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Observation of Diatom Bloom dominated by *Rhizosolenia alata* in Cuddalore coastal waters, southeast coast of India

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ABSTRACT

Algal blooms in coastal waters are considered to be increasing problems throughout the world. Anthropogenic nutrient fortification reported as a principal causative factor of this increase through elevated inorganic or organic nutrient concentrations. In the present study, a diatom bloom was observed in the Cuddalore coastal waters, southeast coast of India during the harmful algal blooms (HABs) monitoring programme. The pale green discoloration was observed on the surface of the coastal waters during the month of June, 2014. The bloom sample was collected and the physico-chemical parameters along with species occurrence were analyzed. The phytoplankton species such as *Rhizosolenia alata*, *Rhizosolenia styliformis*, *Rhizosolenia cylindrus*, *Chaetoceros* spp., *Navicula* sp., *Nitzschia sp., Thalassiosira subtilis* and *Bacteriastrum* sp. were recorded from the collected bloom samples. Among these, *R. alata* was observed to be dominant and the cell density of the bloom area was 16.21×10^4 cells l^{-1} and *R. alata* constituted 89% of the total phytoplankton population. The physico-chemical parameters of the waters inferred Dissolved Oxygen (DO) (2.6 ml L^{-1}), Salinity 35 (ppt), Temperature (29° C), pH (8.2), Chlorophyll '*a*' (14.3 ìg L^{-1}). The nutrients concentration of the bloom area was as follows; nitrate (0.3 ìM L-1), nitrite (0.14 ìM L-1), phosphate (0.61 ìM L-1) and silicate (11.49 ìM L-1). There was lack of evidence of the adverse health impacts of HABs on the fish mortality. Detailed economic evaluation and cost/beneût analysis of the impact of HABs needs to be done in future.

Introduction

Phytoplankton plays an important role as primary producer in marine ecosystems and they form the basis of the marine food chain. These microalgae can proliferate into enormous concentrations (up to one million cells^{-l}) obviously discolour the surface of the sea when environmental conditions are favourable. These natural phenomena are termed as "Harmful Algal Blooms" (HABs). International Council for the Exploration of the Seas (ICES, 1984) has defined the phytoplankton blooms as those which are noticeable, particularly to the general public, directly or indirectly through their effects such as visible discolouration of water, foam production, fish or invertebrate mortality, or toxicity to humans (Cicily *et al*., 2013).

A variety of potent natural biotoxins producing algal species are considered as harmful, noticeably impacting the human, animal health and also causing economic losses through their negative impacts on human uses of ecosystem services (Hallegraeff, 1993; Anderson *et al*., 2002). The causative factors for HABs measures are reported to be the ballast water transport of cells (Smayda, 2007) and climate change (Hallegraeff, 2010; Moore *et al*., 2008) potentially important in governing the biogeography and formation of HABs. It is generally accepted that the availability of dissolved inorganic nutrients likely mediate phytoplankton growth in most coastal waters (Howarth and Marino, 2006). As increases in human coastal populations, industrialization, and the intensiûcation of agriculture have elevated the supply of nitrogen (N) and phosphorus (P) to coastal waters (Ferreira *et al*., 2011). The role of anthropogenic nutrient enrichment and associated changes in nutrient ratios are among the most frequently proposed and debated hypotheses relating to

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increased HABs in coastal waters (Glibert *et al*., 2005; Harrison *et al*., 2012; Heisler *et al*., 2008; Smayda, 1990).

Human usages or discharges such as fertilizers, sewage, industrial effluents, animal wastes, atmospheric inputs and coastal aquaculture contribute to elevated nutrient concentrations in coastal waters with strong evidence that elevated nutrients have led to increased phytoplankton biomass and primary production in some locations (Anderson *et al*., 2008; Gowen *et al*., 2012; Heisler *et al*., 2008; Smayda, 1990). Evidently, the appearance of HABs could be regarded as an undesirable disturbance. Hence, HABs and incidents of high seafood toxicity have been used to "diagnose" eutrophication (Foden *et al*., 2010). Several researchers have reported an apparent global increase in HABs in marine waters (Anderson, 1998; Smayda, 1990; Van Dolah, 2000). Coupled with an increasing demand for seafood products, such an increase would imply that HABs pose important global health and economic risks. Hence, an attempt was made to monitor the occurrence of HABs in the Cuddalore coastal waters through the Monitoring and Surveillance of HABs in Indian EEZ. Further, an effort was directed to identify the causative species in relation to the physico-chemical properties.

Materials and Methods

A multi-species bloom sample was collected from Cuddalore coastal waters (Lat.11°42'N: Long.79° 49'E), southeast coast of India on 26th June 2014 by following the method of Rajkumar *et al*. (2009). The filtrates were preserved in 5% neutralized Formalin Lugol's iodine solution. Quantitative analysis of phytoplankton was done by settling method Sukhnova, 1978 using a Sedgwick Rafter counting chamber under a binocular light microscope. The diatoms were identified up to species level by referring the publications of Venkataraman (1939), Subrahmanyan (1946) and Tomas (1997). Physico-chemical parameters such as surface water temperature (using a standard centigrade thermometer), salinity (using a salino-meter model E.2) and pH (using an Elico pH meter-Model L1-120) were recorded. Dissolved Oxygen (DO), Chlorophyll '*a*' and nutrients such as nitrite (NO_2), nitrate (NO_3), inorganic phosphate (PO_4) and silicate (SiO_3) were estimated by the modified Winkler's method (Strickland and Parsons, 1972).

Results

Diatom bloom was observed in the Cuddalore coastal waters, southeast coast of India during the harmful algal blooms (HABs) monitoring programme. The pale green discolouration was observed on the surface of the coastal waters during the month of June, 2014 (Fig. 1). From the microscopic analysis it was observed that the genus *Rhizosolenia* was the dominant component of the bloom area (Fig.2) and it was represented by *Rhizosolenia alata* Brightwell,

Fig. 1. *Algal blooms collected in plastic container and glass beaker*

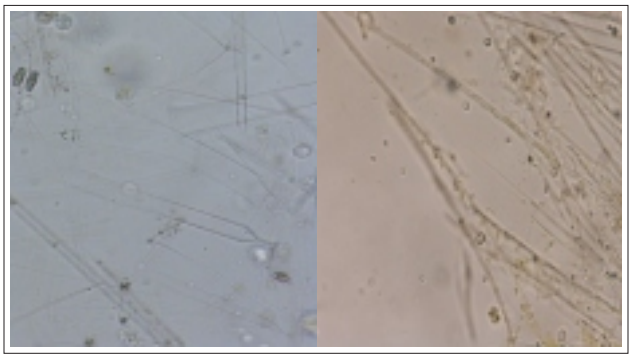

Fig. 2. *Microscopic obersvation of* Rhizosolenia alata

Rhizosolenia cylidrus and *R. styliformis* (Fig. 3). Total diatom cell density of the bloom area was 16. 21 × 10^4 cells l^{-1} and *Rhizosolenia alata* constituted 89% of the total phytoplankton population with a cell density of 13.56 × 10^4 cells l^{-1} (Fig. 4). Other diatoms were represented by the genua *Chaetoceros, Navicula, Nitzschia, Thalassiosira* and *Bacteriastrum*. In the phytoplankton composition of the bloom area, the genus *Chaetoceros* was represented by *C. curvisetus, C. diversus, C. affinis, C. didymus, C. compressus* and *C. lorenzianus* (Fig. 5).

Fig. 3. *Percentage composition of the genus* Rhizosolenia *in the bloom area*

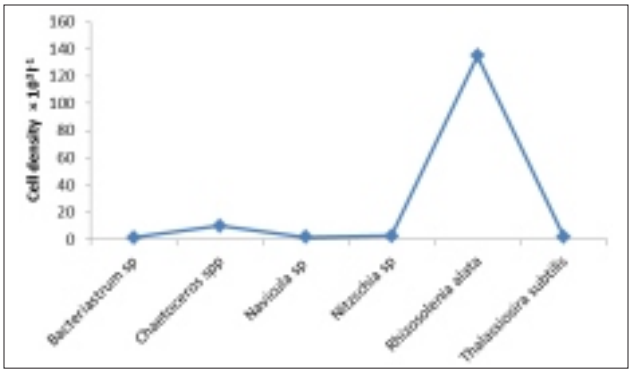

Fig. 4. *Cell density of phytoplankton in the bloom area*

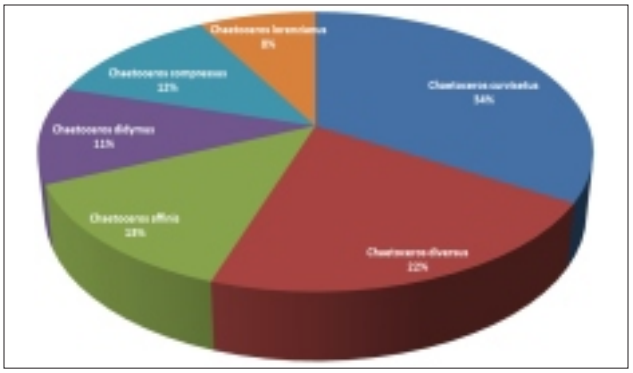

Fig. 4. *Composition of the genus* Chaetoceros *in the bloom area*

The surface water temperature was 29°C and the salinity was 35 (ppt). The DO concentration in the surface waters was 2.6 ml L^{-1} and pH value was 8.2. The nutrients levels in the bloom region showed lower values for nitrite (0. 14 μM L^{-1}), nitrate (0.3 μM L^{-1}) and higher values for phosphate (0.61 μM L^{-1}) and silicate (11.49 μM L^{-1}). The chlorophyll '*a*' concentration in the bloom region was high (14.3 μg L^{-1}) in the bloom waters.

Discussion

Studies on the occurrence of harmful algal blooms in Indian waters are very few (Anantharaman *et al*., 2010; Cicily *et al*., 2013). In the present study, the diatom bloom was highly dominated by the genus *Rhizosolenia*. The occurrence of *Rhizosolenia* dominated important blooms have been reported in different areas of the world (Jordan and Priddle 1991, Jordan *et al*., 1991, Garate Lizarraga *et al*., 2003; Cicily *et al*., 2013).

The physico-chemical parameters of the bloom area were favorable for the formation of a diatom bloom. The present results are in accordance with the previous report (Anantharaman *et al*., 2010). The DO concentration during the present investigation was very low in the surface waters which decreased further in subsurface layers. Surface nutrient levels in the bloom region showed lower values for nitrate and nitrite whereas, the concentration of silicate was observed to be high. The nitrate values of the bloom area were lower whereas the phosphate and silicate values were found to be more or less similar with the earlier report (Cicily *et al*., 2013). The chlorophyll a concentration of the bloom area was recorded as high. The present results are in agreement with the report of Cicily *et al*. (2013).

During this study, the presence of copepod and zooplankton was not recorded. This is may be due to the inhibiting effect of the diatoms and also due to the low dissolved oxygen content. The present findings are more or less agree with the report of Cicily *et al*. (2013) in the Indian coastal waters. Mixed diatom blooms occur in coastal waters because of the increased nutrient inputs due to physical processes like upwelling and terrigenous sources through river run off. Since this area is an active fishing zone, such blooms are of great concern. Even if some of the increase can be attributed to increased monitoring and a change in scientific focus, anthropogenic influences like coastal pollution and increased use of fertilizers, which reach coastal waters through river runoff, alters the marine ecosystem and favours the outbreak of algal blooms. Hence, the monitoring of harmful algal blooms in the fishing area is needed in future.

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