

Phytoplankton pigments in relation to primary production and nutrients in the inshore waters of Tuticorin, southeast coast of India

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Received 23 September 1993, revised 8 September 1994

Annual variation of primary production and chlorophyll-*a* of the inshore area of Tuticorin indicated three peak periods, during March-April, June-July and September-October. The multiple regression analysis indicated significant levels of co-relation by chlorophyll-*a* and nitrates with primary production. Among nutrients only nitrate and phosphate have influence on primary production while nitrite and silicate have insignificant role. The usefulness of chlorophyll-*a* in relation to the primary production rates as a measure of the standing crop of phytoplankton and the role of nutrients in the organic production of the inshore area of Tuticorin are also briefly discussed.

In recent years, considerable information is available on primary productivity of the coastal waters of the Indian seas in general and the east coast in particular¹⁻⁵, yet very little information^{6,7} is available on the phytoplankton pigments of the coastal waters in the Gulf of Mannar. In this study, an attempt has been made to examine the phytoplankton pigments in relation to the primary production and nutrients of the surface waters of the inshore area of Tuticorin, during 1985-88.

Materials and Methods

Fortnightly water samples were collected on board the research vessels, *Cadalmin-IV* and *M.L. Chippy*. Surface water was collected between 0730-0900 hrs from the inshore area. Although 2 stations in the inshore area (Fig. 1) were sampled, only pooled values for these stations are presented. Primary production⁸ was measured on board the research vessel in *simulated in situ* conditions. Winkler's method was employed for the estimation of oxygen and the same converted for carbon equivalent using a PQ of 1.25 for obtaining the gross production.

Estimation of chlorophylls and phaeo-pigments of the surface water was made by filtering one litre of seawater using Millipore HA filters and the same dissolved in 90% acetone and the optical densities were measured using a spectrophotometer (ECL-GS 5700). Chlorophylls and phaeo-pigment concentrations were calculated and nutrients such as nitrite, nitrate, phosphate and silicate were analysed by standard procedures⁹. However, data related to the nutrients for the period 1985-86 are not available.

Multiple regression analysis was made to study the co-relation of these pigments and the nutrients of the seawater with the rates of primary production.

Results and Discussion

Primary production—The rates of gross primary production (Fig. 2A) shows wide range of fluctuations in different months. Three peak periods have been noticed; the primary one during March-April,

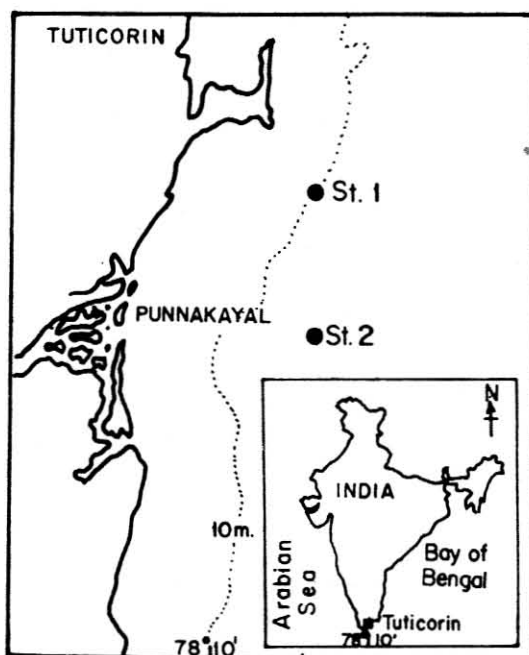


Fig. 1—Sampling stations in the inshore waters of Tuticorin

with high magnitude and the second during June-July and the third during September-October which were of less magnitude. Production was low during November-January. The average primary production for the inshore waters was estimated as $350 \text{ mgC. m}^{-3}.\text{d}^{-1}$ with relatively higher values observed during April '88 ($1600 \text{ mgC. m}^{-3}.\text{d}^{-1}$) and very low values of $114 \text{ mgC. m}^{-3}.\text{d}^{-1}$ during November '85.

Chlorophylls—Chlorophyll-*a* (Fig. 2B) ranged from 1.2 to 11.8 mg.m^{-3} . Chlorophyll-*a* values showed distinct seasonal variations and a close direct

relationship with the primary production. Three peak periods have been noticed, during March-April, June-July and September-October, similar to the peak periods of primary production. Chlorophyll-*b* (Fig. 2C) showed distinct seasonal variations similar to chl-*a*. Chlorophyll-*b* ranged from 0.1 to 1.8 mg.m^{-3} during the entire period of observations. High values of chl-*b* were noted in April, June-July, September and December-January months. Chlorophyll-*b* values were found to be always less than the values of chl-*a*. During September '86, an exceptionally high values of chl-*b*

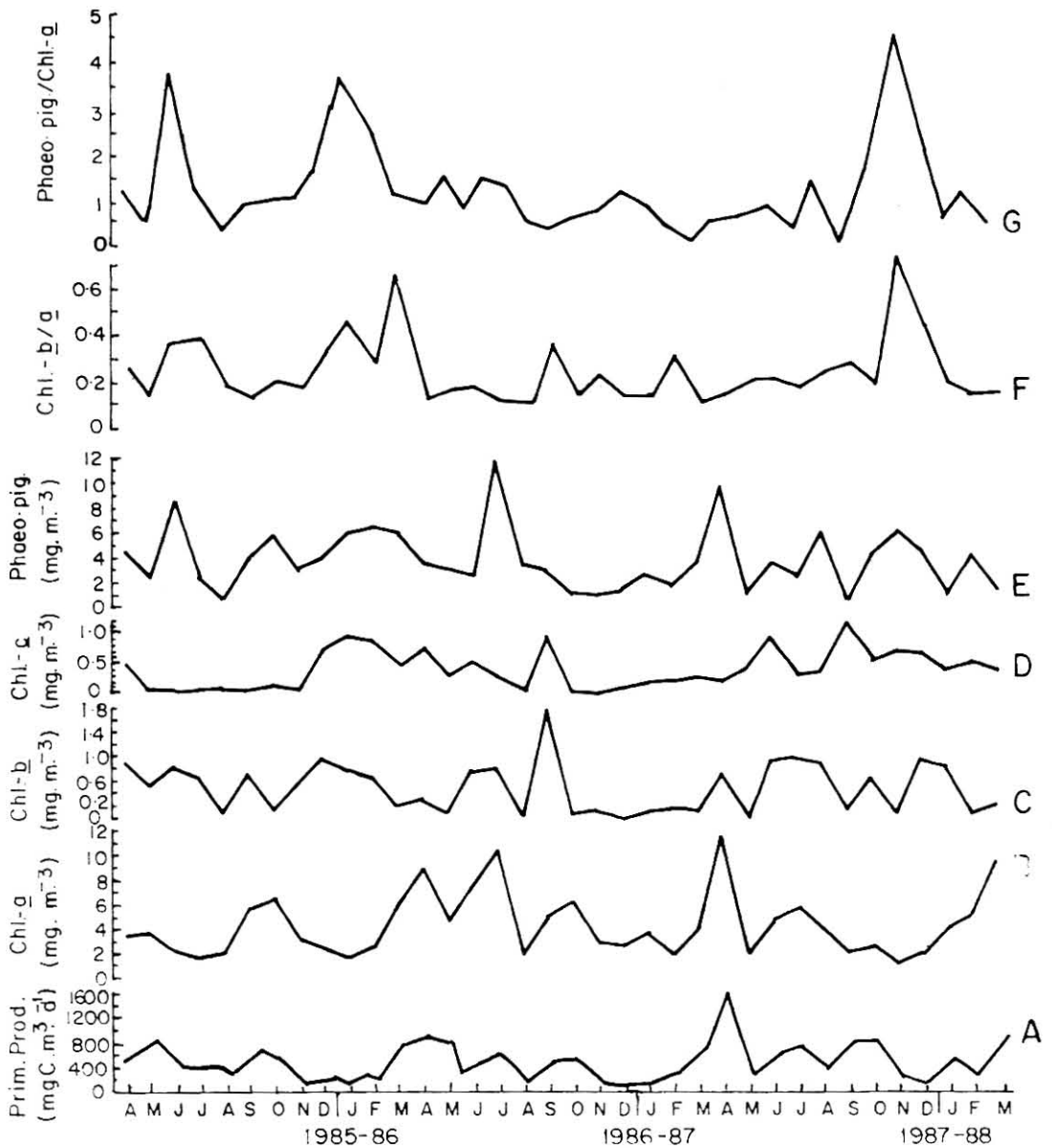


Fig. 2—Seasonal variations of various phytoplankton pigments in relation to primary production and inter-relationship at the surface waters in the inshore area of Tuticorin

was noted which coincided with the third peak of primary production. Figure 2D shows the values of chl-*c* for the study period. The chl-*c* values ranged from 0.02 to 1.2 mg.m⁻³. The values are exceptionally low when compared to the values estimated from the west coast of India^{10,11}. Similar to chl-*b*, chl-*c* showed no distinct variations, but January-February, April, June-July and September months showed moderate values of chl-*c*.

Phaeo-pigments—Phaeo-pigments (Fig. 2E) show close resemblance to chl-*a*. Three seasonal peaks have been observed for phaeo-pigments, and ranged from 0.5 to 11.2 mg.m⁻³. Unusually high values were noted during June '85, July '86 and April '87. The values of phaeo-pigments revealed the dominance of dead photosynthetic pigments in the inshore area of Tuticorin. The inter-relationship of pigments in the surface waters of the inshore area, expressed in terms of ratios, chl-*b/a* and phaeo-pigments/chl-*a* are given in Fig. 2F, G. It can be seen that the ratio chl-*b/a* was considerably lower, ranged from 0.01 to 0.66 while the ratio between phaeo-pigments/chl-*a* was slightly higher, ranged from 0.06 to 5.2 in some months. These ratios of different components of chlorophylls give an insight into the photo-adaptability, physiological and degradation state of communities. The high ratios of phaeo-pigments/chl-*a* suggest the abundance of detritus and predominance of degraded chlorophylls in the inshore waters.

Nutrients—Monthly average values of inorganic nutrients such as nitrite, nitrate, phosphate and silicate for the period 1986-88 are represented in Fig. 3. Both nitrite and nitrate values (Fig. 3A, B) were found to increase during April-July and September-November periods, coinciding with the 2 peak periods of primary production. High rate of primary production and high values of chl-*a* and nitrates indicated a positive co-relation during the period of study. Phosphate variations are unimodal with 2 periods of abundance (Fig. 3C), during

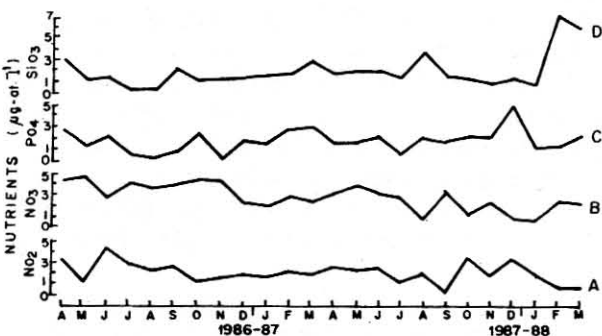


Fig. 3—The monthly average values of nutrients at the surface waters of the inshore area

March-June and August-December. During July-September and November '88 values are low and coincided with the peak periods of primary production, suggesting higher utilization of inorganic phosphate by the phytoplankton. Values of silicate (Fig. 3D) showed less fluctuations as compared to other nutrients.

Statistical analysis—To examine the dominance of different pigments and nutrients on primary production, multiple regression analysis of these parameters was carried out by treating chl-*a*, -*b*, -*c* phaeo-pigments and nitrite, nitrate, phosphate and silicate as the independent variables and primary production as the dependent variable. Though the coe-efficient of determination (R^2) in all the treatments are not high enough, say above 0.8 to permit a confident speculation about cause and effect of the independent variables, the estimates on correlation coefficients, standard partial regression coefficient (SPRC), F ratio and *t* values indicated that among pigments chl-*a* had a significant role in the primary production in 1986-87 and 1987-88 and nitrate in 1986-87. The *t* test indicates that except chl-*a*, none of the pigments were significant for primary production during 1985-86 ($P = <0.2$) and 1987-88 ($P = <0.05$) whereas in 1986-87, chl-*b* and *c* also exhibited significant levels to a limited extent ($P < 0.5$ and $P = <0.04$) along with chl-*a* ($P = <0.03$). The treatment of nutrients indicate that the influence of different nutrients on primary production was in the order of nitrate ($P = <0.1$), phosphate ($P = <0.25$), silicate ($P = <0.4$) and nitrite ($P = <0.5$) during 1986-87.

Multiple regression analysis proved that all phytoplankton pigments are not contributing substantially for the organic production of the surface waters. Among the pigments, chl-*a* had a significant role in the production rates while the dominance of phaeo-pigments indicated the abundance of non-photosynthetic pigments and dead chlorophylls. Among nutrients, only nitrate and phosphate have influence on primary production while nitrite and silicate have insignificant role. Usefulness of chl-*a* in relation to primary production as a measure of the standing crop has been verified since a direct relationship exists between primary production and chl-*a* for the inshore waters.

Acknowledgement

The authors are grateful to Dr P S B R James, Director, for his keen interest and encouragement.

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