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RESEARCH ARTICLE

Responses of phytoplankton community to eutrophication in Semerak Lagoon (Malaysia)

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Abstract

Effects of aquaculture activities on the environmental parameters and phytoplankton community structure were investigated in a semi-enclosed lagoon located at Semerak River, Malaysia. Elevated concentrations of phosphate and ammonia were observed at the aquaculture area and the inner lagoon. Relatively low dissolved oxygen, high total chlorophyll *a*, and high phytoplankton abundances but low species richness were recorded. *Chaetoceros*, *Pseudo-nitzschia brasiliana*, *Blixaea quinquecornis*, and *Skeletonema* blooms were observed, and some were associated with anoxia condition. Eutrophication level assessed by UNTRIX suggests that the water quality in the lagoon is deteriorating. Dissolved inorganic phosphorus and nitrogen at the impacted area were 15 and 12 times higher than the reference sites, respectively. Such trophic status indices could provide a useful guideline for optimal aquaculture management plan to reduce the environmental impact caused by aquaculture.

Keywords Algal blooms · Diatoms · Dinoflagellates · Eutrophication · Phytoplankton · UNTRIX

Introduction

In Malaysia, aquaculture industry has been developed since 1920 and becomes one of the high-value agricultural sectors. Some aquaculture practices have been adopted in Malaysia, i.e., freshwater, brackish water, and marine cultures (Hamdan et al. 2003). However, with the expending coastal aquaculture operations, more public attention and concerns have been given to the potential impact of aquaculture to the surrounding waters (Sidik et al. 2008). While finfish cultures brought the highest economic values to the country, this type of culture system has posed the most serious impact to the surrounding environments as compared to other mariculture activities such as seaweed and shellfish cultures (Jiang et al. 2012).

The increasing severity of the impacts from fish farm effluence has been widely reported worldwide (Alongi et al. 2003; Guo and Li 2003; Navarro et al. 2008; Skejić et al. 2011; Jiang et al. 2013a; Bartozek et al. 2014). For over three decades, water enrichment with excess nutrients, particularly phosphorus and nitrogen, is the major threat to the balance of coastal marine ecosystem (Andersen et al. 2004). The combination of both anthropogenic inputs from terrestrial and intensive aquaculture has intensified eutrophication in the coastal waters (Jiang et al. 2013a); this subsequently affects sustainable economic development and social benefits of the coastal waters (Bricker et al. 2008; Yang et al. 2008).

Micro-phytoplankton are the main primary producers of the estuarine and coastal ecosystems (Nixon 1986). They assimilate nutrients and organic matters, serving as the main food base to higher trophic levels (Alongi et al. 2009). Phytoplankton were widely used as an indicator to measure the changes of ecological and biogeochemical in the water systems as phytoplankton are highly sensitive to various environmental changes, with high growth rate and measurable photosynthetic responses (Paerl et al. 2007). The major cause of the shift in phytoplankton community composition and structure has been linked to nutrient increment and changes

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