

Distribution and abundance of phytoplankton in the estuarine waters of Chennai, south east coast of India

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Abstract

Distribution and abundance of phytoplankton were studied from Adyar and Cooum estuaries at Chennai for a period of one year (April 1998 to March 1999). Physical and chemical parameters like temperature, pH, dissolved oxygen, salinity and phosphate were analysed. The high phosphate (1.45 ± 0.32 mg/l) content registered at Cooum estuary during postmonsoon season suggested that the freshwater influx could be the vital source of nutrients in the estuary. Among phytoplankton, diatoms were the dominant group represented by 43 taxa. The maximum abundance of total phytoplankton was recorded (12200 cells/l) during summer season at Cooum estuary. The low phytoplankton diversity and abundance are mainly due to the waste inflow through various freshwater input in the estuarine region.

Most aquatic ecosystems today are subjected to anthropogenic disturbances, which has considerable effects on habitat quality and associated biota. The current rapid rates of increase in urbanization, industrialization and over exploitation lead to changes in biomass, species composition and diversity (Chapin III *et al.*, 1997). Estuarine habitats situated along the Chennai coast are also exposed to hazards of variety of pollutants.

Adyar and Cooum are the two small urban estuaries along the Chennai coast confluenced by Bay of Bengal. They are shallow tidal estuaries flooded during monsoon months. Studies on ecology, characteristics and bloom forming species of phytoplankton have been carried out in many estuaries of India (Ramaiah and Ramaiah, 1998; Tiwari and Nair, 1998 and Perumal *et al.*, 1999). Phytoplankton

in particular play an important role in ecosystem because they form the basis of the food chain (Ryther, 1969). However, studies on phytoplankton distribution and abundance at Adyar and Cooum estuarine environment are very limited. In the present account an attempt has been made to study the spatio-temporal distribution of phytoplankton of the Adyar and Cooum estuaries of Chennai in relation to hydrological conditions.

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Material and methods

Adyar (latitude $13^{\circ}01'N$ and long. $80^{\circ}17'E$) and Cooum (lat. $13^{\circ}10'N$ and long. $80^{\circ}16'$) estuaries are bar built

estuaries situated at central zone of Chennai and formed by the confluence of river Adyar and Cooum with the Bay of Bengal (Fig.1). Freshwater inflow is conspicuous during monsoon months and the estuarine mouths remain closed during the rest of the year especially in the Cooum estuary.

Sampling was made at monthly intervals from April 1998 to March 1999 at the two estuaries. Water samples were collected in one litre pre-cleaned polypropylene bottles. Temperature was measured *in situ* with Merck mercury thermometer of 0.1°C accuracy. pH was measured with pH meter with reference

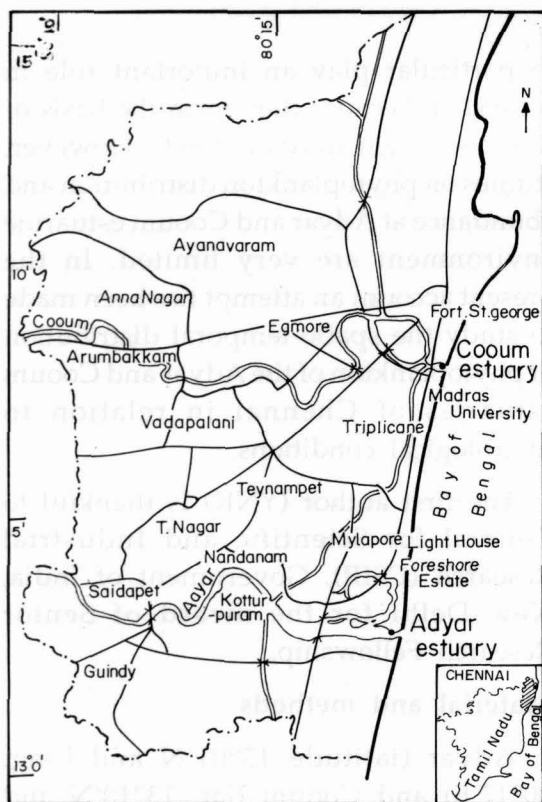


Fig.1 Location map of the study area

to a standard buffer solutions. Rainfall data was obtained from Meteorological Department, Nungambakkam, Chennai. Dissolved oxygen, salinity and phosphate were estimated by following methods given in APHA (1992).

Phytoplankton samples were collected by filtering of surface water through 63 mm mesh netting and preserved with 5% neutralised formaldehyde solution. Several keys (Venkataraman, 1939; Santhanam *et al.*, 1987; Anand, 1998) were used for identification of phytoplankton.

A 1 ml wide mouth pipette and Sedgwick Rafter counting cell were used for subsampling and counting of phytoplankton. The identification and counting were done using an inverted microscope (Nikon) at a magnification of 100x. For easy interpretation, the calendar year was divided into four seasons *viz*; Summer (April -June), premonsoon (July -September), Monsoon (October-December) and postmonsoon (January - March).

Results and discussion

The hydrological features as well as the phytoplankton abundance of these two estuaries are subjected to wide seasonal variations. The maximum rainfall (523.6 mm) was observed during monsoon season with an annual mean of 169.4 mm (Fig.2). The seasonal difference in rainfall has a significant impact on the physico-chemical characteristics of the estuaries. The lowest mean value of surface water temperature (27.67 ± 0.36 and $27.5 \pm 0.39^\circ\text{C}$) were noticed during monsoon

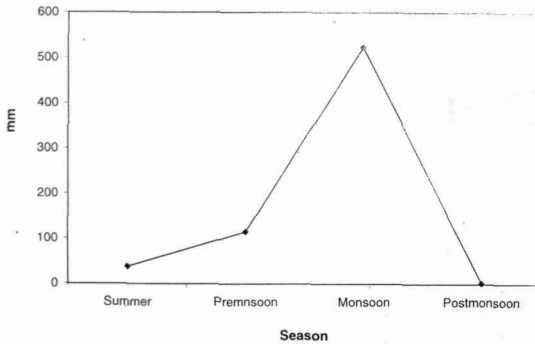


Fig.2 Seasonal variation of rainfall data during the study period

(Cooum) and premonsoon (Adyar) seasons respectively. In general, temperature was high during summer season when compared to other seasons (Fig.3). pH was mostly alkaline and the values ranged between 7.33 ± 0.18 to 8.0 ± 0 . The low pH values observed during monsoon season are clearly due to the heavy freshwater inflow into the estuary.

Dissolved oxygen content was relatively high at Adyar estuary (4.74 ± 0.63 mg/l). High dissolved oxygen content (4.74 ± 0.63 mg/l) was noticed during the premonsoon season at Adyar and monsoon season (4.03 ± 0.58 mg/l) at Cooum estuary (Fig.3). This is attributed to the variations in freshwater inflow and tidal ingress (Nagarajaiah and Gupta, 1983; Xavier *et al.*, 1998). Further, the total depletion of dissolved oxygen content at Cooum estuary during premonsoon season may be due to the utilization of organic matter in the sediment and constant sewage disposal along with other contaminated waste waters by river inflow (Azariah and Damodaran, 1986; Vijayakumar *et al.*, 2000).

Seasonal variation of salinity at Adyar and Cooum estuaries are shown in Fig.3. High seasonal mean values recorded were 34.3 ± 0.34 and 32.5 ± 0.46 ppt during postmonsoon and summer season respectively. Recording of high salinity during the summer season may be due to the low amount of rainfall and high rate of evapotranspiration (Govindaswamy *et al.*, 2000). The seasonal mean salinity was low (11.87 ± 1.02 ppt) during monsoon season at Cooum estuary. It may be due to the incursion of fresh river water. Similar observations were reported by Padmavathi and Satyanarayan, 1999).

The seasonal distribution of phosphate concentration in surface waters varied between 0.19 ± 0.14 to 1.45 ± 0.52 mg/l (Fig.3). In general, phosphate concentration gradually increased from summer to post monsoon seasons. Maximum concentration (1.45 ± 0.32 mg/l) recorded during post monsoon period might have been promoted by the liberation of inorganic phosphate from sediments under high oxygen tension and also due to the fresh water inflow in the river (Chandran and Ramamoorthy, 1984; Das *et al.*, 1997).

A total number of 59 genera of phytoplankton were recorded during the study period. Out of this, the diatoms were represented by 45 taxa followed by 8 green algae, 5 dinoflagellates and 3 blue green algae. Diatoms were the dominant group, accounting for 79.4% and 52.6% of total phytoplankton count (Fig.4). Whereas, the maximum number of phytoplankton (48

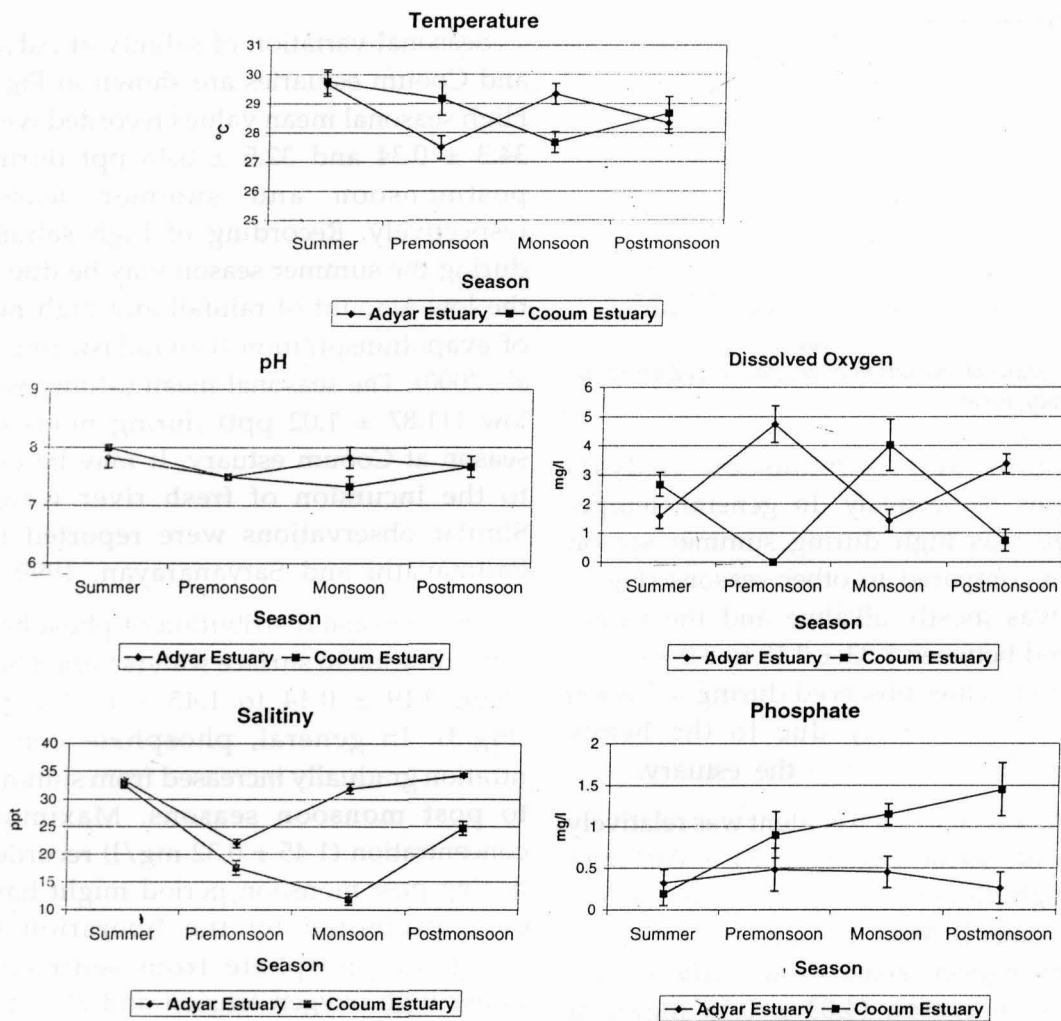


Fig.3 Seasonal mean and S.E. of physical and chemical parameters in the estuarine waters of Chennai.

genera) were recorded at Adyar estuary (Table 1).

The dominant diatoms recorded at Cooum estuary was *Coscinodiscus* sp. and *Nitzschia* sp. At Adyar estuary, *Pleurosigma elongatum*, *Pleurosigma* sp., *Coscinodiscus* and *Navicula* sp. were the common and dominant species. The common green algae species found during the study period was the *Ulothrix zonata* and

Spyrogyra sp. Whereas, dinoflagellates were represented by *Ceratium tripos* and *Triceratium* sp.

Distinct seasonal variation in phytoplankton abundance was noticed during the study period. Maximum phytoplankton abundance (12,200 cells/l) was recorded during summer season at Cooum estuary (mean salinity 32.55 ± 0.46 ppt) whereas, at Adyar estuary the total

Table 1. Occurrence of common phytoplankton taxa at Adyar and Cooum estuaries

Phytoplankton	Adyar Estuary	Cooum Estuary
DIATOMS		
<i>Achnanthes brevipes</i>	+	-
<i>Achnanthes coarctata</i>	+	-
<i>Amphora paludosa</i>	+	-
<i>Asterionella</i> sp.	-	+
<i>Asterionella gracilis</i>	+	-
<i>Bacteriastrium comosum</i>	+	-
<i>Biddulphia mobiliensis</i>	-	+
<i>Biddulphia heteroceros</i>	-	+
<i>Chaetoceros</i> sp.	-	+
<i>Chaetoceros orientalis</i>	+	-
<i>Chaetoceros diversus</i>	+	-
<i>Coscinodiscus gigas</i>	-	+
<i>Coscinodiscus</i> sp.	+	+
<i>Coscinodiscus radiosa</i>	+	-
<i>Cymbella</i> sp.	-	+
<i>Denticula</i> sp.	+	-
<i>Diploneis interrupta</i>	+	-
<i>Dytellum</i> sp.	+	-
<i>Fragilaria intermedia</i>	+	-
<i>Fragilaria</i> sp.	-	+
<i>Gyrosigma balticum</i>	+	-
<i>Gyrosigma</i> sp.	+	+
<i>Mastogloia brauni</i>	+	-
<i>Mastogloia dolosa</i>	+	-
<i>Navicula cuspidata</i>	+	-
<i>Navicula balinarum</i>	+	-
<i>Navicula cinta</i>	+	-
<i>Navicula</i> sp.	+	-
<i>Neridium ampliatum</i>	+	-
<i>Neridium affinie</i>	+	-
<i>Neridium iridis</i>	+	+
<i>Nitzschia</i> sp.	+	-
<i>Nitzschia obtusa</i>	+	+
<i>Nitzschia vitrea</i>	+	+
<i>Pinnularia fasciata</i>	+	-
<i>Planktoniella sol</i>	+	+
<i>Pleurosigma angulatum</i>	+	-
<i>Pleurosigma elongatum</i>	+	-
<i>Pleurosigma normanii</i>	+	-
<i>Pleurosigma</i> sp.	+	-
<i>Synedra ulna</i>	-	+
<i>Thalassiothrix frauenfeldii</i>	-	+
<i>Thalassionema</i> sp.	-	+

<i>Triceratium</i> sp.	-	+
<i>Triceratium favus</i>	+	+
DINOFLAGELLATES		
<i>Ceratium tripos</i>	-	+
<i>Ceratium dens</i>	-	+
<i>Peridinium murrayi</i>	+	+
GREEN ALGAE		
<i>Closterium</i> sp.	+	-
<i>Closteriopsis longisemma</i>	+	-
<i>Closteridium setacium</i>	-	+
<i>Spirataenia condensata</i>	+	-
<i>Spirogyra</i> sp.	+	-
<i>Stigeoclonium</i> sp.	+	-
<i>Ulothrix</i> sp.	-	+
<i>Ulothrix zonata</i>	+	+
BLUE GREEN ALGAE		
<i>Oscillatoria</i> sp.	+	-
<i>Synechocystis</i> sp.	-	+
<i>Trichodesmium</i> sp.	+	-

- Absence + Presence

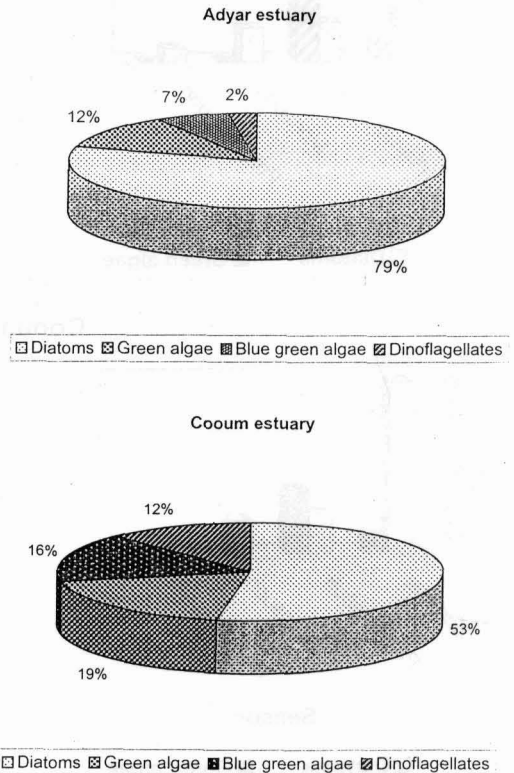
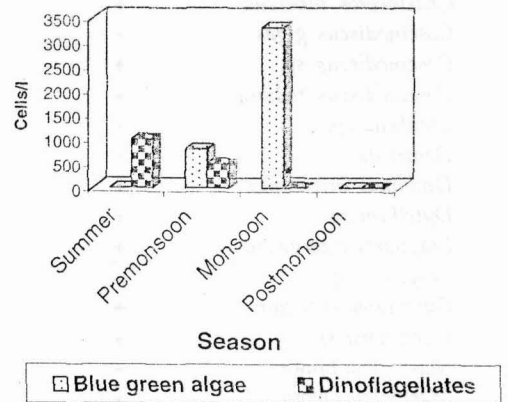
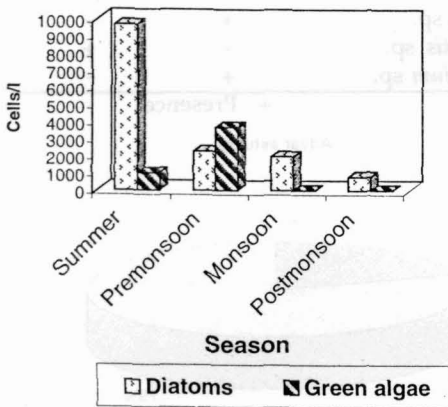


Fig.4 Percentage composition of major phytoplankton groups in the estuarine waters of Chennai

phytoplankton abundance showed maximum values (11,600 cells/l) during summer season with a seasonal mean salinity of 33.35 ± 0.34 ppt. It is evident from this that the salinity influences the phytoplankton abundance at estuarine water. Moreover, the higher solar irradiance might have promoted the maximum phytoplankton production during warmer months (Mallin *et al.*, 1994).

The maximum seasonal mean abundance of diatoms (8,700 cells/l) were found during summer season at Cooum estuary. In the case of Adyar estuary, the maximum abundance was noticed (8050 cells/l) during postmonsoon season (Fig.5). The green algae, blue green algae and dinoflagellates are completely absent during postmonsoon season at Cooum estuary. The seasonal abundance of green algae ranged between 800-3300 cells/l at

Adyar Estuary



Cooum Estuary

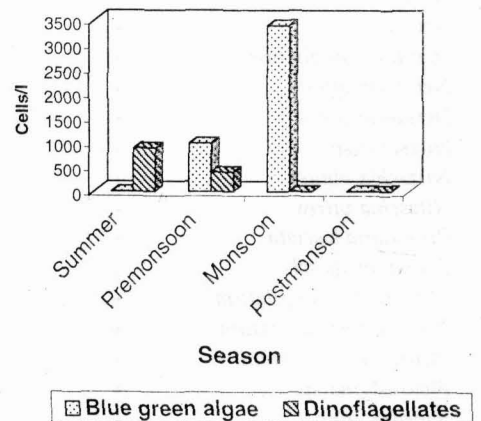
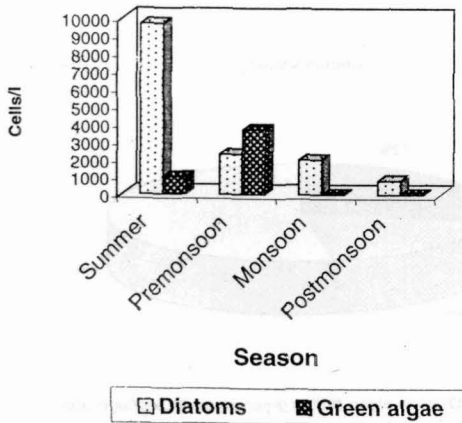


Fig.5 Seasonal mean abundance of phytoplankton during the study period

Cooum estuary and 150-1500 cells/l at Adyar estuary respectively. The maximum seasonal abundance of dinoflagellates (2500 cells/l) found at Cooum estuary and minimum abundance (200 cells/l) was found at Adyar estuary during summer season.

The present study shows that the low phytoplankton occurrence was mainly caused by the waste inflow through the freshwater input. Moreover, the urban untreated wastewater also discharges enormous amount of pollutants into this estuary. The disturbance of phytoplankton abundance and diversity are reflected in the status of estuarine system diversity and productivity as a whole. The present baseline information on the phytoplankton distribution and abundance are useful for further ecological assessment and monitoring of the coastal ecosystem of Chennai.

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