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Elevated sea surface temperature triggers massive bloom of *Protoperidinium pallidum* in Tuticorin coastal waters, southeast coast of Tamil Nadu, India

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Short communication

Abstract

Occurrence of massive blooms of dinoflagellates and other phytoplankton species in the coastal waters indicate the health condition of coastal waters. Dinoflagellate blooms reported around the world are known to be harmful to the coastal marine flora and faunal communities. Therefore monitoring such blooms occurring in the coastal waters are important to monitor coastal water pollution and to make better management strategies towards coastal water quality. In the present study, massive bloom of dinoflagellate *Protoperidinium pallidum* was observed in Tuticorin Bay, southeast coast of Tamil Nadu, India. High densities of *Protoperidinium pallidum* population of 12×10^5 cells ml^{-1} was recorded during this bloom. Occurrence of *Protoperidinium pallidum* bloom recorded in this study is the first report from Tuticorin, Gulf of Mannar region, Tamil Nadu.

Keywords: *Dinoflagellate bloom, Protoperidinium pallidum, Tuticorin, Sea Surface Temperature, Gulf of Mannar.*

Introduction

Occurrences of algal blooms in the ocean are due to three primary phytoplankton groups such as dinoflagellates, diatoms and blue green algae (Ibrahim, 2007). Blooms caused by these planktonic species could be harmful or nontoxic. However the toxicity level of these algal blooms is observed upon ecological disturbance in the coastal faunal communities. Considerably, harmful algal blooms (HABs) are known to damage the economy of finfish and shellfish fisheries through spoilage, and thereby affecting human health (Ibrahim, 2007). Directly or indirectly, HABs are known to show negative impact on fisheries, human health, tourism and ecosystem (Gallardo-Rodrıguez *et al.*, 2018). Therefore, various control methods such as chemical, physical and biological approaches have been practiced worldwide to control HABs in coastal waters (Gallardo-Rodrıguez *et al.*, 2018). Two major key factors such as eutrophication (land based runoff and upwelling phenomenons) and climate change are known to involve in stimulation of algal blooms in the coastal waters (Gallardo-Rodrıguez *et al.*, 2018).

In coastal waters of southeast Asian countries, species belonging to three dinoflagellate orders such as Peridiniales Gonyaulacales and Gymnodiniales are found to be predominant

in surface sediments (Furio *et al.*, 2012). In India, bloom forming dinoflagellates such as *Protoperidinium* sp. in Mangalore coast (Sanilkumar *et al.,* 2009), *Protoperidinium divergens* from Andaman Islands (Karthik and Padmavati, 2014), *P. steinii* and *P. brevipes* from Goa (Pednekar *et al.*, 2012) and several other plankton species from different parts of Indian coast were reported (D'Silva *et al.*, 2012). Blooms of *Protoperidinium* spp. are found to prey upto coastal plankton which will result in imbalance of ecological niche (Gribble *et al.*, 2007). During summer 2019, sea surface temperature increased considerably up to 4°C from normal ranges (from 28°C-31°C to 32°C-36°C). Due to the sudden change in the climate, a massive brown colored dinoflagellate bloom was observed along the Tuticorin Bay, southeast coast of Tamil Nadu, India. The present study reports first record of *Protoperidinium pallidum* bloom from Tuticorin Bay, due to elevated temperatures.

Material and methods

Field surveys were conducted during May 2019 at Tuticorin coastal waters (08° 48' 52" N, 078° 09'43" E). Massive bloom of *Protoperidinium pallidum* was observed in this Bay region (Fig. 1a-b). Samples were collected using bottle and transported to laboratory for identification. Bloom water sample was examined under Lynx microscope for counting the cells with hemocytometer and were photographed. Seawater quality parameters were analyzed by using Manta+ Water Quality Sonde. Study location was marked using Garmin handheld GPS.

Results and discussion

Coastal seawater in the Tuticorin Bay appeared dark brownish in colour, while offshore waters were blue in colour during 22nd May 2019 (Fig. 2a). The bloom was obvious in the coastal waters of Tuticorin up to >3 km and there was no signs of nausea or vomiting at the bloom spot. Microscopic investigations revealed that a unicellular dinoflagellate, *P. pallidum* was responsible for the dark brownish colored seawater in Tuticorin Bay (Fig. 2b-d). The key taxonomic description of *P. pallidum* are: conical shaped epitheca with a small apical horn, right handed cingulum, deep sulcus, hemispherical hypotheca and two solid antapical spines. The first plate is para-type and the other plate is hexa-type.

There were no signs or evidences on the mortality of any fish. During this bloom occurrence, sea surface temperature, salinity and dissolved oxygen recorded were 32.79°C, 34.96‰ and 5.69 ml/L, respectively. These bay waters were also found to be highly polluted with human feces, suggesting that combination of elevated temperature and high nutrient loads (human excreta contains 98% of the nitrogen and 65% of phosphorus) in these waters favored the formation of nontoxic *Protoperidinium* bloom. Cell density of this bloom was 12×10^5 cells ml^{-1}.

An increasing occurrence of HABs around the world than ever before are due to anthropogenic activities (Sellner *et al.*, 2003). A review on the occurrence of dinoflagellate cysts from southeast Asian coasts also show that *Protoperidinium* species form the dominant dinoflagellate cyst assemblages in coastal surface sediments of southeast Asian countries (Furio *et al.,* 2012). Despite favorable environmental conditions, entry of excreta from coastal habitation and domestic effluents into Tuticorin coastal waters are found to be the favorable conditions in inducing *Protoperidinium* bloom. Another study indicated that occurrence of blooms of *P. divergens* in tropical and subtropical regions are due to coastal eutrophication (Karthik and Padmavati, 2014). Increased salinity also reportedly induced the bloom (Pednekar *et al.*, 2012). In the present study, salinity was not higher, but polluted waters and high

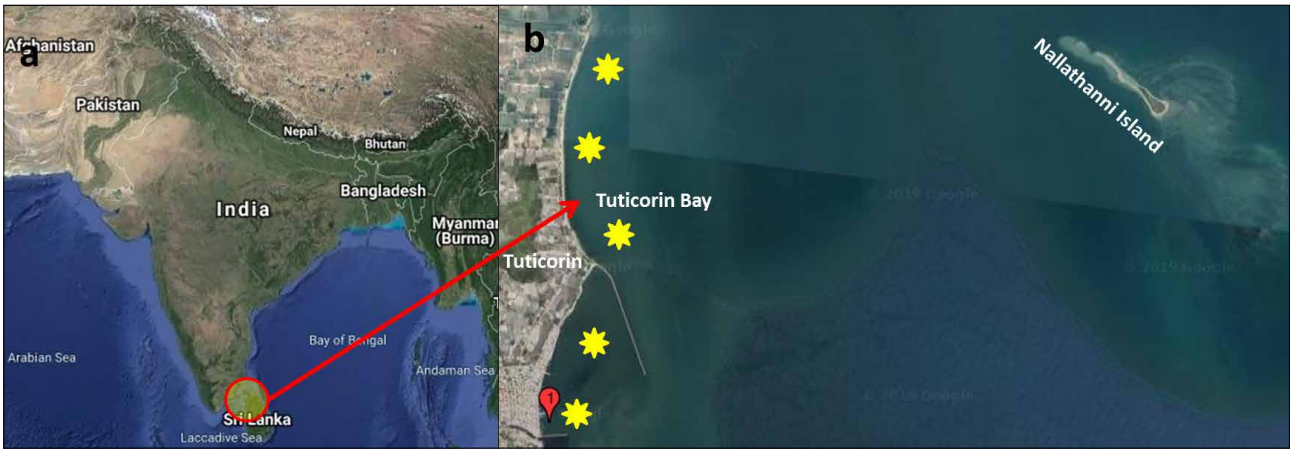

Fig. 1. Bloom of *Protoperidinium* sp. observed at Tuticorin Bay. Map showing Tuticorin in India (a); Bloom occurrence in Tuticorin Bay region indicated in yellow stars (b).

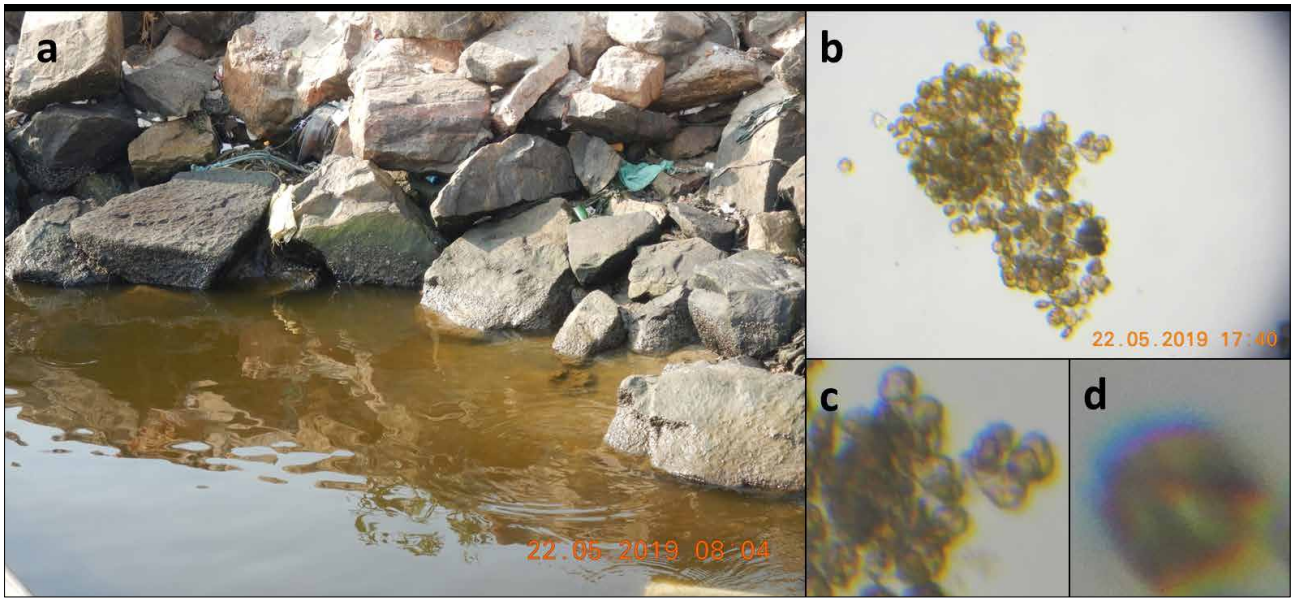

Fig. 2. Massive bloom of *Protoperidinium* sp. observed at Tuticorin Bay (a); Microscopic view of bloom water showing large amount of aggregated cells under 4X magnification (b); the same cells under 10X (c) and a single cell under 40X magnifications (d).

temperature are key factors responsible for *Protoperidinium pallidum* bloom in Tuticorin.

Harmful dinoflagellates blooms have to be controlled by stopping anthropogenic activities such as excretion in the coastal waters and discharge of untreated domestic waste to avoid eutrophication in the coastal waters and to prevent negative impacts on seafood and human health. Therefore, regulatory management steps are required to maintain the coastal waters clean and healthy thereby protecting marine biota and human health. Further studies are necessary to understand the bloom dispersion, succession and diminution dynamics as well as negative impacts (e.g. mortality of fish) and multi factorial conditions that induce these blooms occurrence in the coastal waters of Gulf of Mannar region.

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