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Biodiversity of cyanobacteria from Uppanar estuary, south-east coast of India

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Abstract

The spatial and seasonal patterns of distribution of cyanobacterial species and their abundance in relation to physicochemical parameters were studied during April, 2002 to March, 2003 from two stations of Uppanar estuary in the south-east coast of India (Lat. 11°42'N: Long. 79°49'E). Presently 15 species of cyanobacteria were recorded which belong to different families viz. Chroococcaceae (4), Oscillatoriaceae (7) and Nostocaceae (4). The concentration of nutrients was low during summer season and more number of cyanobacteria was recorded in monsoon season.

Key words: Physico-chemical, Cyanobacteria, Seasonal distribution, Uppanar estuary

Introduction

Estuaries act as natural laboratories for studying the dynamics of terrigenous chemical constituents borne by the river water on their way in to the sea, alongwith interactions and adaptations of organisms to wide range of environmental situations. Hydrographic features like temperature, salinity, dissolved oxygen, pH and transparency constitute the important environmental requisites which govern the distribution and abundance of flora and fauna in estuaries (Rajashree Gouda and Panigrahy, 1993). Cyanobacteria are oxygen evolving photosynthetic prokaryotes, which inhabit various types of marine environments. They occur in oceans, estuaries, saline backwaters, salt lakes, salt marshes and hypersaline salt pans (Fogg et al., 1973).

Cyanobacteria are photoautotrophic picoplankton distributed over vast tracts of the world's oceans where they occupy a key position at the base of the marine food web and contribute significantly to global primary productivity (Partensky et al., 1999). The cyanobacteria are found distributed from polar through temperate to tropical waters and are generally more abundant in nutrients rich surface waters. The basic and fundamental requirement for initiating marine cyanobacterial biotechnology is first to enumerate the natural biodiversity and to understand their innate properties which could be useful for a variety of purposes. Hence, the present investigation of the Uppanar estuary was taken up to understand the seasonal variations of various physico-chemical characteristics and their influence on the cyanobacteria in uppanar estuary.

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Materials and Methods

Uppanar estuary (Lat. 11° 42' N; Long 79° 49'E) (Figure 1) is formed by the confluence of Gadilam and Paravanar rivers, and opens in to Bay of Bengal near Cuddalore old town on the south east coast of India. The present study is focussed on the various hydro- biological and ecological parameters of the Uppanar estuary. Surface water samples were collected from Uppanar estuary covering two stations (Station 1 - mouth and station 2 - estuary) at monthly intervals for a period of one year from April 2002 to March 2003, for the estimation of various physicochemical parameters.

Rainfall data were obtained from the Statistical (Meteorological) Department at Cuddalore. Temperature (air and surface water) was measured using a standard centigrade thermometer; light penetration in the water column was measured with the help of a Secchidisc and the light extinction co-efficient (LEC) was calculated using formula of Pool and Atkins (1929). Salinity was estimated

with the help of a Salinometer Model-E-2 and pH was measured using an Elico pH meter (Model L`-120).

Dissolved oxygen, nutrients like nitrate, nitrite, phosphate and reactive silicate were estimated adopting the standard procedure described by Strickland and Parsons (1972).

Planktonic cyanobacteria were collected using the plankton net made up of bolting silk cloth No. 25 (pore size 64 µM) and the net was towed for 15 minutes in the surface water. The collected planktonic sample was transferred to the laboratory. A portion of this sample was preserved in 5% formalin and subsequently the sample was analyzed under the microscope. Identification of specimen was done using the taxonomic publications (Biswas, 1949; Geitler, 1932; Prescott, 1951; Desikachary, 1959; Anand et al., 1986).

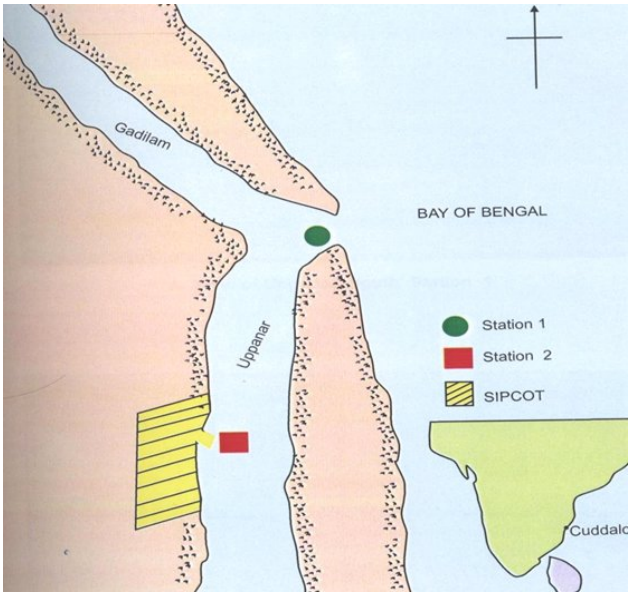

Figure 1. Map showing the study area.

Results and Discussion

The physicochemical characteristic features of the estuarine system which closely follow the pattern of river runoff and tidal variations were mostly controlled by the seasonal regimes. Rain fall is the most important cyclic phenomenon and it brings about important meteorological changes in the physical and chemical characteristics of the coastal and estuarine environments. In the present study, peak values of rainfall were recorded during the monsoon season in October, 2002 (222. mm) (Figure 2). This is because, the study area received bulk rainfall during the northeast monsoon compared to the south west monsoon (May to July).

Temperature variations in the estuarine environment can influence the other physicochemical characteristics. High atmospheric temperature was recorded during the summer season (Figure 3) due to clear sky with more solar radiation less solar radiation with cloudy sky and more rainfall during the monsoon season greatly reduced the atmospheric temperature. The surface water temperature largely depends on the intensity of solar radiation, evaporation and fresh water influx. The presently recorded summer peaks 33°C at Station – 1 and 32.1°C at station – 2 (Figure 4) are closely resemble the data generated earlier by several workers from the east and west coast of India (Vijayakumar et al., 2000; Srinivas Rao and Umamaheswara Rao, 2002).

Light extinction co-efficient (k) at both the stations was high during the monsoon season (Figure 8) due to low intensity of solar radiation, higher concentration of dissolved organic matter, suspended sediments, increased freshwater discharge, wave action and wind action. Similar observations have been made from Vellar estuary by Mani (1989) and Sujata Mishra et al. (1993) from Bahuda estuary. Low light extinction co-efficient was observed during summer season at both stations and it could be due to the high solar penetration, reduced freshwater inflow and land run-off. In general, these values were high during rainy months mostly due, to the biogenic turbidity of the water column. This was due to the monsoon floods which brought in lot of silt and terrigenous material to the biotope coupled with reduced of sunshine (Subramanian and Kannan, 1998).

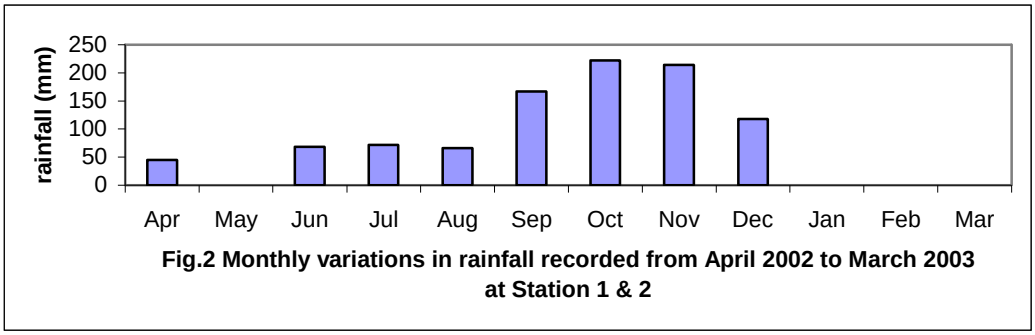

Fig.2 Monthly variations in rainfall recorded from April 2002 to March 2003 at Station 1 & 2

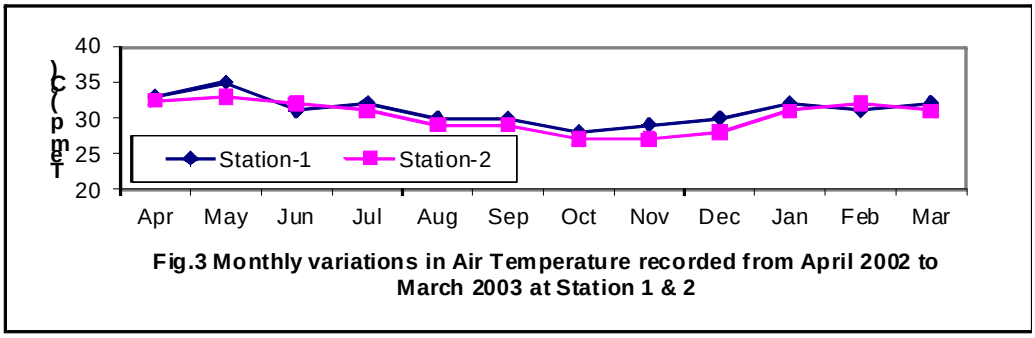

Fig.3 Monthly variations in Air Temperature recorded from April 2002 to March 2003 at Station 1 & 2

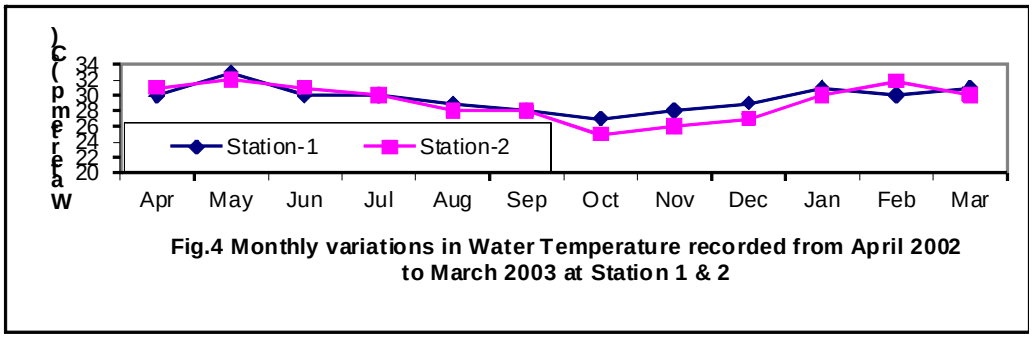

Fig.4 Monthly variations in Water Temperature recorded from April 2002 to March 2003 at Station 1 & 2

Salinity at both stations showed high values during the summer season due to less rain fall, decreased freshwater inflow and rise in temperature of the estuary and low during the monsoon season due to high rainfall and land runoff. Salinity is one of the important factors which profoundly influence the abundance and distribution of the fauna and flora in the estuarine environment which in turn depends on the inflow of fresh water and the prevailing temperature. During the monsoon season low salinity recorded (Figure 5) due to heavy rainfall and large quantity of fresh water inflow. Thus, the variations in salinity were mainly influenced by the rainfall and entry of freshwater (Sasinayar et al., 2000).

The pH was higher during the summer season while it was low during the monsoon period (Figure 6) due to the uptake of CO_2 by the photosynthesizing organisms, especially phytoplankton and planktonic cyanobacteria from the seawater could have increased the pH level during the summer season (Subramanian and Mahadevan, 1999). The low pH observed during the monsoon due to the influence of freshwater influx and dilution of seawater, reduction of salinity and temperature and decomposition of organic matter (Zingde et al., 1987; Subramanian and Kannan, 1998).

Dissolved oxygen concentration varied from 2.8 to 6 ml/l at station-1 and from 3.2 to 6.3ml/l at station-2 (Figure 7) with the maximum during the monsoon season in November and minimum during the post monsoon in March at both the stations. Distribution and behavior of nutrients in the coastal environments particularly in the nearshore waters and estuaries would exhibit considerable seasonal variations depending upon the local conditions of rainfall, fresh water inflow, tidal incursion and some biological activity (Choudhary and Panigrahy, 1991).

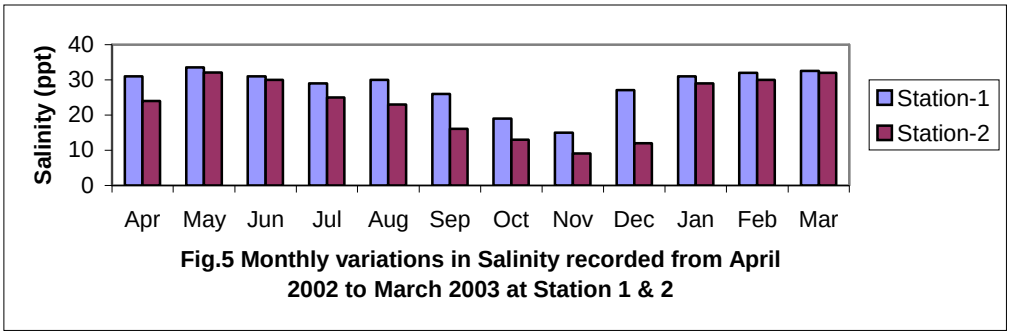

Fig.5 Monthly variations in Salinity recorded from April 2002 to March 2003 at Station 1 & 2

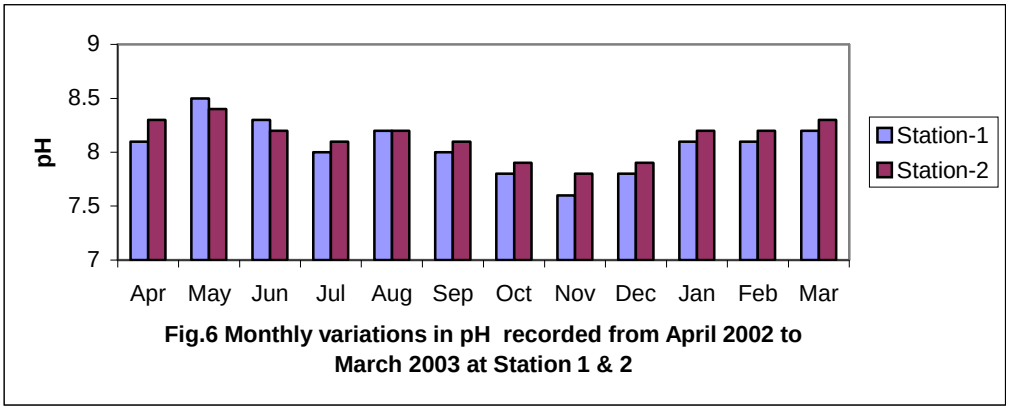

Fig.6 Monthly variations in pH recorded from April 2002 to March 2003 at Station 1 & 2

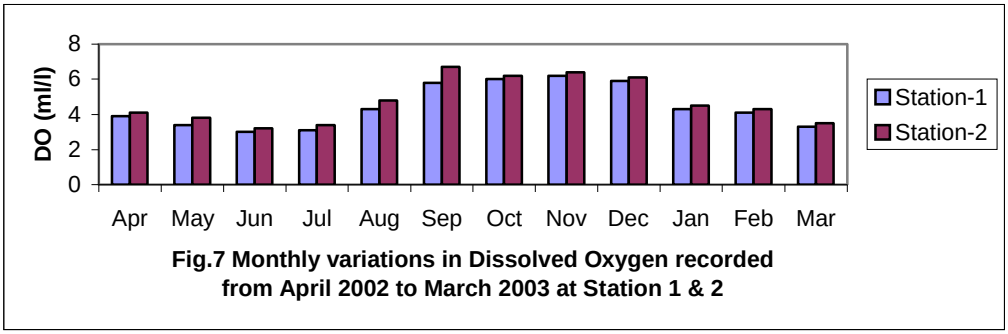

Fig.7 Monthly variations in Dissolved Oxygen recorded from April 2002 to March 2003 at Station 1 & 2

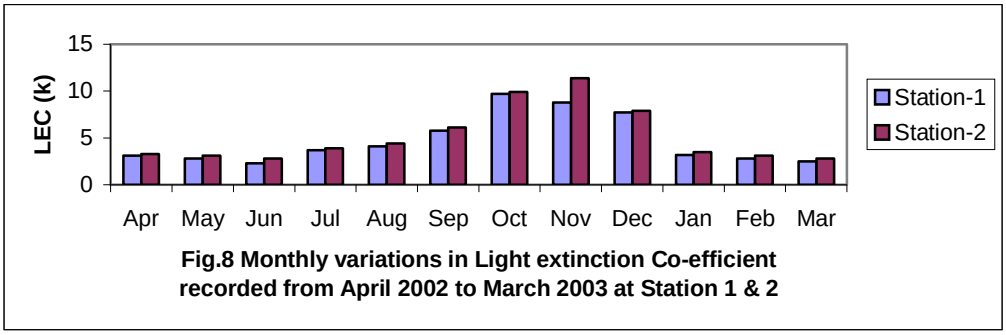

Fig.8 Monthly variations in Light extinction Co-efficient recorded from April 2002 to March 2003 at Station 1 & 2

The higher values of nitrate during the monsoon could be due to heavy rainfall, river and terrestrial run – off (Padmavathi and Sathyanarayana, 1999). The low nitrate concentration during the summer season: 9.04 µm at station-1 and 9.75 µm at station – 2 (Figure 10) were observed during summer months and at the end of the post monsoon which could be attributed to the rapid utilization of nitrate by phytoplankton and Cyanobacteria, (Panigrahy et al., 1999). The higher values of nitrite concentration recorded (Figure 9) at both stations during the monsoon season could be related to the terrigenous input by river and the low values of nitrite observed during the summer season might be due to the lesser amount of freshwater inflow and higher salinity (Sasinayar and Gouda, 1999).

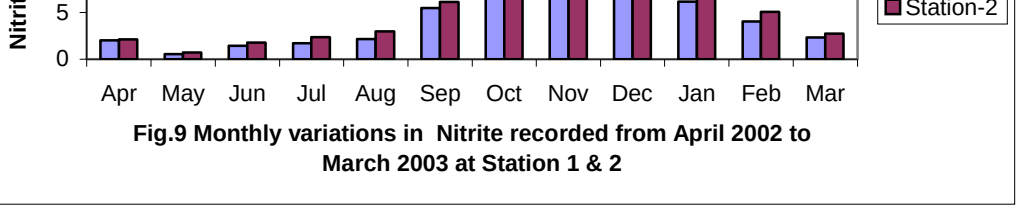

Fig.9 Monthly variations in Nitrite recorded from April 2002 to March 2003 at Station 1 & 2

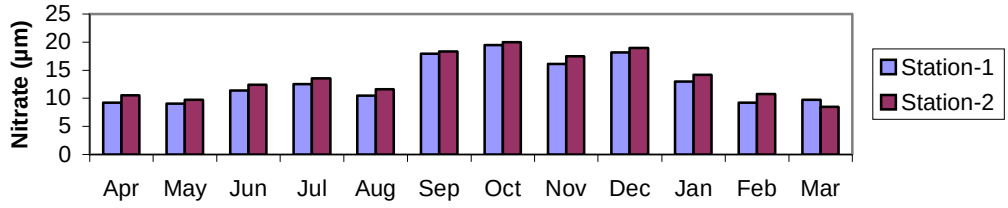

Fig.10 Monthly variations in Nitrate recorded from April 2002 to March 2003 at Station 1 & 2

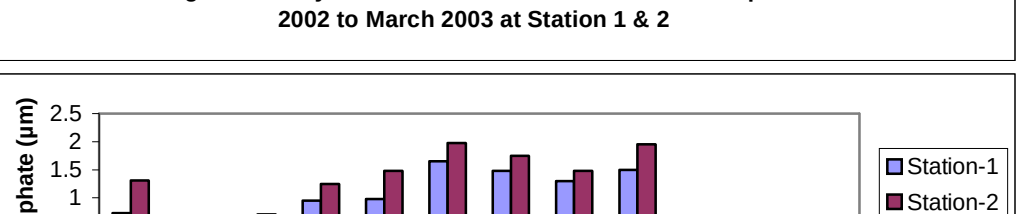

Fig.11 Monthly variations in Phosphate recorded from April 2002 to March 2003 at Station 1 & 2

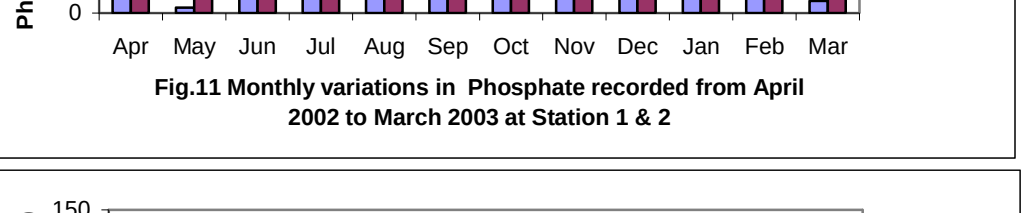

Fig.12 Monthly variations in reactive silicate recorded from April 2002 to March 2003 at Station 1 & 2

Inorganic phosphate registered its peak values during the monsoon season 0.10 to 1.65 µm (Figure 11) and there was a decrease in the concentration during the post monsoon season to summer. The high value in the estuary during the monsoon season was due to fertilizers from the agricultural land run – off and erosion of phosphate rock (Jailalram, 2001). Low concentration of phosphate observed during the summer season was due to the decreased land drainage, utilization by phytoplankton (Srinivasa Rao and Umamaheswara Rao 2002; Sevimpolat and Mine PercinPiner, 2002). The reactive silicate concentration was comparatively higher than other nutrients. High concentration was recorded during monsoon season and low concentrations was recorded during summer and pre-monsoon seasons which were due to the considerable reduction in the freshwater input and greater utilization of this nutrient by the abundantly occurring phytoplankton and cyanobacteria for their biological activity. This is in agreement with the earlier observation in Mulki estuary by Vijayakumar et al. (2002).

Table 1. Cyanobacteria recorded in Uppanar estuary during April 2002 to March 2003.

S. No.	Family	Species	Station-1	Station-2
		Microcystis littoralis [Hang.] Forti.	-	+
1.	Chroococcaceae	*Chroococus tenax* (Kirch) Hiron	+	+
		Gloeocapsa aeruginosa (Carm.) Küetz	+	-
		Synechococcus elongatus Näg	-	+
		Spirulina subsalsa Oerst. ex. Gomont.	+	+
2	Oscillatoriaceae	*Oscillatoria agardhii* Gomont	+	+
		O. salina Biswas	+	-
		Phormidium tenue (Menegh.) Gomont	+	+
		P. fragile (Menegh.) Gomont	-	+
		Lyngbya aesturrii Liebon. ex. Gomont	+	+
		Trichodesmium erythraeum Ehrenberg ex. Gomont	+	-
		Nostoc paludosum Küetz. ex. Born. et Flah	-	+
3.	Nostocaceae	*Anabaena variabilis* Küetz	-	+
		A. ambiqua Rao. C.B	+	-
		Cylindrospermum majus kuetz. ex Born. et Flah	+	+

+ = Present; - = Absent

Cyanobacteria are unique group of photosynthetic prokaryotic microorganisms. They are better known till recent times as blue green algae. Cyanobacteria constitute one of the commercially important marine resources having unique characters of fixing atmospheric carbon and nitrogen; In general, cyanobacteria seem to be more abundant in natural or slightly alkaline habitats. Among the planktonic species several forms blooms. The most common bloom-forming marine cyanobacterium in the tropical water is *Trichodesmium*.

In the present study, an attempt has been made to study the cyanobacteria occurring in estuarine environment. Totally 3 Families, 12 Genera and 15 cyanobacterial species were recorded from both stations (Table 1). The estuary showed a good planktonic cyanobacterial population during monsoon season. The species that occurred in the two stations during monsoon were two colonial form and 3 filamentous forms namely *Anabaena variabilis, Cylindros permum major, Chroococcus tenax, Microcystis littoralis and Oscillatoria agardhii* (Table 1). In general, higher number of species composition and distribution of cyanobacteria were recorded at both the stations during monsoon season. This could be attributed to the presence of fresh water species of cyanobacteria. They would enter in to this ecosystem during monsoon season through the irrigation channels. This was apparent as cyanobacteria occurred in abundance near station-2 of the fresh water connecting inputs in the estuarine ecosystem.

The simple correlation co-efficient analysis between physico-chemical characters and cyanobacterial diversity revealed no significant relationship between them. Similar observation were reported earlier by Selvakumar and Sundararaman (2001) and Thajuddin and Subramanian (1992). Hence, it is necessary to document the biodiversity of Cyanobacterial resources in the estuarine ecosystems. A number of Cyanobacteria from estuarine habitate have potential and commercial value.

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