Physical Influences on Phytoplankton Community Structure off Sanriku in the Northwestern Pacific

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Recent years have witnessed pronounced physical and ecological changes in the Northwestern Pacific, including anomalous behavior of the Kuroshio and its extension, intensified marine heatwaves, and shifts in marine ecosystems. Off Sanriku, located in the Kuroshio–Oyashio Confluence Region, phytoplankton dynamics are strongly influenced by mesoscale and frontal processes, yet their impacts on community structure and material transport remain insufficiently understood.
In this study, we investigate the spatial and temporal variability of phytoplankton community composition off Sanriku and its linkage to physical oceanographic processes. Building on previous ship-based high-resolution Bio-UCTD observations and measurements obtained using the Multi-Exciter (MEX), a multi-wavelength excitation fluorometer, during spring blooms, we extend the analysis using satellite ocean color–based phytoplankton functional type (PFT) products. The results demonstrate that the distribution of dominant phytoplankton groups varies markedly in response to physical environments such as frontal zones, warm-core rings, and surface thermal variability.
Diatom-dominated assemblages formed blooms in Oyashio-influenced waters and exhibited signatures consistent with gravitational sinking and deep vertical transport. In contrast, blooms of other eukaryotes and cyanobacteria in warm Kuroshio-associated waters tended to remain confined to the surface layer; however, in some cases, biomass was entrained into frontal subduction and transported to intermediate depths. These distinct transport pathways suggest that even when surface chlorophyll concentrations are comparable, differences in community composition may influence broader ecosystem functions, including trophic transfer and material cycling, as well as vertical carbon export mechanisms.
Our findings indicate that physical variability in the Northwestern Pacific reorganizes phytoplankton community structure and associated transport processes, rather than simply altering total biomass. This study highlights the importance of considering physical–biological coupling in understanding regional ecosystem variability and its linkage to broader-scale environmental change.

Keywords: Oyashio, Kuroshio, Phytoplankton, Community Structure

