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Phytoplankton diversity in the Coleroon Estuary, southeast coast of India

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Abstract

The results of an investigation carried out during September 1999 to August 2000 on hydrography, composition and community structure of phytoplankton including chlorophyll 'a' (Chl-*a*) content and primary productivity (PP) of the Coleroon Estuary (Southeast coast of India) are reported. The concentration (μm) of nitrate and phosphate ranged from 7.9-69.9 and 0.9-9.0 respectively. The ranges of values of Chl-*a* (mg m^3) and PP (mg C m^3 hr^1) were 1.7-3.2 and 0.2-2.1. While the peak diversity (4.32 bits/ind.) of the phytoplankton was observed during premonsoon season, the maximum population density (37,127 cells/l) was found during summer. The spatio-temporal variations observed in the hydrobiological features appeared to be related to the pattern of meteorological events. The Coleroon Estuary is more fertile and supports a rich and diverse phytoplankton.

Keywords: Coleroon Estuary, diversity of phytoplankton

Introduction

The phytoplankton is responsible for the process of primary production in water bodies and also form a vital source of energy. They serve as bio-indicators with reference to water quality and thus serve as a tool for assessing the health of the aquatic ecosystems. Phytoplankton may also be used to trace climatic changes in different geological periods and currently they are used as live-feed for zooplankton and the larvae of aquatic invertebrates and vertebrates in hatcheries. In recent years it was increasingly felt to explore and exploit all possible aquatic food resources to meet the nutritional requirements of the ever-increasing human population. In this context it is all the more essential to assess the production at primary (phytoplankton), secondary (zooplankton) and tertiary (fish and others) levels in water bodies. Coleroon Estuary is one of the biggest and famous rivers of Tamil Nadu, situated at Pazhayaru (Lat. 11° 21 N', Long 79° 50' E) on the southeast coast of India (Fig.1). During the nineties many shrimp farms were established along the southern side of this estuary. Reports on the hydrobiology with reference to plankton in this estuary is limited to the works of Prabha Devi (1986), Jagadeesan (1987) and Patterson Edward (1989). And hence the present investigation on these aspects was undertaken from September 1999 to August 2000.

Materials and methods

Monthly surface samplings were made from Coleroon Estuary covering two stations (Station 1 - Coleroon mouth & Station 2 - at the estuary). The water samples were collected and used for the analyses of hydrographical parameters, primary productivity and chlorophyll *a*. Nitrate and phosphate were analysed following Strickland and Parsons (1972). The primary productivity was measured by adopting the light and dark bottle method as described by Strickland and Parsons (1972). For chlorophyll *a* measurement, the methods of Parsons *et al.*, (1984) were followed. Phytoplankton samples were collected by plankton net made up of bolting silk cloth (No.30, mesh size 48μm) and preserved in 5% neutralised formalin for qualitative analysis. For the quantitative analysis of phytoplankton, the settling method of Sukhanova (1978) was followed. Biodiversity indices such

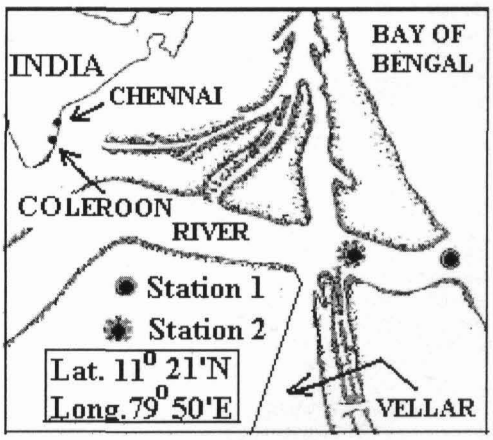

Fig.1 Map showing the location of sampling areas

as species diversity, evenness and richness were calculated following the standard formulae (Shannon and Weaver, 1949; Pielou, 1966; Gleason, 1922).

Results

The (SST) sea surface temperature (°C) and salinity ranged from 24-32; 24.1-34 and 3.0-34.5; 2.0-33.6 at stations 1 and 2 respectively (Fig.2). The nitrate and phosphate ranged from 7.9-53.0; 8.4-69.9 and 0.9-4.2; 1.5-9.0 at stations 1 and 2 respectively. The primary production values (mg $Cm^{-3}hr^{-1}$) ranged between 0.2 and 1.7 at st.1 and 0.3 and 2.1 at st.2 (Fig. 2). The ranges of chlorophyll *a* (mg m^{-3}) concentration were 1.7-3.0 (st.1) and 1.9-3.2 (st.2). While the higher values of primary

Table 1. *List of phytoplankton species recorded at Coleroon Estuary (September 1999 to August 2000)*

Bacillariophyceae (Diatoms)

Amphora coffeaeformis (Ag) Kutz
Asterionella japonica Cl.& Moller
Bacteriastrum comosum Pavillard
B.delicatulum Cleve
Bacillaria paradoxa Gmelin
Bellerochea malleus (Btw.)V.H
Chaetoceros affinis Lauder
C.diversum Cleve
C.lorenzianus Grun
C.peruvianus Brightwell
C.decipiens Cleve
Coscinodiscus centralis Ehrenberg
C.excentricus Ehrenberg
C.gigas Ehrenberg
C.jonesianus (Greg) Ostenf
C.radiatus Ehrenberg
C.marginatus Ehrenberg
Cyclotella stelligera (Cl. & Grun)
Ditylum brightwellii Grunow
Eucampia zodiacus Ehrenberg
Fragillaria oceanica CL.
Fragillaria sp.
Guinardia flaccida (Castracane)
Hemidiscus hardmanianus H.Peragallo
Lauderia annulata Cleve
Melosira sulcata (Ehn.) Kutzing
M.mondiformis (Mueller)
Navicula granulata Berb. & Her.
Nitzschia closterium Ehrenb.
N.paradoxa (Gmelin) Grun.
N.seriata Cl.
N.panduriformis Gregory
Odontella sp.
O.heteroceros Grun.
O.sinensis Grev.
O.mobiliensis (Bailey) Grun
Pleurosigma destuarii Berb.W. Sm
P.angulatum (Kuetz) W. Sm
P.elongatum W. Sm
P.normanni Ralfs
P.carinatum Donk
Planktoniella sol (Wallich) Shuti
Rhizosolenia alata (Cleve) Gran
R.hebetata Bail.
R.imbricata (Cleve) Schroder
Skeletonema costatum (Grev.) Cleve
Thalassiothrix frauenfeldii Grunow
Thalassionema nitzschioides (Grun.) Meresch
T.subtilis (Ostenf.) Gran
Triceratium favus Ehrenberg
Trigonium reticulum Ehrenberg

Dinophyceae(Dinoflagellates)

Amphisolenia bidentata Schroder
Ceratium furca (Ehrenberg)
C.macroceros (Her.) Cleve
C.fusus (Ehrenberg) Dujardin
Ceratium extensum (Paul.) Balch
C.tripos (O.F.Mull) Nitzsch
C.trichoceros (Ehr.) Kofoid
C.breve (Ost. Schm.)
Dinophysis caudata Saville Kent
D.hastata Steris
Gymnodinium breve Davis
Gonyaulax digensis Kofoid
Noctiluca scintillans Macarthey
Ornithoceros steinei Sch.
Protoperidinium pellucidum (Berg) Balech
P.conicum (Gran.) Ostenf & Schmidt
Prorocentrum rostratum Stein
P.micans Ehrenberg
Pyrocystis fusiformis W. Thompson
P.pseudonoctiluca W. Thompson

Cyanophyceae (Blue-Greens)

Trichodesmium erythraeum Ehrenberg
Anabaena sp.
Spirulina major Kutz
Oscillatoria sp.
Nostoc sp.
Lyngbya sp.
Microcystis sp.

Chlorophyceae (Greens)

Chlorella vulgaris Beji
Spirogyra indica Rao
Volvox sp.
Ulothrix sp.
Pediastrum sp.

Chrysophyceae (Silicoflagellates)

Distephanus speculum (Ehr.) Haeckel

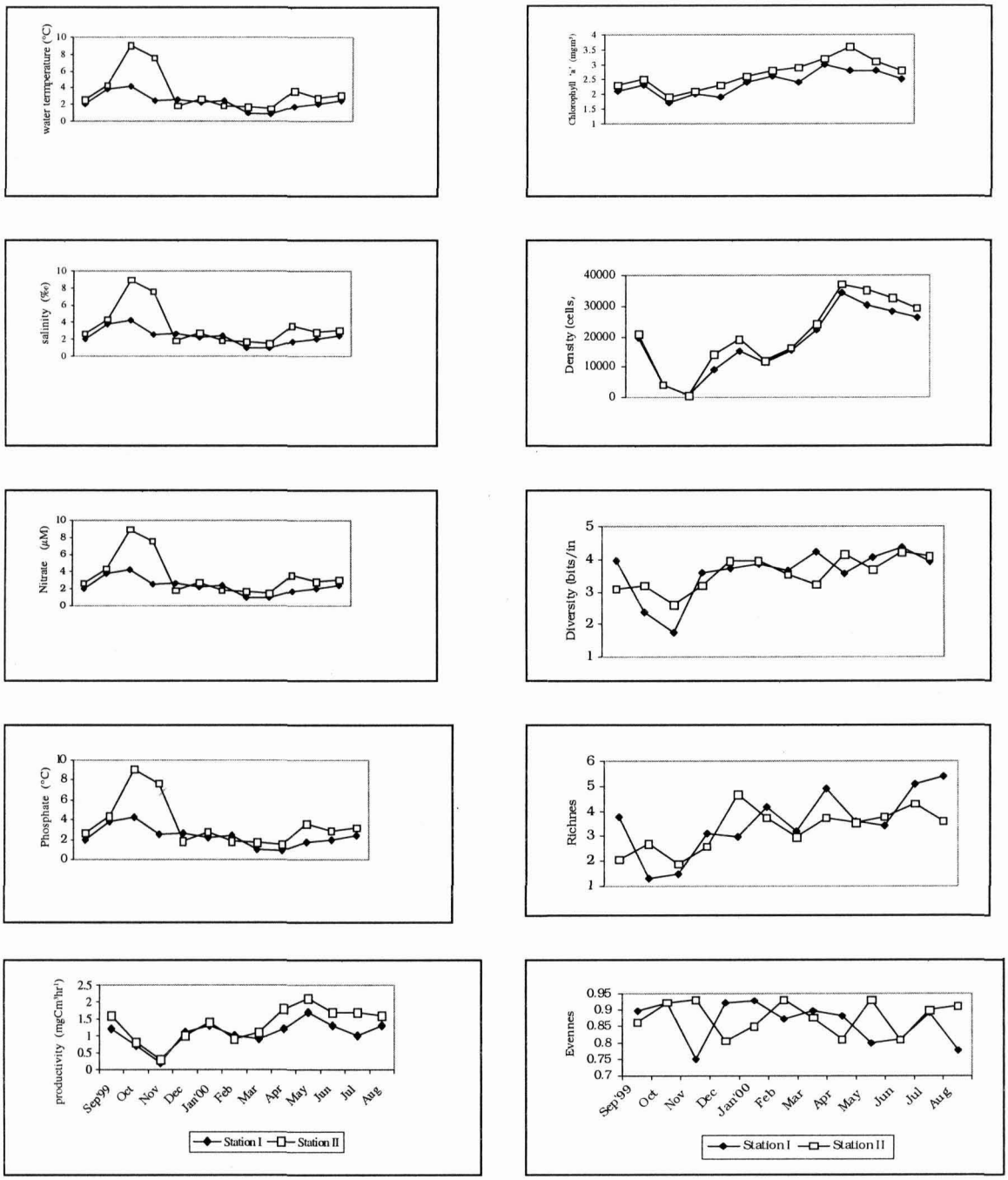

Fig. 2. Variations in hydrobiological parameters of Coleroon Estuary.

productivity and chlorophyll *a* were recorded during summer, the low values were observed during monsoon.

The study recorded 84 phytoplankton species belonging to diverse groups viz. Bacillariophyceae (51), Dinophyceae (20), Cyanophyceae (7), Chlorophyceae (5) and Chrysophyceae (1) (Table 1). The ranges of phytoplankton population density (Cells/l) were: 621-34,450 (st.1); 821-37,127 (st.2). The maximum density was during summer and minimum during monsoon. While the population density showed positive correlation with temperature and salinity, it indicated negative relation with nutrients at both the stations (Table 2). The ranges of species diversity, richness and evenness at stations 1 and 2 were: 1.73-4.32, 1.30-5.41, 0.74-0.92 and 2.61-4.21, 1.86-4.70, 0.80-0.93 respectively. The least values of biodiversity indices were recorded during monsoon season, but were higher during other periods.

Discussion

The northeast monsoon-rainfall played a major role in the variations of biotic and abiotic characters of Coleroon estuarine system. The recorded maximum SST during summer season could be attributed to the dry weather condition and clear sky (Goswami and Padmavathy, 1996). Also the recorded low salinity during monsoon season was owing to the heavy rainfall and fresh water inflow to the estuary. The higher salinity observed during summer season could be attributed to low rainfall, reduction in river runoff and dominance of neretic waters (Ananthan, 1994; Santhanam, 2002). Nutrients like nitrate and phosphate influenced the productivity of the estuary which were always higher during the monsoon season due to river run-off and rapid oxidation of plankton detritus and decomposing matter (Sivakumar, 1982; Nedumaran *et al.*, 2001). The excretion of phosphorous and nitrogenous compounds by zooplankton population is a substantial and important part of the nutrient cycle (Ketchum, 1962; Krishnamurthy, 1970).

Table 2. *Correlation coefficient matrix among phytoplankton population density and physico-chemical parameters at stations 1 and 2 of Coleroon Estuary.*

	Station 1	Station 2
Parameter	Population density r value	Population density r value
S.W.temp	0.060**	0.490
Salinity	0.824***	0.873***
Nitrate	-0.868***	-0.806***
Phosphate	-0.837***	-0.587*

* P < 0.05; ** P < 0.01; *** P < 0.001

High primary productivity was observed during the summer season because of high salinity, surface water temperature and high population density of phytoplankton (Jagadeesan, 1987; Rajasekar *et al.*, 2000; Senthilkumar *et al.*, 2002). During the present investigation, a gradual reduction in primary production was found from creek towards the mouth of the estuary. This is similar to the observations made by Aarati *et al.* (2003) in Achara Creek of Maharastra. The high turbidity and low light intensity were mainly responsible for the recorded low primary productivity during monsoon season (Gowda *et al.*, 2002). The observed low chlorophyll values during the monsoon season might be ascribed to the washing away of phytoplankton into the sea due to heavy rain and high turbidity of water and this is in agreement with the earlier reports (Saraswathi, 1993; Mathavan Pillai, 1994).

During the present investigation, diatoms formed the major component of phytoplankton population, which could be related to their tolerance to the dynamic environmental conditions and euryhaline nature. The stable hydrographical features prevailed during summer season resulted in denser phytoplankton production. The rainfall and consequent reduction in salinity during monsoon drastically reduced the population density. The observed high summer population of phytoplankton could be mainly ascribed to the recorded favourable salinity regime as supported by the obtained significant positive correlation ($r = 0.874$; $P<0.001$ at stn 1; $r = 0.8736$; $p < 0.001$ at st.2) (Table-2). Similar findings were earlier reported from Pichavaram mangrove waters (Mani, 1992), Gopalpur coastal waters (Rajashree Gouda and Panigrahy, 1996) Cuddalore-Uppanar back water (Murugan and Ayyakkannu, 1989) and from Vellar Estuary (Perumal *et al.*, 1999; Senthilkumar *et al.*, 2002). The higher population density of phytoplankton was observed at estuary (than the estuarine mouth) because the estuary received more organic matter from catchment areas. Abdul Lathif (2001), who investigated the zooplankton production around that period (July 2000-April 2001) at Coleroon estuary, reported higher values of zooplankton density (individuals/l) with a maximum of 29,000 at the estuarine biotope and 24,000 at Coleroon mouth. The phytoplankton population density was found to be higher in summer season at both the stations but the species diversity values were observed to be higher only during pre-monsoon period which could be related to the abundance of allochthonous species (Mani and Krishnamurthy, 1989).

The summer peaks in species richness were recorded in the present study and this is similar to the earlier observation from the Arasalar and Kaveri estuarine waters (Saraswathy, 1993; Bragadeeswaran, 2002). The higher values of evenness recorded during the postmonsoon

season coincided with the lower population density of phytoplankton (Gandhiyappan *et al.*, 2001). From the above discussion, it is concluded that the Coleroon estuary is more fertile with rich phytoplankton productivity.

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