This lack of focus on marine microbes and phytoplankton emphasizes the difficulties in integrating these organisms into food web models alongside higher trophic levels.

The importance of curating and creating an open-access database from plankton surveys was also discussed. Although long-term time series data from plankton surveys are available in the North Sea, they are often neither curated nor open-access. Open-access, long-term time series data would enhance collaboration, facilitate efficient data sharing, and enable validation of phytoplankton-zooplankton-fisheries models, all of which are essential for understanding marine microbe and plankton impacts on higher trophic levels. While the session largely met its expectations, additional contributions linking the importance of microbial food webs to higher trophic levels would be beneficial.

Conclusion

This session provided a platform to explore various facets of research on the ocean's smallest organisms, including reviewing top-down and bottom-up approaches for zooplankton dynamics, long-term time series for monitoring zooplankton distribution and abundance, techniques for identifying and quantifying uncertainties in zooplankton communities, and model comparisons to improve predictions of potential changes in ecosystem dynamics. We emphasize the importance of curating long-term time series data as open-access resources and recommend further studies linking marine microbes, phytoplankton, and zooplankton to develop a holistic understanding of the food web base in our changing oceans.