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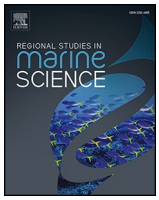

Diversity and distribution of micro-phytoplankton and harmful microalgae along the Malaysian coasts of Malacca Strait and South China Sea

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ABSTRACT

This study aims to examine the spatial distribution and diversity of micro-phytoplankton assemblages, with a particular focus on harmful microalgal species, in two different water masses of tropical Western Pacific, the Malacca Strait (MS) and the South China Sea (SCS). The synergetic responses of climate change and anthropogenic pressures in this region may lead to increase geographical expansion of harmful algal blooms. The micro-phytoplankton taxa were identified from 50 stations during a scientific research expedition in March 2022 and the *in situ* water parameters of temperature, salinity, pH, dissolved oxygen, macronutrients, and chlorophyll-*a* biomass were determined. Our results revealed 69 taxa (60 genera) of micro-phytoplankton, with *Chaetoceros*, *Coscinodiscus*, and *Skeletonema* predominately present throughout the study sites. High abundances of diatoms, either monospecific or multispecies co-dominance, were observed in environmental niche with high nutrient availability. While dinoflagellates, particularly the harmful species, such as *Alexandrium, Prorocentrum*, *Dinophysis*, *Akashiwo sanguinea*, *Karenia*, *Karlodinium*, *Margalefidinium*, and *Noctiluca scintillans*, were positively associated with higher ratios of nitrogen to phosphorus. Our findings indicated that spatial heterogeneity in micro-phytoplankton community and the prevalence of certain harmful microalgal species could be explained by the physicochemical environmental gradients in the region.

1. Introduction

Marine phytoplankton play a crucial role as the primary energy producers in the ocean, contributing approximately half of the global primary production (Falkowski et al., 1998; Baumert and Petzoldt, 2008). Changes in their abundance, community composition, and distribution patterns can profoundly influence trophic levels, impacting key biogeochemical processes (Litchman et al., 2007). Alterations in the composition and distribution of phytoplankton communities could inform the dynamics of aquatic ecosystems, as they respond rapidly to environmental fluctuations, which makes them valuable biotic indicators for assessing the eological status of marine ecosystems (Paerl et al., 2007). Diatoms and dinoflagellates represent the key groups of coastal phytoplankton. While diatoms are commonly linked to coastal blooms, environmental shifts may lead to a transition toward a dinoflagellate-dominanted community. The predominance of dinoflagellates often implies eutrophication. Diatoms tend to thrive in turbulent waters (Wyatt, 2014), whereas dinoflagellates favor warmer, stratified conditions with high nutrient availability (Smayda, 1998; Gilbert, 2016). They exhibit the ability for vertical migration to acquire nutrients (Smayda and Reynolds, 2001), and through mixotrophy or phagotrophy (Stoecker, 1999; Tillmann, 2003) they can exploit alternative food sources to gain a competitive edge over diatoms.

Anthropogenic activities, particularly in coastal region, have led to nutrient enrichment that often accompanied by shifts in nutrient ratios (Spatharis et al., 2007; McQuatters-Gollop et al., 2009). An unintended consequence of this eutrophication is the proliferation of some harmful microalgal species, also termed harmful algal blooms (HABs), which can severely disrupt aquatic ecosystem health (Hallegraeff, 2004; Glibert, 2017). HABs are generally classified into two categories: those caused by toxin-producing species, such as *Alexandrium* and *Pseudo-nitzschia*, which contaminate seafood and cause poisoning events in humans and other marine life, or toxins that directly kill marine organisms (Anderson, 1989; Hallegraeff, 1993; GlobalHAB, 2023), and those

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