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CARBON FIXATION BY PHYTOPLANKTON IN THE NEARSHORE WATERS OFF MANGALORE

T.R.C. GUPTA, S. NAYAR, N.V. YATEESHCHANDRA AND C. LINGADHAL

Department of Aquatic Biology, College of Fisheries, Mangalore-575 002

ABSTRACT

Studies pertaining to the carbon fixation by marine phytoplankton in the Arabian sea off Mangalore were carried out at monthly intervals from October 1995 to April 1996. Surface water samples were collected from 5 stations located on the 10-50 m contour lines. This investigation revealed a distinct spatial variation for with less significant temporal variation both carbon fixation and chlorophyll *a*. Higher production rates were recorded at 10 m depth both in terms of carbon fixation (mean value 8.8 mgC. m^{-3}. h^{-1}) and chlorophyll *a* (mean value 8.8 mg. m^{-3}). Hydrographical parameters such as salinity, ammonia, nitrate and phosphate recorded distinct spatial and temporal variations, while temperature and dissolved oxygen recorded distinct temporal variation only.

INTRODUCTION

CONSIDERABLE information is available on the hydrography and primary production of the coastal waters of Arabian sea (Channespappa, 1991, Gopinathan and Rodrigo, 1991, Gupta, 1980, Gupta *et. al.*, 1988). Wide fluctuations in the values of primary production for different locations have been found in the Arabian sea. Works in the nearshore waters off Mangalore are scanty. Phytoplankton production in tropical marine environment account for nearly 90% of the total production. This data on production and related hydrographical parameters, can be used with remote sensing data to predict the potential fishing grounds.

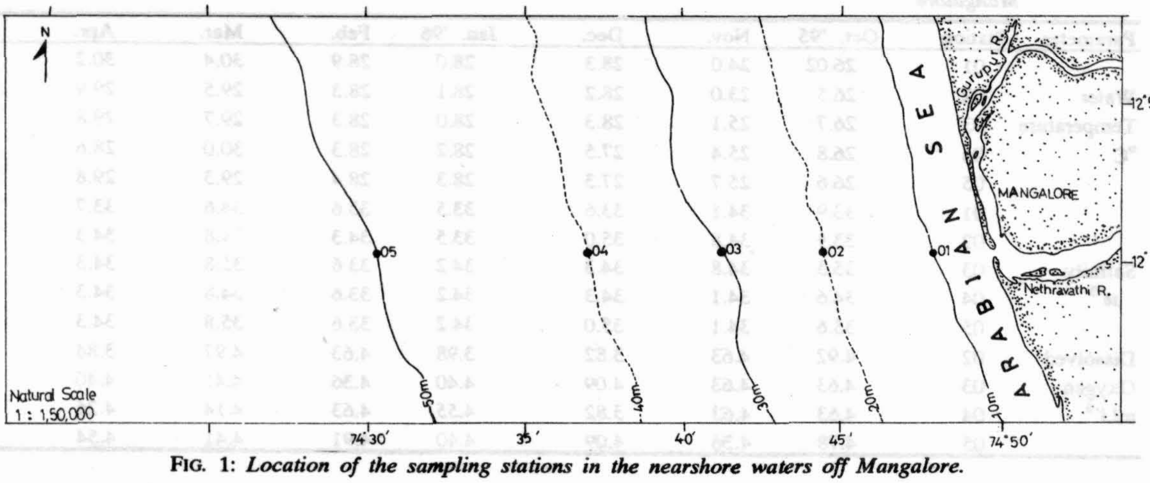

FIG. 1: *Location of the sampling stations in the nearshore waters off Mangalore.*

With this background, the present investigation was initiated for a period of 7 months. The study considered hydrographical parameters and their variations spatially and temporally.

MATERIAL AND METHODS

Surface water samples were collected from 5 stations fixed at 10 m, 20 m, 30 m, 40 m and 50m depth contour lines in the Arabian sea off Mangalore, designated 01, 02, 03, 04 and 05 respectively (Fig. 1), at monthly intervals from October 1995 to April 1996 in cruises undertaken on MFV *Dolphin.*

Surface water temperature was recorded using a mercury in glass thermometer. Samples for dissolved oxygen and ammonia were collected in 125 ml transparent and amber coloured bottles respectively and fixed in the field following standard procedures. Water samples for phosphate was collected in 125 ml capacity glass bottles and transported with water samples collected for other hydrobiological parameters under cold (+4°C) conditions to the laboratory for further analyses.

Primary production was estimated in the laboratory by the radioisotope 14_C technique. (Nair, 1970, Krishnamurthy, 1986). The filters were read for radioactivity in a liquid scintillation counter (Model LSS 20A, ECI). Chlorophyll *a* was estimated adopting the acetone extraction spectrophotometric method and Mohr method (Parsons *et. al.*, 1989) was followed for the analysis of salinity water samples. Nutrients such as ammonia, nitrate and phosphate were estimated adopting standard colorimetric procedures using a Milton Roy Spectronic 21 D spectrophotometer, (Strickland and Parsons, 1972).

The data on primary production, chlorophyll *a*, salinity, temperature and nutrients were subjected to two way analysis of variance (ANOVA) to find out any significant ($P < 0.05$) spatial and temporal variations. ANOVA was computed using MINITAB (Version 8.3) statistical computer package.

RESULTS AND DISCUSSION

Hydrography

Surface water temperatures fluctuated between 23.0 to 30.4°C with an average of 26.4°C (Table 1). Lower temperatures were recorded in November. Increased temperatures towards the premonsoon season culminated in attaining a maxima during the months of March and April. Biomodal distribution of temperature was seen exhibiting a primary peak in March and a secondary peak in October. Similar results have been reported from the nearshore waters

TABLE 1. *Spatial and temporal variation of water temperature, salinity and dissolved oxygen in Arabian Sea off Mangalore*

Parameter	Station	Oct. '95	Nov.	Dec.	Jan. '96	Feb.	Mar.	Apr.
	01	26.02	24.0	28.3	28.0	28.9	30.4	30.2
Water	02	26.5	23.0	28.2	28.1	28.3	29.5	29.9
Temperature	03	26.7	25.1	28.3	28.0	28.3	29.7	29.8
°C	04	26.8	25.4	27.5	28.2	28.3	30.0	28.6
	05	26.6	25.7	27.3	28.3	28.4	29.3	29.8
	01	33.9	34.1	33.6	33.5	33.6	34.6	33.7
	02	33.9	34.8	35.0	33.5	34.3	34.8	34.3
Salinity	03	35.3	34.8	34.3	34.2	33.6	35.8	34.3
10^{-3}	04	34.6	34.1	34.3	34.2	33.6	34.8	34.3
	05	35.6	34.1	35.0	34.2	33.6	35.8	34.3
Dissolved	02	4.92	4.63	3.82	3.98	4.63	4.97	3.84
Oxygen	03	4.63	4.63	4.09	4.40	4.36	4.41	4.40
$ml.l^{-3}$	04	4.63	4.63	3.82	4.55	4.63	4.14	4.26
	05	4.78	4.36	4.09	4.40	4.91	4.41	4.54

of west coast of India (Qasim, 1977, Qasim, *et. al.*, 1978, Pai 1980). Statistical analysis of the data revealed significant (P<0.05) temporal variations.

Salinity varied between 33.5 (January) to 35.8×10^{-3} (March), with a mean value of 34.2×10^{-3} (Table 1). A single peak was recorded in March. The probable causes for higher salinities are higher air and sea water temperature, greater wind force and low humidity, which increases the rate of evaporation and thereby salinity. Statistically, spatial and temporal variations in salinity were significant ($P < 0.05$). No definite pattern for spatial variation could be inferred from the data.

Dissolved oxygen concentrations in the waters ranged from 3.8 to 4.9 ml.l^{-1} (Table 1). The data shows comparatively oxygen poor waters in the nearshore, increasing towards offshore. Large quantum of untreated sewage are discharged into the Nethravathi and Gurupur rivers, which find their way into the sea resulting in higher BOD values in nearshore waters (Ramamurthy, 1963). A bimodal distribution of dissolved oxygen was seen, with peaks in October and the other in February. Lower concentrations of dissolved oxygen in March/April can be attributed to higher temperature retarding the dissolution rates. Spatial variations were not significant, while temporal variations were significant ($P < 0.05$).

Nutrients

Riverine influx is known to influence the nutrient dynamics in the coastal waters. A review of literature on earlier works in this region also points to the distinct influence of the Nethravathi and Gurupur river, on the nutrient dynamics in the nearshore waters of Arabian sea off Mangalore.

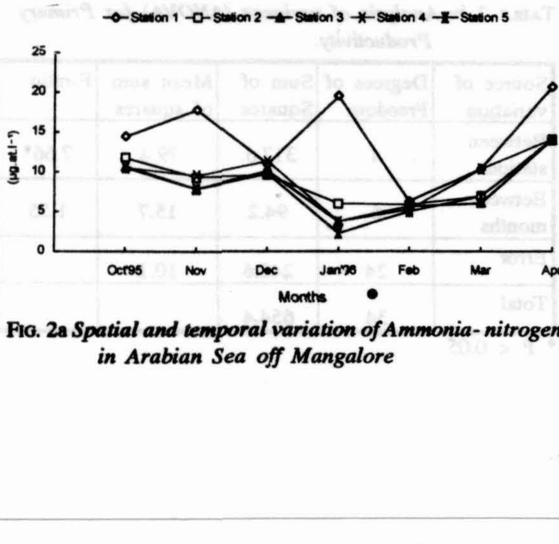

FIG. 2a ***Spatial and temporal variation of Ammonia- nitrogen in Arabian Sea off Mangalore***

Ammonia ranged from 2.25 to 20.69 µg-at. l^{-1} (Fig. 2 a). Statistically, spatial and temporal variations were significant (P<0.05). Station 01, the nearshore station recorded consistently higher concentrations during the study period with a gradual reduction noticed from nearshore to offshore waters. Temporally, trimodal distribution was observed.

Nitrate, the oxidised form of nitrogenous nutrient was recorded in the range of trace levels to 16.2 µg-at l^{-1} (Fig. 2b). Higher concentrations of nitrate has been reported from the coastal waters of east coast of India (Subramanyan, 1959). Significant (P <0.05) spatial and temporal variations were noticed. The nearshore station (01) recorded higher concentrations during the study period, with lower values in the offshore stations. This points out the influence of the river discharge

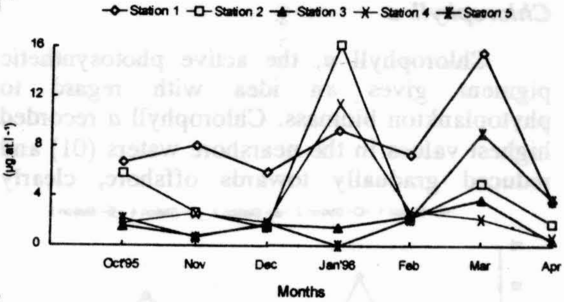

FIG. 2b *Spatial and temporal variation of Nitrate nitrogen in Arabian Sea off Mangalore*

on the nitrogen budget of the nearshore waters. A trimodal distribution was observed in the present study, in contrast to the findings of some earlier workers (Maliel *et. al.*, 1980), who reported trimodal distribution.

Phosphate (Fig. 2c) varied from traces to 3.8 µg-at l^{-1} recording highest concentration in the nearshore station (01). Phosphate, which has a terrigenous origin, clearly explains this phenomenon of recording higher concentrations in the nearshore waters. Temporally, two distinct peaks were recorded, a primary one in March and a secondary peak in January. Bimodal distribution of phosphate during March is perhaps due to the under utilisation by

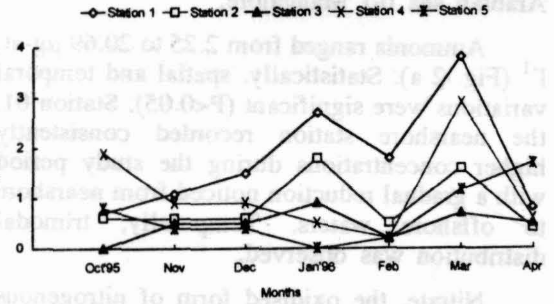

FIG. 2c *Spatial and temporal variation of Phosphatee-phosphorus in Arabian Sea off Mangalore*

phytoplankton cells, when productivity values registered a decline. Lower concentration of phosphate at station 01 in October, coinciding with the productivity peak, can be explained as due to increased utilisation by phytoplankton. Statistically, significant ($P < 0.05$) variations were observed spatially and temporally.

Chlorophyll a

Chlorophyll *a*, the active photosynthetic pigment gives an idea with regard to phytoplankton biomass. Chlorophyll *a* recorded highest values in the nearshore waters (01) and reduced gradually towards offshore, clearly

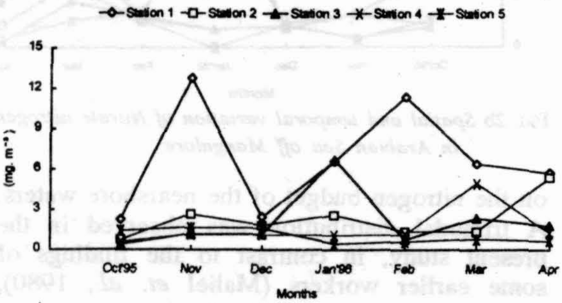

FIG. 3. *Spatial and temporal variation of Chlorophyll a in Arabian Sea off Mangalore*

indicating higher productivity in the nearshore waters (Fig. 3). Temporal variations were not significant (Table 2a), while spatial variations were significant. During the present investigation, chlorophyll *a* varied from 0.41 to 12.79 $mg.m^{-3}$ exhibiting a bimodal distribution with a primary peak in November, and a secondary peak in February. These peaks coincided with the peaks of dissolved oxygen

TABLE 2 a: *Analysis of variance (ANOVA) for Chlorophyll a*

Source of variation	Degrees of Freedom	Sum of Squares	Mean sum of squares	F-ratio
Between stations	4	157.83	39.46	9.16*
Between months	6	27.64	4.61	1.07
Error	24	103.32	4.31	
Total	34	288.79		

*$P < 0.05$

and primary production indicating higher production rates in November and February. Similar peaks have been reported by other workers (Suresh *et. al.,* 1978; Lingadhal, 1995).

Primary productivity

In the present investigation, primary productivity (Fig. 4) exhibited distinct spatial

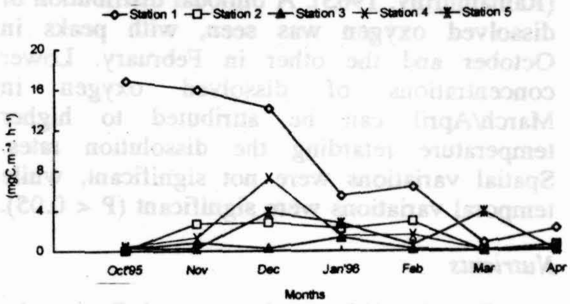

FIG. 4. *Spatial and temporal variation of Primary productivity in Arabian Sea off Mangalore*

TABLE 2 b: *Analysis of variance (ANOVA) for Primary Productivity.*

Source of variation	Degrees of Freedom	Sum of Squares	Mean sum of squares	F-ratio
Between stations	4	317.6.	79.4.	7.66*
Between months	6	94.2	15.7	1.55
Error	24	242.6	10.1	
Total	34	654.4		

* $P < 0.05$

variations, with station 01 recording higher values during the study period. Nearshore waters thus were seen to be more productive. Nutrient rich waters brought in by the Nethravathi-Gurupur riverine complex contributed to higher production rates in the nearshore waters, which was observed to reduce gradually towards offshore. Spatial variations were statistically significant (Table 2b). Productivity values were in the range of 0.02 to 16.87mg $C.m.^{-3}h^{-1}$, recording two peaks, a major peak in October-December and a minor peak in February. The data clearly points out higher production rates in the nearshore waters during the postmonsoon months, due to greater availability of nutrients for phytoplankton production. Substantially lower productivity values were recorded during premonsoon.

Statistical analysis failed to bring out clear cut relationship between nutrients and primary production and chlorophyll *a*. A few hydrographical parameters acting together may be responsible in regulating production rates.

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