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Editorial: The response of microalgae and plankton to climate change and human activities

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Editorial on the Research Topic
The response of microalgae and plankton to climate change and human activities

This special Research Topic is dedicated to exploring the responses of microalgae and plankton to climate change and human-induced environmental alterations. Encompassing disciplines such as ecology, environmental science, marine biology, and biogeochemistry, this Research Topic reflects the intricate and pressing nature of this interdisciplinary field.

Microalgae and plankton are integral to the stability and health of global marine ecosystems. They form the foundation of aquatic food webs, contribute to climate regulation through carbon dioxide absorption, and support biodiversity. Yet, these organisms face unprecedented challenges due to climate change and anthropogenic factors including ocean acidification, rising temperatures, hypoxia, and coastal eutrophication, which profoundly affect their community dynamics and ecological functions (Di Pane et al., 2022). Current knowledge on the mechanisms of microalgae and plankton community response to these changing environmental conditions remains limited. Ocean acidification, a direct consequence of increased CO2 emissions, is altering the carbonate chemistry of marine waters, affecting calcifying organisms and disrupting marine food webs (Doney et al., 2020). Rising ocean temperatures are causing shifts in the distribution of microalgae and plankton species, with poleward movements observed in various regions, indicating changes in oceanic ecosystems (Benedetti et al., 2021). Eutrophication, primarily driven by agricultural runoff and urban wastewater, triggers harmful algal blooms (Glibert, 2020; Kang et al., 2022). These blooms, upon decomposition, disrupt the food chain, leading to the demise of higher trophic level marine animals, and can even pose risks to human health (Liu et al., 2020). Furthermore, hypoxia, resulting from eutrophication and increased stratification of water bodies, leads to the formation of dead zones where marine life struggles to survive, posing a significant threat, especially in coastal and estuarine areas (Wallace and Gobler, 2021). These

alterations affect not only the biodiversity and functioning of marine ecosystems but also have socio-economic implications, particularly for fisheries and aquaculturethat rely heavily on the health of planktonic communities (Doney et al., 2020). Recent research has shed light on the adaptive responses of microalgae and plankton to environmental stressors. Some species demonstrate resilience by adapting their life cycles and physiological processes (Kholssi et al., 2023). However, the long-term implications of these adaptations are still not fully understood. The complexity of interactions between various stressors, such as the combined effects of acidification, warming, and deoxygenation, presents a challenge in predicting the future of these crucial organisms (Doney et al., 2020). In light of these challenges, this Research Topic aims to provide current knowledge on the impact of climate change and human activities on microalgae and plankton. By bringing together studies from diverse geographical regions and ecological contexts, we aim to develop a comprehensive understanding of how these organisms are responding to global environmental changes. This understanding is crucial for developing effective conservation and management strategies to protect and sustain marine ecosystems in a rapidly changing world.

In this Research Topic, 11 papers collaboratively address the multifaceted effects of environmental changes on microalgae and plankton. Key themes include the historical context, ecological sensitivity, and adaptive responses of these organisms.

Several papers focus on historical and regional studies: The first article explores the diatom distribution in Holocene sediments in the West Caroline Basin, offering paleoceanographic insights (Chen et al.). The third paper is related to nanophytoplankton and microphytoplankton in the Western Tropical Pacific Ocean and enhances our understanding of phytoplankton community structures and carbon biomass (Yan et al.). The eighth paper, focusing on planktonic protist Communities in the Jeju Strait, uncovers the complex dynamics and species interactions within these communities (Min and Kim). The tenth paper and analyzes the phytoplankton spring succession patterns in the Yellow Sea, and links these patterns to environmental factors (Hyun et al.).

The vulnerability and adaptive responses of marine organisms to current environmental stressors are central to other papers. The second article investigated the Southern Ocean pteropods' life cycles and discusses the sensitivity of Southern Ocean pteropods to ocean acidification and climate change (Gardner et al.), while the fifth paper examines the warming adaptation of the coccolithophore *Emiliania huxleyi*, highlighting its limited adaptation over 800 generations (Zhou et al.). The seventh paper focuses on the shift in the photophysiology of sea ice algae in response to salinity changes, pertinent to Arctic freshening (Forgereau et al.).

The impact of human activities is also a significant theme. The fourth paper investigates the effects of shellfish aquaculture on phytoplankton, revealing complex interactions between human practices and marine ecosystems (Mo et al.). The ninth article delves into the harmful algal species *Heterosigma akashiwo*, providing insights into the mechanisms of harmful algal blooms (Giesler et al.).

Furthermore, two papers emphasize monitoring and detection techniques as vital tools in marine ecology. The sixth paper stresses the importance of monitoring chlorophyll *a* concentration in the China Sea as an indicator of marine ecological health and its implications for fisheries (Zhang et al.). The eleventh and final article introduces a novel approach for detecting anomalies in phytoplankton populations, a crucial step in understanding the impacts of environmental changes (Ciranni et al.).

These contributions not only deepen our understanding of microalgae and plankton responses to environmental changes but also offer critical insights for future research directions and management strategies. This compilation underscores the vital role of interdisciplinary efforts in advancing our knowledge and addressing challenges within global marine ecosystems. We trust that this Research Topic will spark further dialogue, investigation, and innovation in the pursuit of sustainable solutions for marine environmental issues.

Author contributions

ZL: Writing – original draft, Writing – review & editing. KH: Writing – review & editing. YZ: Writing – review & editing. HM: Writing – review & editing.

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