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

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Annual variations in phytoplankton characteristics were studied from Bombay Harbour-Thanha creek-Bassein creek (BHTC CBC) 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 Synedra 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 mg m⁻³) and phaeophytin (av. 4.2 mg m⁻³), cell counts (av. 631.9±10¹³) and productivity (71.4 mgC m⁻³ 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 bays¹, adversely affecting the water quality and resulting in stress on the estuarine microflora² and fauna³. Earlier studies on phytoplankton around Bombay address only on primary productivity⁴,⁵. Overall phytoplankton characteristics from entire Bombay harbour-Thanha creek-Bassein creek (BHTC CBC) 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 BHTC CBC (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 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 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⁻¹ 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 nitrate concentration (34.5 µg-at l⁻¹) 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⁻¹) at st. 4 and least at st. 8 (1.2-2.3 µg-at l⁻¹). Chlorophyll a, phaeophytin, cell counts and column production were generally the

![Fig. 2](image-url)  
**Fig. 2**—Seasonal variations in hydrographic parameters at different sampling locations.

![Fig. 3](image-url)  
**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; Coscinosira 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. fragilissima Bergon; R. setigera Brightwell; Schroederella delicatula (Peragallo) Pavillard; Skeletonema costatum (Greville) Cleve; Surirella fluminensis Grunow; Synedra spp; Thalassiosira subtilis (Ostenfeld) Gran; Thalassiothrix nitzschioides Grunow; Triceratium favus Ehrenberg and Tropidelis sp. The dinoflagellates: Ceratium sp; Dinophysis sp; Gonyaulux sp; Procentrum sp. Thalassiosira, Cosinodiscus, Nitzschia and Synedra 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.

Abundance of Thalassiosira subtilis in the entire BHTCBC confluence, particularly at st. 4 (av. 1059.23×10³ 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.13,14 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.15 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 elsewhere16 also suggest deteriorating environmental quality in this study area.

As highlighted by several recent studies,3-6,17 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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