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Seasonal variation of phytoplankton in Chinnathurai Coast along southwest coast of India

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Abstract

The seasonal variation of Phytoplankton was investigated in Chinnathurai Coast along Southwest coast of India during February 2003 to January 2005. Monthly collections at two stations revealed the existence of 74 phytoplankton taxa belonging to diatoms (58 species) and dinoflagellates (16 species). Dinoflagellates never exceeded 25 percent of the total composition. The diatoms dominated throughout the investigation. Blooms or single taxa dominance was never encountered. Phytoplankton species diversity varied between 4.45 and 7.72; species dominance index between 0.01 and 0.07; species richness index between 4.76 and 9.17 and species evenness index between 1.21 and 1.42. Their density showed considerable seasonal fluctuations with peak abundance during the monsoon and early postmonsoon periods.

Keywords: Phytoplakton, seasonal variations, Chinnathurai, India

Introduction

The phytoplankton initiate the marine food chain. The species composition and distribution of phytoplankton taxa undergo spatio-temporal changes due to the effects of physico-chemical and biological factors on individual species (Larson and Hagstrom, 1982; Furuya and Marumo, 1983). They often serve as bioindicators too. A study was undertaken to analyse phytoplankton and their relationship with nutrients and hydrographic factors in the coastal waters of Chinnathurai along southwest coast of India.

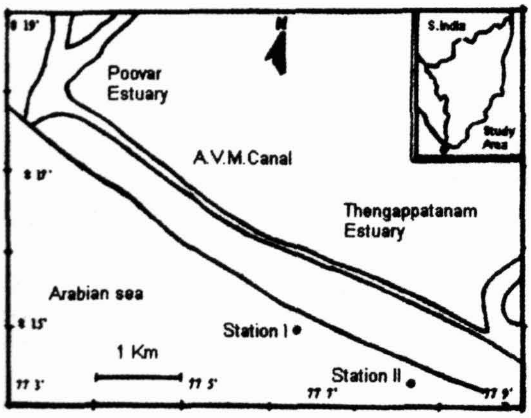

Fig. 1. Map showing study area

Materials and methods

Two sites were chosen for this study – a reference station at Chinnathurai(Lat. 8°15'22 N, Long. 77°48'14E) and another station at Erayumenthurai representing the marine zone of Thengappattanam Estuary. The study is based on monthly data collected during February 2003 to January 2005 (Fig. 1).

Plankton samples were collected by towing a phytoplankton net (Mouth diameter 0.35 m) made of bolting silk No. 25 (with mesh size 55 mm) in a mechanized country boat. The net was towed for half an hour for qualitative estimation. 100 litres of water was filtered through the net for quantitative estimation of phytoplankton and the density of organisms was calculated and represented per cubic metre. Plankton samples were preserved in buffered 4% formalin and used for qualitative analysis. The phytoplankton were identified up to species level, with the help of standard keys by Subrahmanyan (1946) and Taylor (1976). For the quantitative analysis of phytoplankton, the settling method described by Sukhanova (1978) was adopted. Numerical analyses of the plankton were carried out using Utermohls inverted plankton microscope. The physico chemical characters were studied following methods described by Strickland and Parsons, (1972).

Results

The study of physico chemical characters showed that the monthly rainfall ranged from 0 – 443 mm with an annual average value of 72 mm. The atmospheric temperature ranged from 24°C to 30°C and surface water temperature from 23°C to 28.5°C. The highest temperature was noticed during April and the lowest in July. The *p*H and salinity was highest during March and lowest in November. The dissolved oxygen content was highest during monsoon and lowest during summer. Nitrite, nitrate organic phosphate and reactive silicate were generally higher during monsoon season.

A total of 74 taxa of phytoplankton belong to 37 genera under 12 families were isolated and identified. Out of which 58 species belonged to diatoms and 16 to dinoflagellates. The seasonal abundance of phytoplankton showed a peak during monsoon ($18465.625 x 10^3$ cells m^{-3}) and it was lowest during premonsoon ($4134.875 x 10^3$ cells m^{-3}). The average seasonal abundance in the number of diatoms was $12879.25 \times 10^3 m^{-3}$, $55259.25 \times 10^3 m^{-3}$ and $48371.37 \times 10^3 m^{-3}$ during premonsoon, monsoon and postmonsoon seasons respectively. (Table 1). The average seasonal variation of diatoms respectively for the above periods was 72.8%, 76.0%, and 72.3% of the total phytoplankton. The index of dominance was higher during monsoon season. It ranged from 0.01 to 0.07. The species diversity was moderately higher throughout the investigation. The values ranged between 4.45 and 7.72. The species richness index values were also moderately higher in all the seasons. The higher species richness values were noticed at the end of premonsoon and early monsoon period. The vales ranged from 4.76 to 9.17. The values of evenness index showed very little difference throughout the study period. (Tables 2 & 3).

Discussion

The taxonomic structure of phytoplankton community is known to change through time in response to abrupt alterations and seasonal oscillations in the hydrography of the environment (Arfi *et al.*, 2003). Seasonal variations of phytoplankton related to monsoonal changes are commonly reported from tropical coastal waters (Choudhury and Panigrahy, 1991). The causes of seasonal succession of phytoplankton species are among the major problems in the study of marine phytoplankton. Species succession may be considered as an expression of the dynamism of food chain processes.

In the present investigation, the diatoms were found to be the predominant group. Diatoms and dinoflogellates were recorded throughout the study period. The former always contributed more than 80% of the total collection. Dinoflagellates contributed to the second position (Figs. 2, 3 and 4). The other groups were very meager or nil. The number of species of phytoplankton occurring at a time varied from 34 to 74 and the majority of them were diatoms. This is because in the inshore environment, the wind plays a role in the mixing up of the water layers more thoroughly. Another reason is the influx of land runoff to the coastal waters which increases the nutrients and reduces salinity, which inturn boost up the productivity of the region. Nutrient enrichment could influence only the basic bloom conditions.

The plankton count was lowest during premonsoon season (Fig. 2). This can be attributed to low rainfall, low nutrients and high temperature. The abundance of phytoplankton was due to a drop in salinity owing to the precipitation. But during the premonsoon season, the fate of the stenohaline as well as stenothermal microalgae were in the state of sporeformation or dormancy. In this study a negative correlation was noticed between salinity and phytoplankton occurrence (Table 4).

The phytoplankton population density increased considerably and reached the peak during monsoon. Diatoms decreased markedly during premonsoon. Changes in salinity and nutrient concentration play a major role in controlling the distribution of phytoplankton. The index of dominance was very small, which could be interpreted that there was no plankton bloom in the study area. (Tables 2 and 3). This is due to the presence of certain species, which can tolerate the adverse climatic conditions become abundant and contributed major part in the phytoplankton population. Remarkable variation of species diversity index was observed. (Tables 2 and 3). This may be due to the presence of almost all the species in all the seasons, while a few common species or dominants largely account for the energy flow in each trophic group. One major component might be called the species richness, the values of which are high in the post monsoon seasons. This means that the post monsoon is the most favourable season for the species abundance. Evenness values of individuals among the species showed no marked difference in the present investigation. (Tables 2 and 3). It means that the distribution of different species of phytoplankton were not uniform between the density.

Perumal *et al.* (1999) established the interaction between the density of bloom forming species and changes in the water quality. Madhav and Kondalarao (2004) indicated high diversity and low production of phytoplankton from the east coast of India. Lande and Sangolkar (2002) reported that the water dilution during monsoon

Table 1. *Seasonal variation of diatoms and dinoflagellates in % at Station I and II during the year 2003 - 2005*

Year	Seasons	Premonsoon		Monsoon		Postmonsoon	
	Station	Diatoms	Dinoflagellates	Diatoms	dinoflagellates	Diatoms	dinoflagellates
2003 - 2004	Station I	76.96	23.04	81.89	18.11	69.67	30.33
	Station II	79.94	20.06	75.06	24.94	72.52	27.48
2004 - 2005	Station I	79.65	20.35	75.95	24.05	72.21	27.79
	Station II	74.92	25.08	71.22	28.78	75.67	24.33

Table 2. *Species diversity indices of phytoplankton at station I and II during the year 2003-2004*

Month	Index of dominance		Species diversity		Species richness		Species evenness	
	Station I	Station II	Station I	Station II	Station I	Station II	Station I	Station II
Feb.	0.01	0.02	5.92	5.68	7.62	6.64	1.38	1.38
Mar.	0.02	0.02	5.70	5.68	7.74	6.72	1.35	1.39
Apr.	0.03	0.02	5.52	5.47	7.83	7.37	1.32	1.34
May	0.03	0.05	5.19	4.45	6.68	4.76	1.3	1.26
Jun.	0.02	0.04	5.48	4.96	7.45	6.01	1.31	1.27
Jul.	0.02	0.02	5.73	5.58	7.4	6.67	1.34	1.34
Aug.	0.02	0.03	5.74	5.49	6.98	6.19	1.34	1.31
Sep.	0.03	0.04	5.55	5.35	7.74	7.09	1.3	1.28
Oct.	0.02	0.02	5.81	5.37	8.07	7.13	1.37	1.36
Nov.	0.02	0.03	5.72	5.21	7.69	7.92	1.33	1.25
Dec.	0.03	0.01	5.62	5.87	6.92	6.66	1.3	1.39
Jan.	0.01	0.01	7.72	5.83	6.94	6.67	1.38	1.37

Table 3. *Species diversity indices of phytoplankton at station I and II during the year 2004-2005*

Month	Index of dominance		Species diversity		Species richness		Species evenness	
	Station I	Station II	Station I	Station II	Station I	Station II	Station I	Station II
Feb.	0.015	0.03	6.09	5.27	7.89	6.08	1.41	1.28
Mar.	0.017	0.07	5.99	4.79	8.18	6.12	1.39	1.12
Apr.	0.017	0.04	6.0	4.95	9.02	6.34	1.39	1.34
May	0.02	0.03	5.83	5.41	9.17	7.76	1.37	1.36
Jun.	0.017	0.02	5.99	5.73	7.44	6.9	1.39	1.13
July.	0.015	0.02	6.07	5.83	6.95	6.82	1.41	1.42
Aug.	0.017	0.02	5.98	5.77	7.14	7.18	1.39	1.27
Sep.	0.017	0.02	5.98	5.67	7.24	6.81	1.39	1.21
Oct.	0.019	0.03	5.91	5.52	7.98	6.64	1.37	1.34
Nov.	0.018	0.02	5.9	5.74	7.42	6.9	1.37	1.19
Dec.	0.016	0.02	6.02	5.8	7.24	6.83	1.4	1.13
Jan.	0.018	0.02	5.93	5.95	7.31	6.97	1.38	1.37

and zooplankton grazing might be the factors affecting the phytoplankton density and species richness. Horn, (2003) suggested that it is difficult to reliably forecast or control the plankton dynamics because the impact of hydrobiological factors is decisive even in strongly nutrient limited water bodies.

Zimmer *et al.*, 2003 indicated that phytoplankton and nutrient concentrations in Prairie Wetlands are strongly influenced by submerged macrophytes. Goericke (2002) reported that the phytoplankton abundance and community structure in the high-nutrient, low chlorophyll areas of the monsoonal Arabian Sea are controlled by top-down forces and grazing rather than bottom-up forces, availability of resources. In the present study it is noticed that the phytoplankton failed to manifest a distinct pattern of species succession. Though not well defined a pattern of

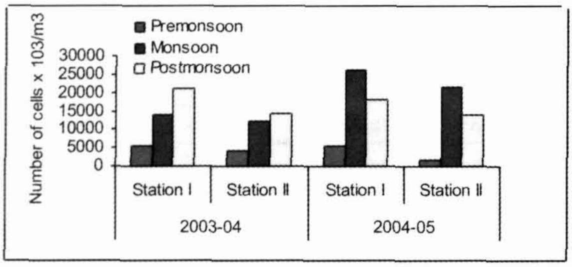

Fig. 2. Seasonal variation of phytoplankton during study period

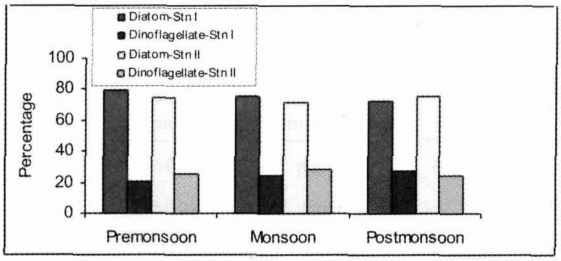

Fig. 4. Seasonal variation of diatoms and dinoflageliates during 2004-05

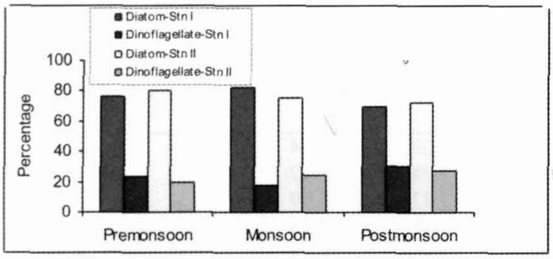

Fig. 3. Seasonal variation of diatoms and dinoflagellates during 2003-04

phytoplankton species could be traced throughout the period of study.

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Table 4. *Correlation of phytoplankton counts, with the physico-chemical parameters and biological factors*

Year	2003-2004				2004-2005			
	Station I		Station II		Station I		Station II	
AT	-.4904	P=.053	-.4370	P=.078	-.1771	P=.291	-.7166**	P=.004
SWT	.2133	P=.253	.1525	P=.318	.2312	P=.235	-.7713**	P=.002
*p*H	.2364	P=.229	.3954	P=.102	.3954	P=.102	-.2546	P=.212
SAL	-.5490*	P=.032	-.2743	P=.194	-.3856	P=.108	-.5648*	P=.028
DOC	.2453	P=.231	.1586	P=.304	.2367	P=.229	-.2062	P=.260
NIT	.6021*	P=.019	.4440	P=.074	.0723	P=.412	.7488**	P=.003
NAT	.4644	P=.064	.3395	P=.140	.3091	P=.164	.7450**	P=.003
PHOS	.2876	P=.182	.3323	P=.146	.4612	P=.066	.9136**	P=.000
SIL	.1109	P=.366	-.0069	P=.491	.028	P=.447	.6656**	P=.009
ZOO	.9149**	P=.000	.9135**	P=.000	.5660*	P=.028	.8189**	P=.001
GPP	.6509*	P=.011	.4964**	P=.050	.4867	P=.054	.0735	P=.410
NPP	.6031*	P=.019	.5447*	P=.034	.3902	P=.105	.8817**	P=.000
CHLa	-.8504**	P=.000	.8018**	P=.001	.4475	P=.072	.8672**	P=.000
CHLb	.882**	P=.000	.7147**	P=.004	.5621*	P=.029	.8174**	P=.001

* 5% level of significance, $p \leq 0.05$
** 1% level of significance, $p \leq 0.01$
Others : Not significant

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