Journal of Environmental Biology
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March 2008, 29(2) 271-274 (2008)
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Abundance and seasonal variations of phytoplankton in the creek waters of western mangrove of Kachchh-Gujarat

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(Received: August 14, 2005 ; Revised received: July 10, 2006 ; Accepted: August 12, 2006)

Abstract: *The phytoplankton was assessed quantitatively and qualitatively in regard to their abundance in creek waters at three sites along the western mangrove of Kachchh. In total one hundred and four species of phytoplankton were identified. Among them 82 species diatoms (Bacillariophyceae), 16 species dinoflagellates (Dinophyceae), 3 species blue greens (Cyanophyceae) and 2 species were green algae. The density in all the three sites varied from 94,166.67 to 2,44,500 cells l^{-1}. The salinity ranged from 36 to 44‰ , temperature 17 to 35°C and pH ranged from 7 to 8.9 respectively. These semi arid zone mangrove creek area having high densities were recorded during monsoon and early winter season.*

Key words: *Gulf of Kachchh, Mangroves, Phytoplankton*
PDF of full length paper is available with author ***(*sarvaan@rediffmail.com)***

Introduction

Phytoplankton forms the vital source of energy in the marine environment. They initiate the marine food chain, by serving as food to primary consumers, which include zooplankton, shellfish, finfish and others (Ananthan *et al*., 2004; Tas and Gonulol, 2007). The pelagic algal communities make important contributions to the smooth functioning of mangrove ecosystem. Robertson and Blabber (1992) suggested that the plankton in mangrove habitats contribute from 20 to 50% total fish productivity. Fertility and healthiness of mangrove environment is reflected through productivity of the phytoplankton and zooplankton as primary and secondary producers. However studies on phytoplankton abundance and distribution in the Western mangrove belt of Kachchh region is lacking. Species composition and seasonal variation in phytoplankton abundance has been studied in other regions of Indian coastal waters (Tiwari and Nair, 1998; Ramaiah and Ramaiah, 1998; Perumal *et al.,* 1999; Padhi and Padhi, 1999; Gopinathan *et al.,* 2001; Tiwari and Chauhan, 2006; Sridhar *et al.,* 2006; Mathivanan *et al*., 2007). In the present paper an attempt has been made to study the spatial and temporal distribution of phytoplankton in western mangrove regions of Kachchh.

Materials and Methods

The water temperature was measured *in-situ* with Merck mercury thermometer of 0.1°C accuracy. Hydrogen ion concentration was measured with pH meter with reference to a standard buffer solution. Rainfall data was obtained from meteorological department at Bhuj, Kachchh Gujarat. The salinity was estimated by hand refractometer (Atago, Japan) and DO was estimated by Winklers method on the spot (Strickland and Parsons, 1972). The site selection was based on their proximity to open coast and the level of anthropogenic pressure. The three selected sites (St.), namely, Site 1 – Jakhau – Babber Creek (Lat N23°13 59'2; Long E 68°36 38'1), Site 2 – Sanghi – Kharo Creek (Lat 23° 17' 36.4 – N; Long 68° 31' 21"- E) and Site 3 – Medi – Sinthodi Creek (Lat N 23° 27 54.8, Long E; 68° 29 15.1) (Fig. 1) were with 2-5 km distances between each other.

Sampling of phytoplankton at each of the three sites was carried out every month from the surface creek water. The plankton net (mouth diameter 0.35 µm) made of bolting silk (No 30, Mesh size–48 µm) was towed for half an hr at each station. These samples were preserved in 5% neutralized formalin for further analysis. For the quantitative analysis of phytoplankton, the settlement method described by Sukhanova (1978) was adopted. Numerical plankton analysis was carried out using Utermohl's inverted plankton microscope. Biodiversity indices such as species diversity, richness and evenness were calculated following the standard formulae (Shannon and Weaver, 1949; Gleason, 1922; Pielou, 1966). The data collected was grouped into different seasons and a calendar year was divided into 3 main seasons *viz*. winter (November to February), summer (March to June) and monsoon (July to October).

Results and Discussion

The salinity varied from 36.5 to 42‰ (Fig. 2). The water temperature ranged from 21.8 to 33.5°C (Fig. 3). The dissolved oxygen concentrations ranged from 4.0 to 5.2 ml l^{-1} (Fig. 4). The monthly fluctuations in the pH followed a trend ranged from 7.3 to 8.4 (Fig. 5). The maximum value was recorded in winter and minimum during monsoon season.

Monthly variation in phytoplankton species composition, percentage composition, population density, species diversity, richness and evenness were documented for a period of two years from January 1999 to December 2000 at all the three sites. A total of 103 species of phytoplankton were recorded during the present study. Among them 82 species diatoms (Bacillariophyceae), 16 species dinoflagellates (Dinophyceae), 3 species blue green algae

Table - 1: Phytoplankton species diversity, richness and evenness at three study sites

Year	Site 1			Site 2			Site 3		
	Winter	Summer	Monsoon	Winter	Summer	Monsoon	Winter	Summer	Monsoon
				Diversity					
1999	1.568	1.635	1.569	3.355	3.224	3.227	2.240	2.424	2.273
2000	3.950	3.670	3.970	3.805	3.547	3.883	3.915	3.907	4.050
				Richness					
1999	0.800	0.900	0.970	0.850	0.890	0.982	0.921	0.978	0.991
2000	0.820	0.920	0.985	0.878	0.925	0.974	0.945	0.945	0.987
				Evenness					
1999	0.413	0.383	0.385	0.800	0.818	0.858	0.505	0.548	0.508
2000	0.945	0.935	0.970	0.948	0.908	0.960	0.945	0.928	0.981

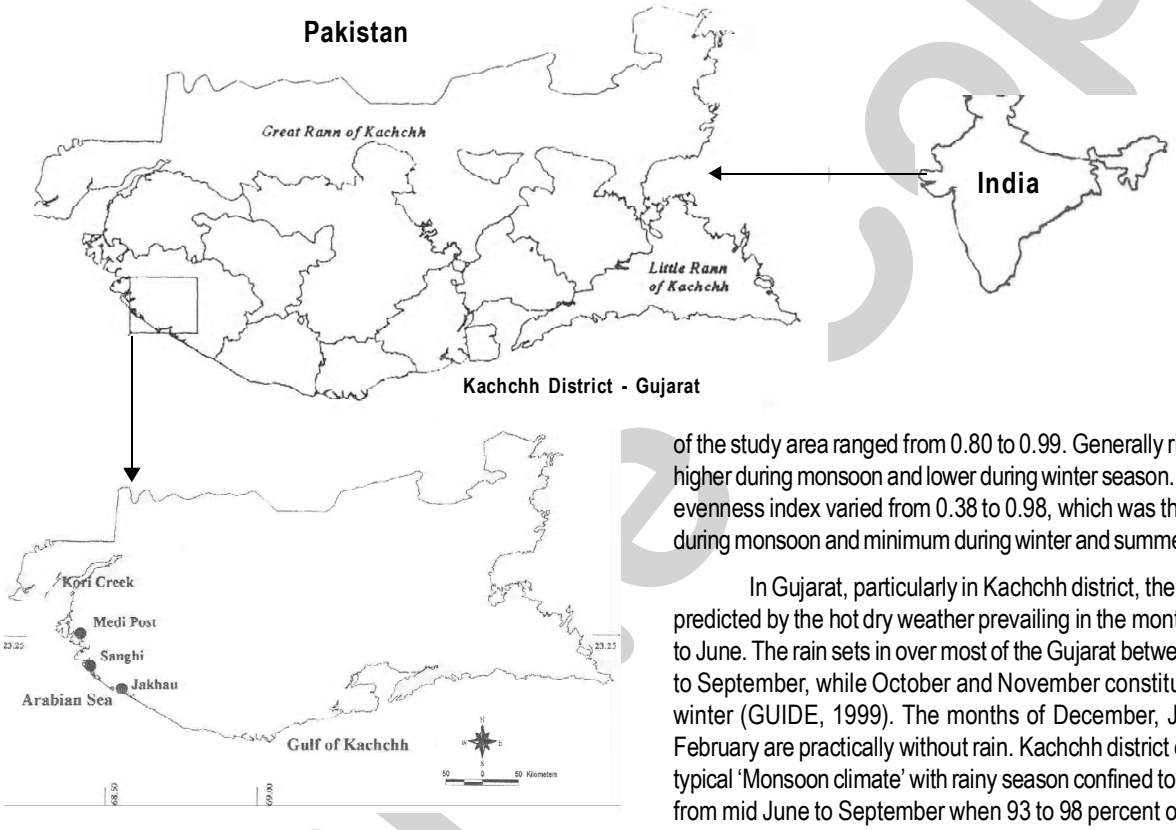

Fig. 1: Map showing the study area

(Cyanophyceae) and 2 species were green algae. Among various species, *Hemidiscus hardmanianus*, *Cosinodiscus radiatus*, *Cerataulina bergonii* and *Spirulina* were the most abundant. The population density in all the 3 sites varied between 2,44,500 to 94,166,67 cells l^{-1} (Fig. 6). When compared site wise, abundance the highest value was recorded in Site 3 which was more in monsoon and less in the same site during winter. The overall species percentage was diatoms 79.61%, dinoflagellates 15.53%, blue green algae 2.92% and green algae 1.94% respectively. The diversity values varied from 1.56 to 4.05 bits/individual (Table 1). The overall richness values of the study area ranged from 0.80 to 0.99. Generally richness was higher during monsoon and lower during winter season. The species evenness index varied from 0.38 to 0.98, which was the maximum during monsoon and minimum during winter and summer seasons.

In Gujarat, particularly in Kachchh district, the monsoon is predicted by the hot dry weather prevailing in the months of March to June. The rain sets in over most of the Gujarat between late June to September, while October and November constitute the early winter (GUIDE, 1999). The months of December, January and February are practically without rain. Kachchh district experiences typical 'Monsoon climate' with rainy season confined to four months from mid June to September when 93 to 98 percent of the annual rainfall occurs (GUIDE, 2000).

The surface water temperature in the present study ranged between 17 and 37°C. There was a steady increase in temperature from March to June, which was peak during May and very low temperature of 17°C recorded during winter. All the stations showed a similar trend in terms of seasonal changes. Generally, surface water temperature is influenced by the intensity of solar radiation, evaporation, freshwater influx and cooling and mix up with ebb and flow from adjoining neritic waters. In the present study, summer peaks and monsoonal troughs in air and water temperature has been found to be similar to that reported for west coast of India (Desai, 1992; Arthur, 2000).

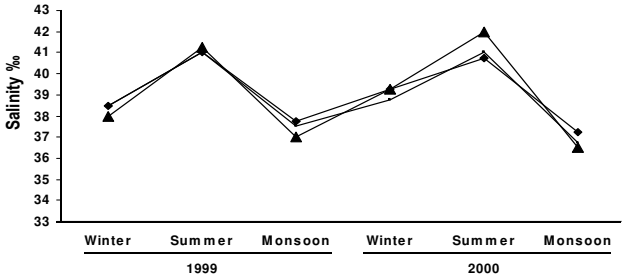

Fig. 2: Seasonal variation of salinity recorded from Site 1, 2 and 3

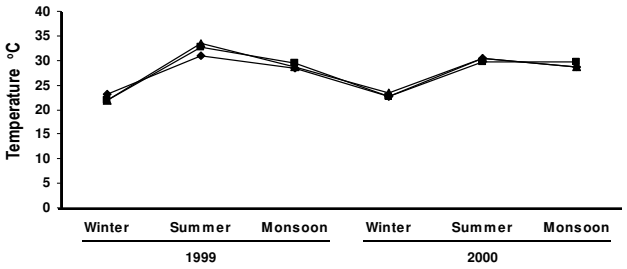

Fig. 3: Seasonal variation of temperature recorded from Site 1, 2 and 3

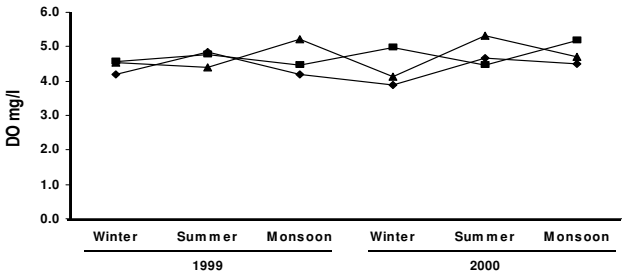

Fig. 4: Seasonal variation of dissolved oxygen recorded from Site 1, 2 and 3

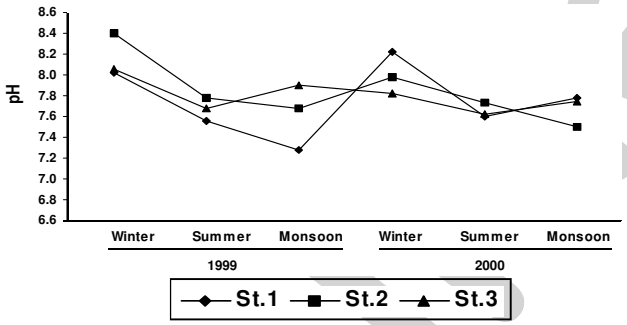

Fig. 5: Seasonal variation of pH recorded from Site 1, 2 and 3

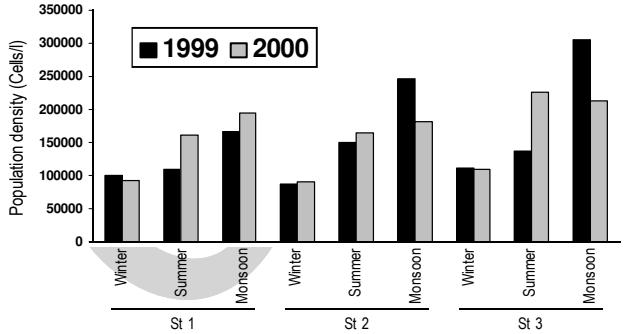

Fig. 6: Seasonal variation of population density recorded from Site 1, 2,3

The salinity acts as a limiting factor in the distribution of living organisms, and its variation caused by dilution and evaporation and influences the fauna of the intertidal zone (Gibson, 1982; Balasubramanian and Kannan, 2005; Sridhar *et al.*, 2006). Generally, changes in salinity in the brackish-water habitats such as estuaries, backwaters and mangrove are due to the influx of freshwater from land run off caused by monsoon or by tidal variations. In the present study, salinity at all the sites was high during summer and low during the monsoon season. Higher values during summer could be attributed to the high degree of evaporation in the study area (Sampathkumar and Kannan, 1998). Though perennial rivers are absent, the run off due to rains during the monsoon season could influence the reduction in salinity. Thus the variation of salinity in the study sites could probably be due to mainly freshwater run off entering the creek systems as reported by Vijayalaksmi *et al.* (1993) for the Gulf of Kachchh and Saisastry and Chandramohan (1990) for the Godavari estuary.

In the present investigation, dissolved oxygen was high during monsoon in all the sites which might be due to the cumulative effect of higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing or it may be also due to photosynthesis. Relatively low values recorded during winter may be due to reduced agitation and turbulence of the coastal and creek waters. De Souza and Sen Gupta (1986), Zingde *et al*. (1987) have attributed seasonal variation of dissolved oxygen mainly to the freshwater influx and ferruginous impact of sediments. It is well known that the temperature and salinity also affect the dissolution of oxygen (Vijayakumar *et al.,* 2000).

Hydrogen ion concentration (pH) in surface waters remained alkaline at all the sites throughout the study period with maximum value during the summer and winter seasons and minimum values during monsoon. Generally, fluctuations in pH values during different seasons of the year are attributed to factors like removal of CO_2 by photosynthesis through bi-carbonate degradation, dilution of seawater by freshwater influx, reduction of salinity and temperature and decomposition of organic matter (Upadhyay, 1988; Ragothaman and Patil, 1995; Paramasivam and Kannan, 2005). In the present study, diatoms formed the dominant group followed by dinoflagellates, blue green and green algae in all the three sites. Percentage contribution of each group of phytoplankton was in the order: Diatom>Dinoflagellates>Blue greens>Greens.

Generally, diatoms were found to be dominant in near coastal and estuarine waters in west coast (Tiwari and Nair, 1998; Ramaiah and Ramaiah, 1998; Gopinathan *et al.,* 2001; Gowda *et al.,* 2001). High population density and species diversity was observed during monsoon at all the three sites. The lowest population was recorded in early winter. A similar trend was evident in the west coast by Subrahmanyan (1959) and Rajagopalan *et al*. (1992), which revealed that the phytoplankton production was at its peak during southwest monsoon (June to September). During monsoon season the *Bacillaria paradoxa, Bellerochea malleus, Odentella pulchella,*

O. heteroceros, Cerataulina bergonii and *Chaetoceros compressus* were the dominant diatoms.

Further, high density of phytoplankton of 50, 11,872 cells l^{-1} and 6,85,260 cells l^{-1} was observed in the Pichavaram mangrove east coast by Kannan and Vasantha (1992). It is evident that in the present study highest population recorded in all the sites. According to Subrahmanyan (1967), optimum conditions such as a fall in water temperature and salinity due to monsoon and abundance of nutrients due to upwelling and river discharge are the important factors for high production of phytoplankton. Southwest monsoon in India is of prime importance in the production of phyto and zooplankton, especially in the inshore upwelling areas. It is well known that an intense monsoon triggers strong upwelling along the west coast of India (Subrahmanyan, 1967). The hitherto study revealed that the distribution of phytoplankton abundance and diversity reflects the status of mangrove creek systems diversity and productivity as a whole. The present baseline information of the phytoplankton distribution and abundance would form an useful tool for further ecological assessment and monitoring of these coastal ecosystems of western mangroves of Kachchh.

Acknowledgments

The authors would like to thank Gujarat State Forest Department for giving permission to carry out this study. We are grateful to Director of Gujarat Institute of Desert Ecology and Prof. T. Kannupandi, CAS in Marine Biology, Parangipettai, Annamalai University, Tamilnadu for their constant encouragement and advice in various stages of the studies.

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