Indian Journal of Geo-Marine Sciences
Vol. 45(3), March 2016, pp. 425-430

Climatic changes and anthropogenic influences on *Rhizosolenia imbricata* Brightwell 1858 Bacillariophyceae Bloom in Sisostris Bay, Port Blair, Andaman, India

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Received 21 August 2014; revised 26 November 2014

Present study consists the Harmful Algal Blooms (HABs) of *Rhizosolenia imbricata* Brightwell 1858 in SisostrisBay, Port Blair, South Andaman region during February 2013. *R. imbricata* was counted as 24,000 colony/L observed 3 days blooms appeared in study site. Role of nutrients and environmental parameters changes during bloom outbreak is also investigated. Status of temperature, salinity and nutrient nitrite as the principal limiting parameters for this bloom is presented in this study.

[Keywords: *Rhizosolenia imbricata*; Diatoms Blooms; Port Blair; HABs; South Andaman]

Introduction

In the recent decade, HABs have become one of the serious environmental problems in tropical and subtropical region[1]. HAB is a condition in which certain species of phytoplankton bloom cause damage to food web dynamics of marine ecosystems are kill and directly affect human society[2]. Coastal waters, such as bays, estuaries and lagoons are very diverse system and relative importance to naturally eutrophic ecosystems, where both the biology and the physical dynamics are strongly influenced by the freshwater runoff from the land, as well as the exchange of water[3-4]. The increase of nutrients such as nitrogen (N) and phosphorous (P) derived sources by anthropogenic activity influences to severe eutrophication problems in coastal waters, inducing an enrichment of phytoplankton primary production[5-6]. However, the variability of the environmental condition on account of the impacts of climate change and anthropogenic-driven can affect the ecology of coastal and/or marine environments[7]. In addition, a sudden nutrient supply from landward to seaward through rainfall run off and turbulence typically yields a response from phytoplankton such as diatom and dinoflagellates[8].

Fietz et al.[9] and Hassan et al.[10] suggested that phytoplankton dynamics are affected through environmental parameters and influence the plankton abundance, diversity and growth significantly[11]. Further, phytoplankton is an excellent indicator of marine ecological niches[12].

Diatom are composed of a large number of species inhabitants in coastal and open sea water and include various harmful blooms-forming species *R. imbricata* Brightwell, *Coscinodiscus wailesii* Gran and *Thalassiosi radiporocyclus* Hasle[13-15]. In recent years, diatom blooms have been frequently reported and observed in many regions and significant problems were observed in coastal waters of Japan[16]. This bloom occurred due to nutrient from landward side runoff supplied through anthropogenic sources including domestic wastes and agriculture activity. There are numerous studies about the effects of abiotic factors such as temperature, salinity, light intensity, and nutrient profiles that the play a vital role in diatom growth[17]. Another

interesting factor is that *Rhizosolenia* spp. taxa have diazotrophs (atmospheric N_2fix) characters and play a vital role in oceanic and marine nitrogen cycle, which form large scale surface blooms in tropical and subtropical regions[18].

D'Silva et al.[19] and Sachithanandam et al.[2] have reported that around 103 algal blooms have been documented along the west and east coasts of Indian Ocean including Andaman Sea from 1908 to 2012. Moreover, the west coast of India witness majority of blooms by dinoflagellates whereas diatom blooms prevail along the east coast. In Indian waters, 19 diatom blooms in the west coast by 7 causative agents and 12 diatom causative organisms East coast region (Table 1) was reviewed by D'Silva et al[19].

Table 1 Synoptic View of Diatoms algal blooms along the India coastal region. PreM: Pre–monsoon, SWM: South–West Monsoon, PoM: Post–monsoon[2 &19]

S. No.	Causative organism	Place of occurrence	Year	Season
1	a) *Ditylum* sp. b) *Thalassiosira* sp.	Malabar coast	1st May 1922 7th May 1922	Pre M Pre M
2	*Fragilaria oceanica*	Off Kaikani, Mangalore	Aug. 1972	SWM
3	a) *Nitzschia sigma* b) *Skeletonema costatum*	Cochin backwaters, Kerala	May 1970 Nov.1970	Pre M Po M
4	*S. costatum*	Dharamtar Creek, Mumbai	Oct. 1984–1985	Po M
5	*C. asteromphalus*	Off Kodikkal–Calicut, Kerala coast	Aug. 2006	SWM
6	*R. alata*	inshore waters off	March 1950	PrM
7	*R. imbricata*	Mandapam, Tamil Nadu	Feb. 1951	PrM
8	*A. japonica*	off Vishakhapatnam, Andra Pradesh	April 1967	Pre M
9	*A. glacialis*	Vellar estuary, Tamil Nadu	March & Sep./Oct. 1983	Pre M SWM
10	*A. glacialis*	Gopalpur, Orissa coast	26th March 1988	Pre M
11	*A. glacialis*	Rushikulya estuary, Orissa coast	April–May 1988	Pre M
12	a) *A. glacialis*	Bahuda estuary,	May 1991	Pre M
13	*T. fraunfeldii*	Orissa coast	Sep. 1991	SW M
14	*C. centralis* & *C. excentricus*	Orissa coast	June 1992	SW M
15	*A. glacialis*	off Kalpakam, Tamil Nadu	May 1993	Pre M
16	*A. glacialis*	Gopalpur, Orissa	24th March – 4th April 2004	Pr M

Further, In Indian waters HABs is mainly influenced by seasonal upwelling and monsoonal forcing that influences high riverine runoff resulting in nutrient-enriched waters that induces a competitive edge for blooming of phytoplankton species[19]. In Andaman coastal area, few blooms have been reported but still remain largely unexplored[2]. In order, to the assess environmental impact and scarcity of reports from this study site, an

investigation was carried out every three month intervals December 2012 onwards in Sisostris Bay, Port Blair township. Seasonal variation in planktonic community and related with physio-chemical parameters of water quality were also estimated. The present work was reported on HAB's of diatom bloom *R. imbricata* in Sisostris bay, South Andaman region during February 2013.

Materials and Methods

The Andaman and Nicobar (A&N) Islands are one of the union territories of India, situated in the eastern part of Bay of Bengal. There are 572 islands within the A&N archipelago, which is one of the known biodiversity hotspot of the world[2]. Climate of these island are typically equatorial with temperature variation from 25 to 35°C. Average rainfall is about 300-350 cm spreading from May to November with very high percentage (74.5%) of humidity. It is bestowed with rich marine and floral biodiversity and has pristine environment due to its remoteness from the mainland[20]. In Port Blair, eastern part of the Sisostris Bay, Andaman Sea situated and high populated inhabited in their surrounding areas and it is significant domestic waste water runoff mixing in this region (Fig. 1).

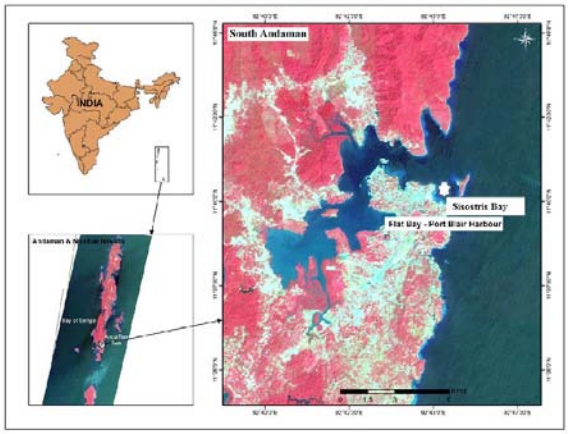

Fig. 1 Study area

Surface and depth seawater parameters were studied at Sisostris Bay, South Andaman (Fig. 1) around the Port Blair Islands. The physico-chemical parameters such as Water Temperature (WT), salinity, Dissolved Oxygen (DO), pH and Turbidity were recorded in situ using Hydrolab (USA) probe water quality instrument used during the survey. Seawater samples (triplicates) were collected using Niskin water samplers and were analyzed laboratory using standard methods[21] for nitrite, nitrate, silicate and phosphorus. Similarly, surface phytoplankton samples were collected using plankton net (0-20 µm mesh size) fitted with digital flow meter. Phytoplankton samples were preserved with 4 % formalin and Lugol's iodine solution. Samples were processed using Utermol's settlement method[22]. Total number of organism were enumerated using Nikon Eclipse microscope (E1500) with a Sedgwick Rafter plankton counting chamber and identified up to species level following standard keys[23].

Results and Discussions

During the study, the values of surface temperature ranged from 29.01 to 33.27°C show significant variation in water column. In general temperature has long been recognized as a key factor that control phytoplankton blooms in marine ecosystems[24] and low temperature could not growth *R. imbricata*[13]. Present study also agreed with this point and observed the same situation during bloom outbreak. pH values ranged from 8.05 to 8.41 and salinity 34.21 PSU was observed in study site during bloom which was not significant. The harmful diatoms are vice versa relationship with environmental factors in Japan waters[15]. DO concentrations ranged from 5.9 to 7.1mgL^{-1} during this time and the DO values had significant correlation with biotic factors. This could be due to the photosynthetic produced oxygen by the dense algal biomass[24]. There are the reports about the effects on physiochemical parameters playing a negative role in the growth of diatoms in Lab conditions as well as in natural condition as observed and reported by Nishikawa[25] and Nishikawa and Yamaguchi[17]. Nitrate concentration ranged from 0.055-0.48µg/L, the highest value observed near mouth region of domestic waste outlet the routes. This high nitrate might be directly attributed to play a key role for *R. imbricata* bloom in the study site. Moreover, *Rhizosolenia* spp. have atmospheric N_2 (diazotrophs) fixation role in marine nitrogen cycle or biogeochemistry, which leads to outbreak in surface waters observed by Poulton et al[18]. This reason was supported in the present work observed data of

nitrogen high in water column during bloom outbreak. However the remaining nutrients such as phosphate, nitrite and silicate had no detectable limits, because of full utilisation of the same the growth of this bloom. From the analysis it is confirmed that excess nutrients especially nitrate have significant role on blooms. Further, Sasaki and Kito[13] were reported that *R. imbricata* species more sustain during the low nutrients available in maximum cell division rate under the conditions periods. This study suggests that *R. imbricata* bloom occur temperature difference, stable salinity (33 to 34 PSU) and low nutrient concentration were observed during the bloom outbreak. During the study *R. imbricata* dominated 90 – 95%, which was considered as a bloom occurred in Sisostris Bay, South Andaman region. *R. imbricata* population (24,000cell/ml) of total phytoplankton biomass was recorded in the surface water column (Fig. 2).

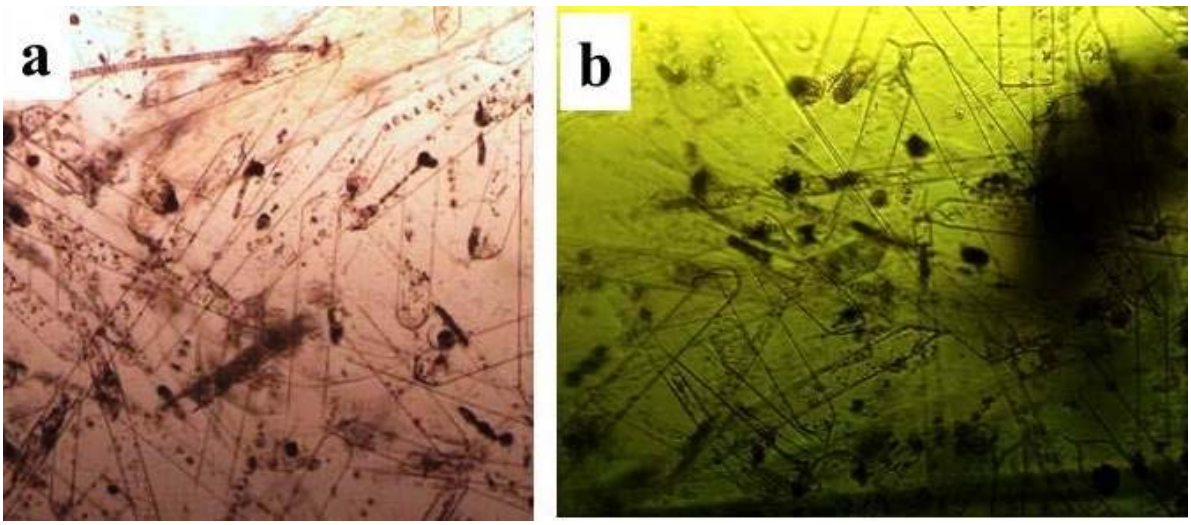

Fig. 2a&b Diatom Bloom of *R. imbricata* species Outbreak in Sisostior Bay, South Andaman

Massive growth of phytoplankton bloom-forming was found predominantly due to physiochemical parameter fluctuation or enrichment in water column of Sisostris Bay region i.e. temperature (29.01 to 33. 72°C) and salinity significant changes (33.23 – 34.74 PSU) from surface to 15 meters water column. As per the review of algal blooms off India D'Silva et al[19] suggested that till date only one report of *R. imbricata* in Mandapam, Tamil Nadu exist in 1951 pre monsoon period[19]. Besides this the species bloom was nowhere noticed in Indian waters as well as Andaman coastal stretch (Table 1). The strong relationship of nutrient - salinity indicates that physical processes have significant control on phytoplankton blooms in the Indian coastal waters especially Bay of Bengal[27]. In general, diatom blooms are generated by upwelling-induced condition during monsoon periods reported in Indian waters[19]. In Andaman waters are still infant stages on ocean modelling of nutrients upwelling especially current pattern and climatic changes studies in recent decade. The present study was to evaluate along the costal anthropogenic activity influence on the *R. imbricata* and its environmental status observed in Port Blair Township.

Conclusion

This study record an occurrence of blooms from Sisostris Bay South Andaman coastal region. This work concludes that *R. imbricata* algal bloom is driven due to the physico-chemical parameters especially temperature, salinity and nitrate triggering bloom formation in the study site. The present work summarises that the Andaman coastal regions records very limited work on phytoplankton blooms. Further, the algal bloom formations or outbreak are unpredictable, so continuous monitoring of blooms prone areas will provide significant awareness. In future, the continuous monitoring may helpful to the marine ecosystems conservation and sustainable management of coastal activity. The *R. imbricata* bloom had first time documentation for this study area.

Acknowledgements:

Authors are thankful to the University Grand Commission (UGC) major research fund scheme, New Delhi & the higher authorities of Pondicherry University, Puducherry, India for support to carry out this work.

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