

Primary Productivity in Nearshore Waters of Thal, Maharashtra Coast

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Primary productivity off Thal was evaluated at 3 stations during Feb. 1980 to Jan. 1981. The area was quite turbid and the euphotic zone never exceeded 2.5 m. Column production ranged from 0.69 to 605.21 mg C m⁻² d⁻¹ (av. 78.2 mg C m⁻² d⁻¹). Rate of production at all stations was maximum in August. Chl *a* maxima were spread over the July-August period. Correlation between nutrients and production was very low suggesting that instantaneous concentration of nutrient was insignificant. The estimated annual primary production potential of the study area (38.72 km²) was 1105 tC.

A comprehensive account on the primary productivity of the Indian Ocean has emerged from International Indian Ocean Expedition¹⁻³. However, investigations on the rate of primary production for the coastal waters of India are limited⁴ and detailed studies from confined areas are necessary to augment the existing data.

Available information on the primary productivity of the nearshore waters of Maharashtra is for the Bombay coast^{5,6}. Measurement of primary production along the northern Arabian Sea^{7,8} includes a few stations in the offshore waters of Maharashtra. A systematic study of the primary productivity along the coast of Thal has been carried out and the results are presented in this communication.

Materials and Methods

Thal is situated in the coastal approaches to Bombay harbour (Fig. 1). The entire coast line is characterised by sand banks and reefs. The 3 stations—S (south), M (middle) and N (north) are approximately 1 km away from the coast. Mean depth⁹ at these stations was approximately 6 m. Primary production was estimated following the ¹⁴C technique with *in situ* incubation¹⁰. Monthly observations were made at all stations. From each station 9 samples were taken from 3 light penetration depths (100, 30 and 1%) and incubated for 4 hr from 0900 to 1300 hrs. Radioactivity was determined in a GM Counter and the efficiency of the counter was obtained by comparison with a liquid scintillation system. The counts were corrected for dark uptake and from this value daily production rate was estimated. By integrating the values for different depths production for the water column is obtained. Chl *a* was estimated following the standard method¹¹. Salinity, dissolved oxygen, nitrate and phosphate data were obtained⁹.

Results

Variation in environmental parameters and production rate are given in Table 1. Fig. 2 gives column production values. The difference in chemical parameters with depth was negligible and hence the given values are mean for the surface and 5 m. The area is quite shallow and turbid. The euphotic zone never exceeded 2.5 m and usually it extended up to 1.5 m. During peak monsoon period (June to August) salinity was relatively low ($20.23-34.05 \times 10^{-3}$) while fluctuating conditions were characteristic of the post monsoon period (October-January). Thereafter a gradual increase in salinity ($35.73-38.27 \times 10^{-3}$) was observed. Level of dissolved oxygen in the area was usually above 6 mg l⁻¹ (Table 1). High values of nitrate were mostly

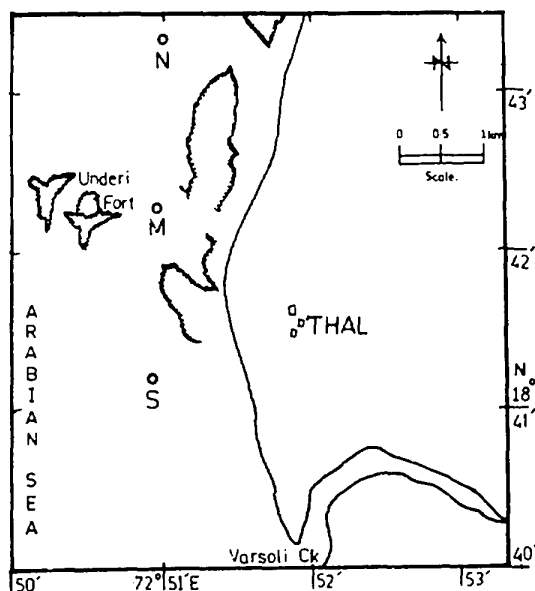


Fig. 1—Station locations

Table 1—Productivity and Environmental Data at the Different Stations

	Sal. ($\times 10^{-3}$)	Dissolved oxygen (mg.l^{-1})	Nitrate ($\mu\text{g-at.l}^{-1}$)	Phosphate ($\mu\text{g-at.l}^{-1}$)	Chl <i>a</i> (mg.m^{-3})	Production at different light penetration depths ($\text{mg.C.m}^{-3}.\text{d}^{-1}$)		
						100%	30%	1%
St S								
Feb. '80	35.73	6.6	1.07	0.81	0.44	122.6	25.98	6.24
March	35.82	5.6	2.5	0.42	2.6	50.6	—	19.8
April	35.92	5.9	2.21	0.97	1.29	48.1	34.20	25.62
May	38.08	6.1	2.71	0.68	1.98	84.6	32.46	12.90
June	34.05	5.7	0.71	—	3.1	10.1	0.54	0.96
July	20.23	7.1	1.71	4.61	11.76	54.3	21.18	4.5
Aug.	25.6	7.2	7.33	2.42	10.74	629	350.34	194.52
Sept.	34.05	8.1	1.36	1.23	8.04	392.7	243.18	206.94
Oct.	35.82	5.1	13.43	1.42	0.99	16	12.48	4.32
Nov.	34.9	5.7	3.36	1.39	0.66	111.7	22.32	38.94
Dec.	33.93	7.1	11.5	1.42	2	251.6	0.84	11.76
Jan. '81	36.72	7.3	12	1.52	1.66	71.9	56.52	31.02
St M								
Feb. '80	36.68	7.5	6.21	1.84	1.32	75.2	63.18	7.2
March	36.16	6.1	5.5	1.68	1.87	82.1	96.18	46.38
April	36.18	6.1	2.86	1.39	2	37.8	22.2	19.08
May	37.01	6.3	3.57	1.35	3.69	39.1	20.58	2.16
June	33.95	6.1	2.5	5.16	3.19	14.5	9.54	21.9
July	24.7	6.4	1	1.87	10.46	1.7	—	5.46
Aug.	25.01	7.2	3.43	1.32	4.12	305.2	349.74	114.72
Sept.	35.71	6.1	2.21	1.1	4.43	219.1	57.18	154.68
Oct.	35.71	6	11.14	1.71	1.42	51.7	27.3	41.1
Nov.	35.88	5.7	4.5	1.71	0.77	54.5	17.04	17.76
Dec.	34.84	8	8.5	3.32	0.77	123.9	93.42	63.12
Jan. '81	33.73	7.9	12.86	1.61	0.77	55.1	51.48	20.4
St N								
Feb. '80	36.52	7.6	3	1.45	1.33	86.8	44.82	0.02
March	36.4	6.3	1.64	0.74	2.36	68.9	—	30.84
April	36.52	7.2	5.79	0.94	2.86	48.2	20.52	35.64
May	38.27	7	5.64	0.87	2.5	101.3	35.4	12.6
June	33.31	5.7	1.07	1.52	2.9	32.6	13.8	5.46
July	21.97	6.7	4.0	1.45	10.52	12.4	—	13.74
Aug.	24.76	8.2	4.21	1.35	10.8	240.4	477.9	123.36
Sept.	35.15	6.5	2.43	1.42	5.82	84.9	73.98	36.78
Oct.	35.45	6.7	5.64	3.45	1.56	143	71.16	50.4
Nov.	34.94	5.6	2.64	1.35	0.89	59.6	33.12	32.7
Dec.	35.57	6.7	7.43	1.65	2.36	76.6	20.46	12.3
Jan. '81	35.71	7.9	17.71	1.84	1.28	73	38.1	5.1

recorded during the postmonsoon period. Relatively high concentration of phosphate was observed during the monsoon and postmonsoon periods.

Station S—Peak in primary production was recorded in August (Fig. 2). Low production was observed during March to July. Rate of production at surface, 30% and 1% light penetration indicated wide variations (Table 1). High values of chl *a* were confined mostly to July-September. Correlation coefficient between carbon assimilation and chl *a* was only 0.58. High values of nutrients often coincided with relatively high values of production. The correlation between

nitrate and production was 0.13 while that for phosphate and production was 0.17.

Station M—Maximum production was noticed in August and lowest rates were spread over to June-July (Fig. 2). Production rate in August at 30% light intensity was more than that recorded for the surface (Table 1). Maximum value of chl *a* was recorded in July and low values were restricted to November-January. Correlation between production and the corresponding chl *a* concentration (-0.02) was not significant. High values of nutrients were not associated with high production rate. Correlation between production and

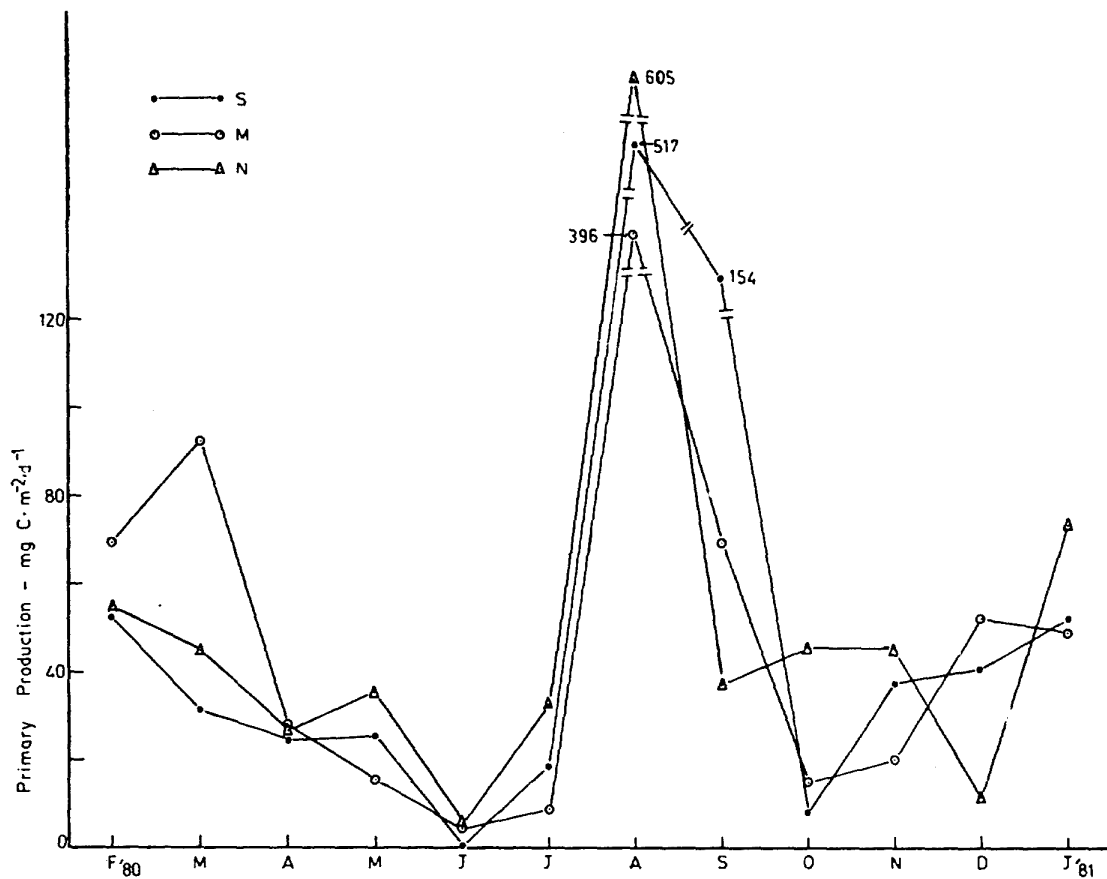


Fig. 2.—Variations in column production at different stations

phosphate (-0.19) and production and nitrate (-0.1) were also negative.

Station N—As observed at other stations maximum production was obtained in August. Lowest production was in June-July. The production estimated for 30% light penetration in August was higher than that observed for the surface (Table 1). Chl *a* values were maximum in July-August. Correlation between chl *a* and production was only 0.56. High values of nutrients rarely coincided with corresponding high values in production rate. Correlation between nitrate and production (-0.04) and between phosphate and production (0.03) were not significant.

Discussion

The results indicated that all stations sustain moderate production. Maximum average column production ($\text{mgC} \cdot \text{m}^{-2} \cdot \text{d}^{-1}$) was at st N (85.1) followed by st S (80.7) and st M (68.9). Rates of production at all stations are comparable with peak during the monsoon period (August). Off Bombay Coast

maximum primary production was observed during August or October¹². An appreciable number of the phytoplankton species found in the nearshore waters of Thal are of euryhaline nature¹³. High production during the monsoon period had been attributed to the relatively low salinity when the photosynthesis would be maximum and also due to euryhaline nature of the phytoplankton crop prevailing at that time¹⁴. During February to April invariably st M sustained higher values while for the remaining period maximum values were recorded mostly at st N. Mean rate of column production for the area of study was $78.2 \text{ mgC} \cdot \text{m}^{-2} \cdot \text{d}^{-1}$. The estimated total yearly primary production covering an area of 38.72 km^2 (Fig. 1, north of $18^{\circ} 41'$) amounted to 1105 tC .

High values in nitrate and phosphate were recorded during monsoon and postmonsoon periods which probably associated with the period of maximum land run off. Correlation coefficient between nitrate and production or phosphate and production was very low suggesting that instantaneous concentration of

nutrients is not as significant as regeneration rate to affect production¹⁵.

Light penetration as measured by Secchi disc was limited to a very narrow zone in this system comparable to that reported for an estuarine habitat¹⁵. The area is characterised by sand banks and reefs. The topography of the area leads to the formation of circulation cells along the shore⁹. This appears to make the water turbid resulting in the reduction of compensation depth. Maximum uptake was generally recorded at the surface, except in some instances when it was at 30% light intensity. Similar instances of higher production at a few metres below the surface were reported for Palk Bay¹⁶.

Previous studies on measurement of primary production for the Bombay harbour showed a variation of 0.015 to 4.99 gC.m⁻³.d⁻¹ with maximum production in February⁵. Range in chl. *a* values observed during the above study⁵ (1.77-11.98 mg.m⁻³) is comparable with the present observation. The reported ¹⁴C assimilation rate in the nearshore waters off Bombay for the premonsoon period was very low⁶. The mean rate of primary production recorded¹² off Versova, Bombay was 106.9 mgC.m⁻².d⁻¹ and the rate is higher than that recorded for Thal area.

Radhakrishna *et al.*⁷ reported that waters off Bombay are very fertile with column productivity of more than 1 gC.m⁻².d⁻¹. During February-March the recorded rate of primary production off Bombay (445 mgC.m⁻².d⁻¹) was quite high⁸. Rate of primary production observed during the above studies⁸ for a station northwest of the present area of study showed a much lower rate of production (283 mgC.m⁻².d⁻¹) and chl *a* at this station was only 0.29 mg.m⁻². Comparison of the results obtained from the present study with the above observations^{7,8} cannot be done since the methodology adopted is different. However, it may be concluded that the recorded production rate off Thal was lower than the adjoining areas. It appears that the prevailing turbidity of the nearshore waters of

Thal is responsible for the low rate of primary production.

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