Studies on phytoplankton pigments in a tropical coastal lagoon

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ABSTRACT

Temporal variations of phytoplankton pigments in relation to nutrients were estimated at monthly intervals in Talapady lagoon, a shallow coastal lagoon near Mangalore on the southwest coast of India (12° 47'N, 74° 51'E). Chlorophyll a content varied from 1.14 to 16.2 mg m\(^{-3}\), chlorophyll b from 0.15 to 29.38 mg m\(^{-3}\), chlorophyll c from 0.52 to 54.17 mg m\(^{-3}\), carotenoid pigments from 0.11 to 3.62 mg m\(^{-3}\) and phaeopigments from 3.02 to 30.52 mg m\(^{-3}\). Spatial variations were not significant. Diel variations were studied during monsoon, postmonsoon and premonsoon, but statistically there were no significant variations.

Quantitative estimation of pigments in aquatic ecological studies can be used to estimate phytoplankton biomass. Among the phytoplankton pigments, chlorophyll a is the most active and universal pigment. The chlorophyll degradation product, phaeophytin is as important as the other pigments, and it is used to measure the physiological state of the aquatic ecosystem in addition to using it to assess the detrital load and grazing activity. With this background, the present study was undertaken to estimate the variations in phytoplankton pigments in Talapady lagoon, a small and shallow coastal lagoon located on the southwest coast of India.

Talapady lagoon (Fig. 1) is located about 10 km south of the old Mangalore port (12° 47'N, 74° 51'E). It has a north-south orientation parallel to the sea coast, and a water-spread area of 10 ha.

Fig. 1. Layout of Talapady lagoon, southwest coast of India, showing sampling stations.

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round the year. It is shallow, rarely exceeding 1 m in depth and the off-side is bordered with mangroves belonging to the genera *Avicennia* and *Rhizophora*. The lagoon is strongly influenced by the sea for eight months of the year. For about four months, during the southwest monsoon and early postmonsoon, the Talapady river brings in silt-laden waters into the lagoon. The region receives 4,100 mm precipitation. The sea water enters the lagoon both through seepage across the sandbar and during the southwest monsoon through an opening cut across the sandbar to drain out the flood waters.

Samples were collected between 15-20th of every month during April 1996 - March 1997 from 4 stations in the lagoon (Fig. 1), using a dug-out canoe. Surface water samples were collected in 5 l cans after filtering through a 198 μ mesh size zooplankton net to filter out zooplankton. Samples for ammonia-nitrogen were collected in 125 ml amber coloured bottles and fixed with phenol. All samples were carried to the laboratory at 4°C. Diel variation was studied on 26 July 1996, 17 December 1996 and 27 March 1997 at 3 hour intervals from 0600 to 1500 h at station 2 in the lagoon. For phytoplankton, a known volume of water was filtered through a 60 μ mesh size phytoplankton net and preserved in 4 % buffered formalin.

A known volume of water (500-1,000 ml) for phytoplankton pigments was filtered through a 0.45 μ millipore membrane filter of 47 mm diameter, after adding 2 drops of magnesium carbonate. The pigments were extracted in 90 % acetone under dark and refrigerated conditions for 24 h, the extractant was centrifuged and the supernatant was used to determine chlorophylls a, b and c, carotenoids and phaeopigments (Parsons et al, 1989).

Standard colourimetric procedures were used to estimate the nutrient concentrations in the water samples, adopting the methodologies given by Parsons et al. (1989). A spectrophotometer (Milton Roy Spectronic 2 ID) was used to determine the absorbance. Phytoplankton cell counts were assessed using a Sedgewick Rafter cell and they were expressed as numbers per m².

The month wise data of phytoplankton pigments, nutrients and phytoplankton cell counts were statistically analysed using MINITAB (Version 8.3) computer package to estimate the coefficient of variation, standard deviation, mean and correlation coefficients. Since the spatial variations in the parameters studied were not significant, the data of a particular month at different stations were pooled and expressed as mean ± standard deviation. The significance of the correlation coefficients was tested at p<0.10. Two-way analysis of variance (ANOVA) was applied on diel variations of chlorophyll pigments.

In the study, temporal variations were observed for chlorophyll a (CV= 108 %); with values ranging from 1.14 to 16.20 mgm⁻³ (Table 1, Fig. 2a) Spatial variations were not distinct during this study. Comparatively higher concentrations of chlorophyll a were obtained during premonsoon, when phytoplankton cell counts were also the highest, exhibiting a direct and close relationship between chlorophyll a and phytoplankton cell counts (r = +0.892). Higher phytoplankton biomass and chlorophyll a can be attributed to increased light penetration and higher salinity in the lagoon waters.
Studies on phytoplankton pigments

Chlorophyll a — Chlorophyll b — Chlorophyll c — Carotenoids

Phaeo pigments — Phytoplankton counts

Fig. 2a. Temporal variations of chlorophyll a, phaeopigments and phytoplankton cell counts in Talapady lagoon.

The interaction with sea plays an important role in the seasonal distribution of chlorophyll a in the lagoon waters. The concentration of chlorophyll a was low during the monsoon and postmonsoon period when fresh water influx takes place from Talapady river.

Diel variations in chlorophyll a were not significant (p<0.10) but variations were observed between the three days on which the diel studies were conducted (Fig. 3a). The highest concentrations were seen in December.

Chlorophyll b, the principal pigment in Cyanophyceae (Fielding et al., 1988), was present in higher concentrations during the later part of premonsoon and early monsoon (Table 1, Fig. 2b). Temporal variations were also distinct (CV=200%) with concentrations ranging from 0.15 to 29.38 mg m$^{-3}$. With the onset of the monsoon, lower values were recorded, and this continued during the postmonsoon also. Higher values in August is attributed to the entry of sea water into the lagoon through a natural breach in the sandbar, resulting in a temporary increase in chlorophyll b concentrations at station 2. Vijayalakshmi (1986) recorded comparable values (range: 2.15 to 21.3 mg m$^{-3}$) from Vellar estuary. Raman et al. (1990) reported values ranging from traces to 18.6 mg m$^{-3}$ in Chilka lake.

The dominance of Oscillatoria sp. during premonsoon months could be attributed to higher concentrations of chlorophyll b. Chlorophyll b content was significantly (p<0.10) correlated with chlorophyll c (r=+0.977), carotenoids (r=+0.682) and phaeopigments (r=+0.658). ANOVA of the diel variation (Fig. 3b) of chlorophyll b did not show any significant variation (p<0.10) over time. But significant variations were

Fig. 3a. Diel variations of chlorophyll a in Talapady lagoon.

Fig. 3b. Temporal variations of chlorophyll b, chlorophyll c and total carotenoids in Talapady lagoon.

Fig. 2b. Temporal variations of chlorophyll b, chlorophyll c and total carotenoids in Talapady lagoon.
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CV% stands for coefficient of variation.
observed between the sampling days. A distinct peak at 0900 h (Fig. 3 b) was observed in July. The present observation is in agreement with that of Bhargava and Dwivedi (1974), from Zuari estuary, Goa. Chlorophyll $b$ content was negatively correlated with all nutrients, except total dissolved phosphorus ($r = +0.025$) and silicate ($r = +0.177$).

Chlorophyll $c$, the dominant pigment in Bacillariophyceae (Table 1, Fig. 2 b), showed wider temporal fluctuations (CV=228 %) than the other pigments. Their concentrations were higher with the onset of the monsoon. Qasim and Reddy (1967) also observed a similar peak in the Cochin estuary. In the present investigation, chlorophyll $c$ concentrations ranged from 0.52 to 54.17 mg m$^{-3}$. Spatial variations were not significant. Vijayalakshmi (1986) recorded values in the range of 0.55 to 7.97 mg m$^{-3}$ and Raman et al. (1990) from traces to 59.03 mg m$^{-3}$. A study of benthic flora in Cochin estuary by Sivadasan and Joseph (1995) showed two peaks, in April and August, but did not show any significant variation between premonsoon and monsoon periods.

Significant correlation was observed between chlorophyll $c$ and carotenoids ($r = +0.509$) and phaeopigments ($r = +0.682$). No correlation was recorded with nutrients. Diel variations (Fig. 3c) were not significantly different nor did they show any consistency in the values. Carotenoids play (Table 1, Fig. 2b & 3d) an important role in the photosynthesising process. Carotenoid pigments varied temporally (CV= 115 %), but not spatially. During the study, these pigments varied between 0.11 to 3.62 mg m$^{-3}$, registering higher concentrations in premonsoon months. Carotenoids were significantly correlated with all the other pigments including phaeopigments ($r = +0.539$). A moderate correlation, though not significant statistically, ($r = +0.429$) was also seen with phytoplankton cell counts. There was no correlation with nutrients. Phaeopigments (Table 1, Fig. 2a) were consistent (CV=80%) during the study period (mean values: 3.02 to 30.58 mgm$^{-3}$). Phaeopigments were significantly correlated with all phytoplankton pigments and exhibited a similar trend in distribution also. Statistical analysis showed significant diel variation (Fig. 3e) registering a peak at 1500 h on all the study days.
It can therefore be concluded that pigment concentrations were generally higher during the premonsoon and postmonsoon, probably influenced by the higher quantum of light available for photosynthesis due to reduced load of suspended particulates.

Acknowledgments

We are grateful to Mr. K.S. Udupa, Associate Professor of Fishery Statistics, College of Fisheries, Mangalore for his guidance on the statistical tests. We thank Prof. T.R.C. Gupta, Head of the Department of Aquatic Biology for the laboratory facilities. The first author (S.N) thanks the Indian Council of Agricultural Research for the Junior Research Fellowship awarded during the tenure of the study.

References


