

## Phytoplankton characteristics in a polluted Bombay harbour-Thana-Bassein creek estuarine complex

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Annual variations in phytoplankton characteristics were studied from Bombay Harbour-Thana creek-Bassein creek (BHTCBC) estuarine confluence to assess the levels of pigment concentration, productivity and, qualitative and quantitative nature of these microalgae during the premonsoon, monsoon and postmonsoon seasons. Of the 37 genera (33 diatoms and 4 dinoflagellates) recorded, *Thalassiosira*, *Coscinodiscus*, *Nitzschia* and *Synaedra* were most common. Maximum density of *Skeletonema costatum* (up to 93% of total cells) was observed during monsoon (June-September) months in the creek region which receives effluents from adjacent industrial estates. Chlorophyll *a* (av.  $3.5 \text{ mg m}^{-3}$ ) and phaeophytin (av.  $4.2 \text{ mg m}^{-3}$ ), cell counts (av.  $631.9 \times 10^3 \text{ l}^{-1}$ ) and productivity ( $71.4 \text{ mgC m}^{-3} \text{ d}^{-1}$ ) were high and diversity index was low ( $H' 1.3$ ) in the creek region compared to those recorded from the outer (coastal) stations, suggesting eutrophication in the former area. Effluents from the Bombay metropolis seem to have adversely affected phytoplankton diversity, abundance and productivity.

Rapid industrialization and human aggregation of the Bombay metropolis have resulted in the production and disposal of enormous quantities of wastes into adjacent creeks and bays<sup>1</sup>, adversely affecting the water quality and resulting in stress on the estuarine microflora<sup>2,3</sup> and fauna<sup>4-6</sup>. Earlier studies on phytoplankton around Bombay address only on primary productivity<sup>7,8</sup>. Overall phytoplankton characteristics from entire Bombay harbour-Thana creek-Bassein creek (BHTCBC) confluence has not been investigated earlier. Present study was primarily to assess the seasonal variations in phytoplankton composition and distribution, pigment concentration (chlorophyll *a* and phaeophytin), productivity with an overall idea that these results would be useful in an understanding of the phytoplankton dynamics in this estuarine complex.

### Materials and Methods

Samples were collected for a year during October 1985-September 1986 from eight locations along the 87 km stretch of BHTCBC (Fig. 1). Thana-Bassein creek opens into Arabian Sea via Bombay harbour in the south and off Bassein in the north. Considering the proximity of

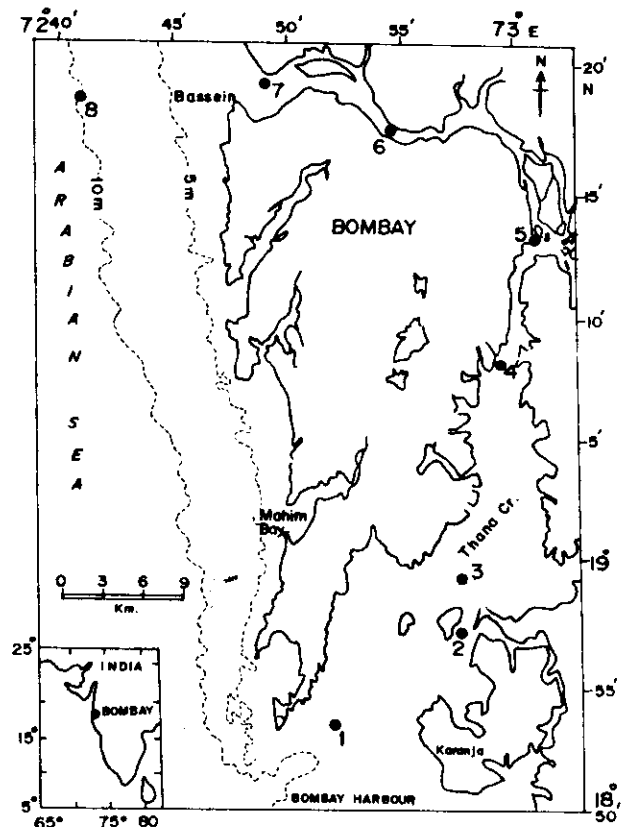


Fig. 1—Sampling locations.

stations 1,2,3,7 and 8 to the coastal waters, these were considered as 'outer' (coastal), and sts 4,5 and 6 as 'interior' (creek) stations. Standard methods were followed<sup>9</sup> for the determination of water quality parameters and phytoplankton characteristics (chlorophyll *a*, phaeophytin, cell counts, generic/species composition and primary productivity). Phytoplankton cells were counted using a Sedgewick-Rafter counting chamber. Diversity index of Shannon & Weaver<sup>10</sup>  $H'$  was calculated using the data on cell counts and species composition.

### Results

As the data obtained were too exhaustive, they were pooled seasonwise i.e. monsoon (June-September), postmonsoon (October-January) and premonsoon (February-May). Figures 2 and 3 depict the seasonal variations of water quality parameters and phytoplankton characteristics. Temperature variations were limited with similar

trend at all stations. There was a gradual drop in temperature from premonsoon through monsoon to postmonsoon seasons. Salinity variations were well defined at all stations with relatively lower ranges of variations at all stations with relatively lower ranges of variations at the outer locations. Low salinity was recorded during monsoon period. Dissolved oxygen varied between 2.4 and 9 mg l<sup>-1</sup> and values were generally low at sts. 4 and 5. Nitrite and nitrate were generally low in coastal stations and high in creek region. Highest nitrite concentration (34.5 µg-at l<sup>-1</sup>) was recorded in the month of July at st. 4, and maximum values were recorded at sts. 4 and 5 during most part of the year. Maximum nitrate concentration was recorded during the premonsoon period at sts. 5 and 6. Also, higher levels of phosphate and nitrite were seen at these stations during most part of the year. Phosphate concentration remained the highest (2.3-15.9 µg-at l<sup>-1</sup>) at st. 4 and least at st. 8 (1.2-2.3 µg-at l<sup>-1</sup>). Chlorophyll *a*, phaeophytin, cell counts and column production were generally the

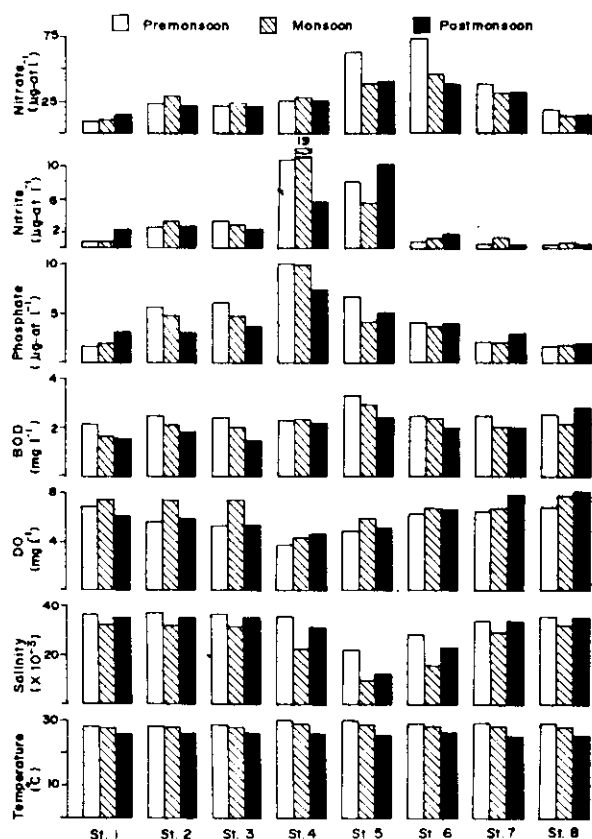


Fig. 2—Seasonal variations in hydrographic parameters at different sampling locations.

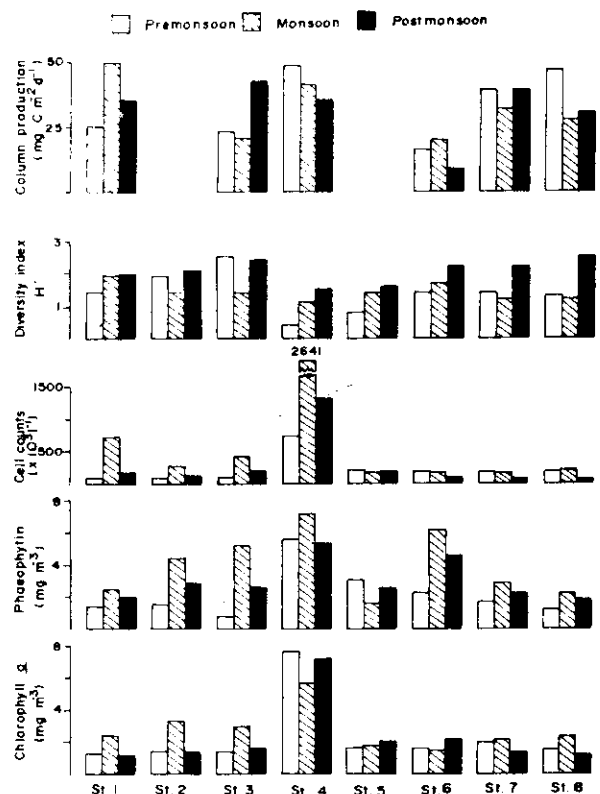


Fig. 3—Seasonal variations in Chl *a*, phaeopigments, cell counts, diversity index  $H'$  and column production at different stations.

highest, and diversity index the lowest at st. 4 throughout the period of observation (Fig. 3). Excepting for a consistently higher rate during all seasons at st. 4, primary production showed wide range of fluctuations at other stations. Column production was generally higher at locations with low turbidity.

A total of 37 genera (33 diatoms and 4 dinoflagellates) were recorded during the period of study. Diatoms: *Amphiprora* sp; *Amphora* sp; *Asterionella japonica* Cleve; *Biddulphia sinensis* Gray; *Cerataulina bergoni* Peragallo; *Chaetoceros* spp; *Cocconeis* sp; *Corethron hystrix* Hensen; *Coscinodiscus* spp; *Coscosira* sp; *Cyclotella*

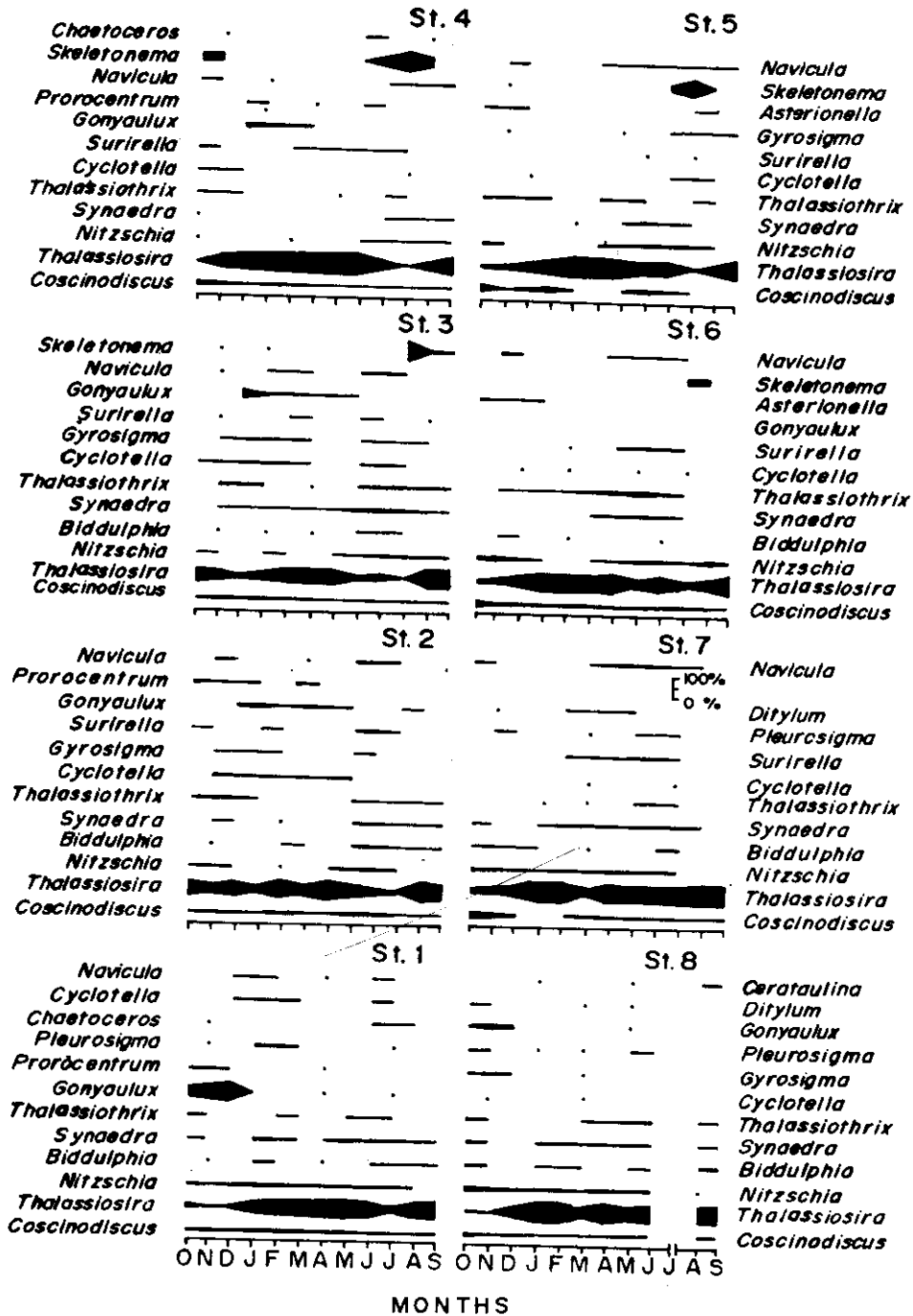


Fig. 4—Monthly variations in the occurrence of some dominant genera of phytoplankton.

*meneghiniana* Kutzing; *Denticula* sp; *Detonula* sp; *Diploneis weissflogii* (A. Schmidt) Cleve; *Ditylum sol* Grunow; *Fragillaria oceanica* Cleve; *Gyrosigma* spp; *Leptocylindrus minimus* Gran; *Navicula* spp; *Nitzschia bilobata* W. Smith; *N. closterium* (Ehrenberg) W. Smith; *N. seriata* Cleve; *Nitzschia* sp; *Pinnularia* sp; *Pleurosigma* spp; *Planktoniella sol* (Wallich) Schutt; *Raphoneis amphiceros* Ehrenberg; *Rhizosolenia* sp; *R. alata* Brightwell; *R. fragilisima* Bergon; *R. setigera* Brightwell; *Schroederella delicatula* (Peragallo) Pavillard; *Skeletonema costatum* (Greville) Cleve; *Surirella fluminensis* Grunow; *Synaedra* spp; *Thalassiosira subtilis* (Ostenfeld) Gran; *Thalassiothrix nitzschioides* Grunow; *Triceratium favus* Ehrenberg and *Tropidoneis* sp. The dinoflagellates: *Ceratium* sp; *Dinophysis* sp; *Gonyaulux* sp; *Prorocentrum* sp. *Thalassiosira*, *Cosinodiscus*, *Nitzschia* and *Synaedra* were found to be common in all seasons (Fig. 4). *Thalassiosira subtilis* was the most abundant species contributing on an average 51.8 to 67.5% of the total cell counts. *Skeletonema costatum* dominated at sts 3-5 during monsoon months, coinciding with low salinity and high nutrient concentrations. Generally, diatoms dominated and contributed more than 90% of the total counts. However, on a few occasions *Gonyaulux* sp. dominated the phytoplankton standing stock.

### Discussion

Indiscriminate disposal of sewage and industrial wastes have been a major cause for the nutrient enrichment in coastal waters resulting in a decrease in diversity and an increase in biomass promoting some opportunistic algal species to dominate and suppress others<sup>11,12</sup>. Increasing nutrients in the interior creek areas of Bombay must, therefore, have been stimulating excessive growth of a few tolerant phytoplankters leading to generally higher values of chlorophyll *a* at st. 4.

Higher rates of primary production in Thana creek region (st. 4) during all the seasons indicate a eutrophicated condition due to increased allochthonous input of inorganic and organic nutrients from urban and industrial settings. Earlier studies around Bombay<sup>7</sup> suggested enormous variations in primary production mainly due to indiscriminate disposal of wastes to be the cause.

Abundance of *Thalassiosira subtilis* in the entire BHTCBC confluence, particularly at st. 4 (av.  $1059.23 \times 10^3$  cells  $l^{-1}$ ) appears to be an adaptation of this species to the deteriorating water quality of this region. Species of *Thalassiosira* are known to bloom in areas affected by sewage pollution<sup>13,14</sup>. Besides implying the influence of sewage pollution on phytoplankton species composition and diversity, observations during this study serve to delineate their ability to adapt and proliferate under eutrophicated conditions. *Skeletonema costatum* dominance was found at sts. 3, 4 and 5 during monsoon. Harrison *et al.*<sup>15</sup> also reported such a rapid proliferation of this species in nutrient rich areas due to the input of organic wastes. Lower diversity indices in Thana creek region compared to those from relatively pollution free areas as reported elsewhere<sup>16</sup> also suggest deteriorating environmental quality in this study area.

As highlighted by several recent studies<sup>3-6,17</sup>, substantial inputs of various kinds of wastes into the coastal environs of Bombay has already begun to adversely affect the biology of this once very active fishing region. From this study, it is possible to suggest that pollutants from the Bombay metropolis have affected phytoplankton diversity and abundance.

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