

Short Communication

Intense blooms of *Trichodesmium erythraeum* (Cyanophyta) in the open waters along east coast of India

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Received 15 April 2002, revised 10 March 2003

Two blooms of *Trichodesmium erythraeum* were observed during April 2001, in the open waters of Bay of Bengal and this is the first report from this region. The locations of the bloom were off Karaikkal ($10^{\circ}58'N$, $81^{\circ}50'E$) and off south of Calcutta ($19^{\circ}44'N$, $89^{\circ}04'E$), both along east coast of India. Nutrients (nitrate, phosphate, silicate) concentration in the upper 30 m of the water column showed very low values. High-integrated primary production (Bloom 1- $2160 \text{ mgC m}^{-2} \text{ d}^{-1}$, Bloom 2- $1740 \text{ mgC m}^{-2} \text{ d}^{-1}$) was obtained in these regions, which indicated the enhancement of primary production in the earlier stages of the bloom. Very low $\text{NO}_3\text{-N}$ concentrations, brownish yellow bloom colour, undisturbed patches and high primary production strongly suggested that the blooms were in the growth phase. Low mesozooplankton biomass was found in both locations and was dominated by copepods followed by chaetognaths.

[**Key words:** Bay of Bengal, bloom, nutrients, chlorophyll *a*, primary production]

Trichodesmium, a marine cyanobacterium is an important known nitrogen-fixer in the sea. The importance of these organisms in the open waters has been recognised and lend support to N_2 fixation by *Trichodesmium* which can, at times, match or exceed NO_3^- fluxes into the upper water column¹. In Indian waters *Trichodesmium* blooms and associated 'Red-Tide' phenomenon were addressed by many researchers in the neritic areas of the west and east coasts of India²⁻⁶. However, no reports are available on *Trichodesmium erythraeum* blooms from the open waters of Bay of Bengal. The present report gives information on an oligotrophic system that at times becomes highly productive due to *Trichodesmium erythraeum* blooms. In connection with Marine Research-Living Resource (MR-LR) Assessment Programme observations were made during cruise-192 of *FORV Sagar Sampada* from 3rd April to 30th April 2001. Two oceanic blooms of *Trichodesmium erythraeum* were observed, first one stretching around 10 km off Karaikkal ($10^{\circ}58'N$, $81^{\circ}50'E$) and the second one off south of Calcutta ($19^{\circ}44'N$, $89^{\circ}04'E$) on 11 and 25 April 2001 respectively (Fig. 1). The second bloom was occupied in a smaller area as compared to the first one (Fig. 2). The locations of the bloom were more than 200 km away from the coast with a water depth of $> 1000 \text{ m}$. The blooms were so intense and appeared as a thick layer of saw dust on

the surface waters. Samples were collected using a plastic bucket and the adhering nature of the algae

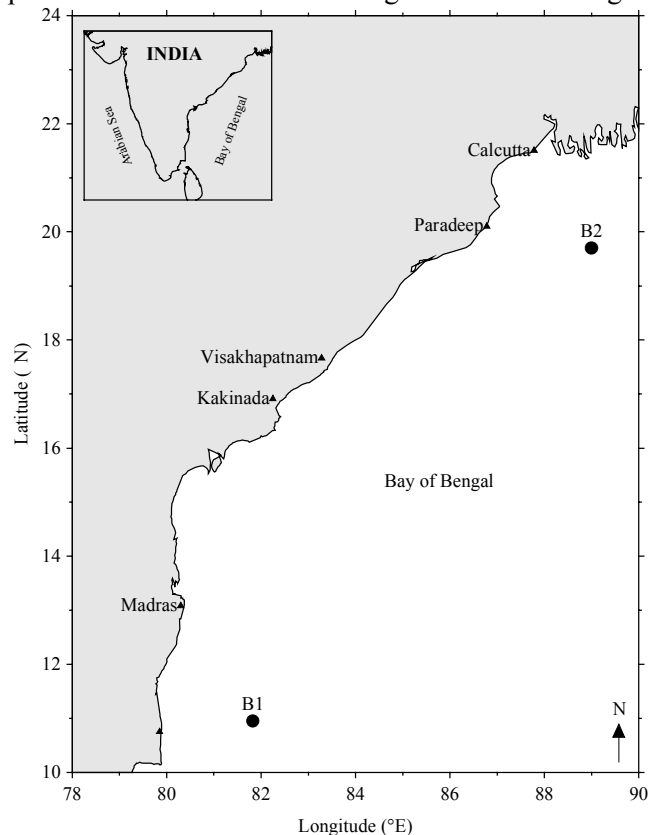


Fig. 1 — Locations of the occurrence of algal blooms

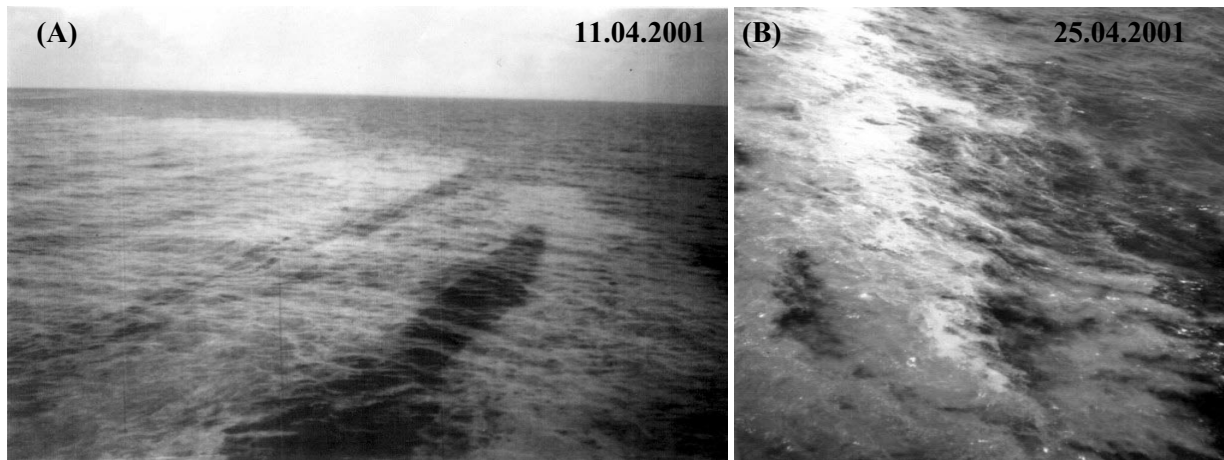


Fig. 2 — *Trichodesmium erythraeum* bloom observed (A) off Karaikkal, (B) off south of Calcutta

Table 1 — Details of the location, nutrients, primary production and mesozooplankton biomass of the bloom regions in the Bay of Bengal

| Bloom date | Lat (°N) | Long (°E) | Nutrients ($\mu\text{mol.l}^{-1}$) | | | Primary production ($\text{mgC m}^{-2} \text{d}^{-1}$) | Zooplankton biomass ($\text{ml } 100\text{m}^{-3}$) |
|---------------|----------|-----------|--------------------------------------|-----------|----------|---|--|
| | | | Nitrate | Phosphate | Silicate | | |
| 11 April 2001 | 10° 58' | 81°50' | 0.05 | 0.9 | 2.2 | 2160 | 22.8 |
| 25 April 2001 | 19°44' | 89°04' | 0.14 | 0.56 | — | 1740 | 17.7 |

made it difficult to handle the sample. One small trichome was taken on a glass slide, pressed gently after placing a cover slip and observed under a compound microscope.

Water column transparency and sea surface temperature (SST) of the bloom regions were measured by secchi disc and bucket thermometer, respectively. Nutrients (nitrate, phosphate and silicate) were analysed in a SKALAR SAN PLUS Autoanalyser. Primary productivity was estimated using ^{14}C technique (onboard incubation) and experiments were conducted for four hours. Prior to incubation of ^{14}C -series, 1 ml of $\text{NaH}^{14}\text{CO}_3$ was added to each sample (5 μCi 300 ml seawater). After the 4-hour incubation, the samples were filtered through 47 mm GF/F (nominal pore size $0.7\mu\text{m}$) filters with gentle suction. These were exposed to concentrated HCl fumes to remove excess inorganic carbon and kept in scintillation vials for subsequent estimation of ^{14}C uptake. Liquid scintillation cocktail was added to the vials a day before analysis, and activity counted in Wallac scintillation counter. The Disintegration Per Minute (DPM) values were converted into daily production rates ($\text{mgC m}^{-3} \text{d}^{-1}$) using appropriate formula⁷. Mesozooplankton samples were collected from the mixed layer by multiple plankton net (Hydrobios) and preserved in 4% formalin in seawater.

The weather was calm with clear sky and the water transparency was high (Secchi disc depth ~ 30 m at both locations). The surface seawater was warm ($>29^\circ$). Average column values of different chemical parameters in the upper 30 m water columns indicated the oligotrophic nature (Table 1). Primary productivity studies using ^{14}C technique showed increased integrated primary production in the regions of algal blooms (Table 1), which were much higher than the average primary production of the Bay of Bengal ($225 \text{ mgC m}^{-2} \text{d}^{-1}$) during this season⁸. Very low $\text{NO}_3\text{-N}$ concentrations, undisturbed patches with brownish yellow colour and increased primary production indicated that the blooms observed were in the growth phase. Some of the earlier researchers also reported similar situations – Devassy³ observed a four fold increase in surface primary production in the bloom ($500 \text{ mgC m}^{-3} \text{h}^{-1}$) against non bloom areas ($150 \text{ mgC m}^{-3} \text{h}^{-1}$) in the near shore waters of Goa, while Santhanam⁴ reported around five times increase in surface primary production during the early stages of the bloom ($535 \text{ mgC m}^{-3} \text{d}^{-1}$) compared to the post bloom period ($150 \text{ mgC m}^{-3} \text{d}^{-1}$). The enhanced primary production could be due to the increased carbon requirement /uptake during the initial phase or the peak of the bloom for constituting the necessary biomass of the algae which, in turn, is required for N_2 fixation. Along with the advancing of the bloom,

Table 2—Zooplankton population density (no/100m³) and percentage (%) contribution of dominant groups

| Groups | Bloom 1* | | Bloom 2* | |
|--------------|----------|------|----------|-------|
| | Density | % | Density | % |
| Hydromedusae | 9 | 0.06 | 28 | 0.26 |
| Siphonophora | 330 | 2.55 | 43 | 0.40 |
| Polychaeta | 20 | 0.15 | 12 | 0.112 |
| Ostracoda | 90 | 0.69 | 52 | 0.48 |
| Amphipoda | 10 | 0.07 | 8 | 0.07 |
| Copepoda | 11200 | 86.7 | 9800 | 91.57 |
| Decapoda | 210 | 1.62 | 45 | 0.42 |
| Euphausiacea | 30 | 0.23 | 21 | 0.19 |
| Gastropoda | 9 | 0.06 | 13 | 0.12 |
| Pteropoda | 30 | 0.23 | — | — |
| Chaetognatha | 550 | 4.25 | 680 | 6.35 |
| Thaliacea | 35 | 0.27 | — | — |
| Copelata | 390 | 3.02 | — | — |

*Bloom 1- 11 April 2001, Bloom 2- 25 April 2001

nutrient enrichment of the environment increases (the main source are the decaying of the algal cells and extra cellular metabolites) and is attributable to accessible exudates and recycling products^{3,4}.

In the regions of the bloom, zooplankton biomass (as displacement volume) in the mixed layer was comparatively low (Table 1). Copepods showed maximum numerical abundance and percentage contribution among zooplanktonic organisms followed by Chaetognaths (Table 2). Available literature indicate that *Trichodesmium* is not a feed for most of the zooplankton and this can be possibly the reason for the low mesozooplankton biomass in the mixed

layer^{3,6}. The occurrence of *Trichodesmium* blooms in the open waters of Bay of Bengal as reported in this paper merit more detailed studies targeting its ecological significance.

The observations were made in connection with Marine research-Living resources programme funded by Department of Ocean Development (DOD), New Delhi. First author expresses his thanks to CSIR for financial support.

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