

Curry<sup>15</sup>, the rate of rise during the last 4000 yrs, has been slower, probably of the order of 0.3 to 0.8 cm/yr. Such a slow rate would probably lead to optimum growth of corals and perhaps for this reason some parts of the bank, for example, the pinnacle has reached fairly high.

Since the bank was discovered for the first time by the Research Vessel *Gaveshani*, it is named as Gaveshani Bank.

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### Primary Productivity of the Bay of Bengal During March-April 1975

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Primary productivity has been measured at 12 stations in the Bay of Bengal and 2 stations in the south-eastern Arabian Sea, during March-April 1975. Data on phytoplankton and zooplankton standing crops and inorganic phosphate and nitrate are presented and the correlations between these parameters and productivity discussed. Primary productivity in the Bay of Bengal is maximum at the surface as compared to subsurface waters. Daily productivity varies from 1.56 to 110.26 mg C at the surface and from 0.063 to 0.25 g C in the euphotic column.

**I**NFORMATION on primary productivity of the Bay of Bengal is limited to few areas<sup>1-4</sup>. As a part of the oceanographic studies in the Bay of Bengal conducted during March-April 1975 on

board *INS Darshak*, primary productivity measurements were made at 12 stations in the Bay of Bengal and 2 stations in the Arabian Sea. These results are discussed in the present paper.

The samples were collected from predetermined optical depths after measuring the light attenuation with a submarine photometer. Productivity was measured by the radiocarbon technique after making due correction for dark uptake, under simulated *in situ* conditions for 24 hr. Radioactivity was counted on a liquid scintillation system. Nutrients were estimated by standard methods<sup>5</sup>. Zooplankton was collected by standard IOSN tows (0-200 m).

Details of station locations and depth, and sampling depths and dates along with primary productivity and related parameters are given in Table 1.

One interesting feature observed in the present study is that at all the Bay stations, productivity at the surface was maximum as compared to other depths sampled in the euphotic zone. This vindicates the view that in the Bay of Bengal, the light intensity at the surface is optimum and is not too high to inhibit photosynthesis as is generally the case in tropical latitudes. This situation is probably due to the relatively heavy cloud cover over the Bay most of the year round — 4.1-5.1 oktaves<sup>6</sup>.

Information regarding the quantitative distribution of phytoplankton in the offshore regions of the Bay of Bengal is virtually nil. LaFond<sup>7</sup> made a passing reference to high nearshore phytoplankton concentration on the northern and eastern sides of the Bay. In the present study, a preliminary attempt is made to quantify the phytoplankton standing crop and correlate it with primary production and nutrients.

In general, the phytoplankton were relatively high in the oceanic stations both at the surface and in the column although the primary production was low in comparison. On the other hand, in the Sandheads (station 194), the unusually high phytoplankton standing crop of  $40 \times 10^6/m^2$  at the surface was associated with high productivity. At the offshore stations, cell counts at the surface varied from  $10.27 \times 10^6/m^3$  (av.  $15.6 \times 10^6/m^3$ ) and the integrated counts in the column from  $300.537.7 \times 10^6/m^3$  (av.  $435.5 \times 10^6/m^2$ ). The standing crop values for the various stations are given in Table 1.

Diatoms dominated the samples; dinoflagellates were relatively few. Among the diatoms, *Bacteriastrum*, *Rhizosolenia*, *Chaetoceros* and *Coscinodiscus* were the most frequent and were encountered throughout the area.

Correlations between primary productivity and other variables like phytoplankton, zooplankton and inorganic nutrients are presented in Table 2. Correlation coefficients and their levels of significance are given in order to bring out the interrelationships of the parameters involved. The correlation between productivity and phytoplankton was not significant at the surface; the coefficient value was 0.52. However, the correlation coefficient between column productivity and column phytoplankton count was -0.58, significant at 10% level.

The inorganic phosphate concentration at the surface in the oceanic region of the Bay of Bengal

TABLE 1 — PRIMARY PRODUCTIVITY AND RELATED PARAMETERS AT DIFFERENT STATIONS

Stn No.	Date	Location	Station depth m	Sampling depth m	Primary productivity gC/m <sup>2</sup> /d	Primary productivity mgC/m <sup>2</sup> /d	Phytoplankton 10 <sup>9</sup> /m <sup>3</sup>		Phosphate µg at/litre		Nitrate µg at/litre		Zooplankton biomass ml/m <sup>3</sup>
							10 <sup>9</sup> /m <sup>3</sup>	10 <sup>9</sup> /m <sup>3</sup>	IMC	surface	IMC	surface	
192	21-3-75	13°15'N 84°34'E	3210	50	0.174	9.78	460	27	1.18	0.66	2.94	1.17	2.1
193	22-3-75	16°22' 86°00'	3000	50	0.188	6.92	515	16	0.77	0.6	1.3	0.57	2.2
194	26-3-75	21°21.5' 89°14.5'	8	6	0.25	110.26	136	40	—	—	—	—	—
195	27-3-75	21°14.2' 89°14.3'	10	6	0.117	17.91	66	15	—	—	—	—	—
196	27-3-75	20°12' 88°01'	850	75	0.243	10.34	537.5	13	—	—	—	—	1.95
198	28-3-75	18°05' 85°53'	2220	75	0.214	6.29	517.5	13	—	—	—	—	2.2
199	29-3-75	17°01' 84°45'	3000	75	0.22	14.25	300	18	0.63	0.53	3.13	2.36	1.6
200	29-3-75	15°35' 83°10'	3000	75	0.189	3.96	445	18	1.77	1.97	5.08	4.03	0.5
202	5-4-75	10°40' 81°06'	3500	75	0.096	2.68	430	13	1.69	1.77	1.49	0.41	0.4
203	5-4-75	09°32' 81°21'	3500	75	0.119	3.19	412.5	15	1.43	1.13	2.83	2.28	0.9
204	6-4-75	08°44' 81°36'	2200	75	0.063	1.56	332.5	13	3.34	1.44	16.63	1.39	1.2
205	7-4-75	06°30' 79°00'	2000	75	0.091	3	405	10	1.58	0.9	1.59	0.25	1
207	8-4-75	08°01' 76°17'	1450	75	0.173	7.57	495	9	1.69	1.1	6.64	2.5	5
209	9-4-75	10°20' 75°20'	1360	50	0.485	2.2	205	12	1.09	0.77	3.61	2.82	3

— = no data.

is about 0.2 µg at/litre<sup>8</sup>. The Anton Bruun<sup>2</sup> average was 0.06 and the Galathea average was 0.12 µg at/litre. Low phosphate concentration is generally associated with warm and high saline waters<sup>8</sup>. In the present study, however, phosphate concentrations at the surface were high (0.53-1.97 µg at/litre; av. 1.14 µg at/litre) notwithstanding the prevailing high temperature and salinity (29.07°C and 34.00‰). Since these stations were oceanic, the upwelling prevailing along the east coast of India during that season<sup>9</sup> could not have influenced such offshore waters and resulted in such high phosphate concentrations in surface waters. The integral mean concentration (IMC) of the phosphate in the euphotic column was also high (0.77-3.34 µg at/litre; av. 1.55 µg at/litre).

Although the phosphate concentrations were relatively high both at the surface and in the euphotic zone, the productivity was low. For example, at station 204, the surface phosphate value was 1.44 µg at/litre and the surface productivity was the lowest recorded in this study — 1.56 mgC/m<sup>2</sup>. Likewise, IMC of phosphate at this station was 3.34 µg at/litre (the highest recorded) and column productivity — 0.063 gC/m<sup>2</sup>, the lowest recorded (Table 1). The correlation coefficient between productivity and phosphate concentration at the surface was -0.58, significant at 10% level and in the column was -0.49, not significant (Table 2). Correlation between phytoplankton and phosphate was also not significant either at the surface or in the column.

The inorganic nitrate concentration at the surface in the offshore waters of Bay of Bengal varies from 0.1 to 2.0 µg at/litre<sup>9</sup>. The average value for the Anton Bruun<sup>2</sup> stations was 0.39 µg at/litre. But in the present study, the nitrate concentration was high (av. 1.56 µg at/litre at the surface and IMC of 4.37 µg at/litre for the column). As in the case of phosphate, at station 204, nitrate was very high at the surface and in the column, IMC of 16.63 µg at/litre being the highest recorded. Correlations between productivity and nitrate and between phytoplankton and nitrate were not significant. However, the correlation between phosphate and nitrate was significant.

An attempt is made to correlate primary productivity with zooplankton standing crop. Zooplankton biomass in the Bay was poor varying from 0.4 to 2.2 ml/m<sup>2</sup> (av. 1.76 ml/m<sup>2</sup>) while at the 2 stations (207 and 209) in the Arabian Sea, the average was 4 ml/m<sup>2</sup>. The Anton Bruun<sup>2</sup> average biomass value was 14 ml/m<sup>2</sup> for the same season over an extensive area of the Bay. According to the IOBC Atlas<sup>10</sup>, the average for day collections over an year in the Bay is <10 ml. The correlation between zooplankton biomass and other parameters was poor.

In general, primary productivity in the offshore waters of the Bay of Bengal is low. Beyond the continental shelf the Galathea measurements<sup>1</sup> averaged 0.22 and those of Anton Bruun<sup>2</sup> 0.13 gC/m<sup>2</sup>/day. Kabanova<sup>11</sup> reviewing the literature on primary productivity in the northern Indian Ocean summarized the various measurements and concluded that the column productivity varied from

TABLE 2 — CORRELATION MATRICES FOR VARIOUS PARAMETERS AT SURFACE AND IN THE COLUMN

	Surface			Column			
	Primary productivity	Phytoplankton	Phosphate	Primary productivity	Phytoplankton	Phosphate	Nitrate
Phytoplankton	0.52	—	—	-0.58*	—	—	—
Phosphate	-0.58*	0.21	—	-0.49	0.039	—	—
Nitrate	0.08	0.025	0.67†	-0.24	-0.22	0.859‡	—
Zooplankton	—	—	—	0.43	0.066	-0.193	0.076

Level of significance: \*10%, †5%, ‡1%.

0.1 to 0.5 gC/m<sup>2</sup> while the surface productivity from 100-250 mgC/m<sup>3</sup>; her data were limited to the winter months only. Nair<sup>4</sup> calculated the production rate for offshore waters of the Bay as 0.19 gC/m<sup>2</sup>. The present measurements give a comparable average of 0.16 gC/m<sup>2</sup>/day.

Primary production in the Bay of Bengal is relatively low as compared to the Arabian Sea<sup>4</sup>. This can be attributed to (i) topographical feature like the narrow continental shelf, (ii) meteorological feature like the heavy cloud cover and (iii) certain oceanographic features. The Bay of Bengal, as a whole, is more or less an estuarine sea with an average salinity of 30-34‰. A number of major rivers open into the Bay both from east and west sides, bringing in huge quantities of inorganic and organic material which lower the transparency of the waters to a considerable extent, thus limiting photosynthesis. Upwelling in the Bay is less intense and limited compared to the Arabian Sea. The heavy river discharge offsets the offshore transport of surface waters caused by winds and thus damps upwelling. The other oceanographic mixing processes (vertical advection, diffusion etc.) that transfer the subsurface nutrients to the euphotic zone are also less intense in the Bay as there is a greater degree of stratification and stability due to the river discharge and concomitant lowering of salinity in the surface waters.

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Biodegradation of Organic Matter in Sea Water

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Biodegradation of 3 different biological materials (*Trichodesmium erythraeum*, Lucifer and mixed plankton) was studied to estimate their rate and extent of decomposition in surface sea water under controlled laboratory conditions. Rate of decomposition during the first 20 days was approximated by the 1st order Kinetics. Rate constants for the degradation suggested that there were 3 stages in the microbial decomposition and that 2 labile organic fractions and a refractory organic fraction could be identified. Approximately, 15-20% of the initial dissolved organic matter (DOM; fraction F<sub>1</sub>) was oxidized. The other labile fraction F<sub>2</sub> was about 30-45% of the total DOM. The refractory portion was about 40% and it was resistant to biological oxidation. Rate constant for F<sub>1</sub> of *T. erythraeum* was 0.0331 day<sup>-1</sup> and of Lucifer was 0.0723 day<sup>-1</sup> and for mixed plankton, it was 0.1188 day<sup>-1</sup>.

PRIMARY sources of energy of the coastal aquatic ecosystem are available at the producer-decomposer level. Number of dynamic and interacting environmental parameters influence this basic trophic level and control the development and optimization of energy flow. Higher components of the system such as predators, influence production rates within the system with their own variable populations and production dynamics.

Autotrophic productivity and related heterotrophic utilization of organic compounds are greatly influenced by the trace but highly dynamic pool of labile organic substrates. Free amino acids<sup>1</sup> and other growth factors such as vitamins<sup>2</sup> occur in exceedingly low concentrations in sea water but may undergo rapid utilization and synthesis. Degraded hydrolytic products of proteins, carbohydrates and fatty acids generally occur in large quantities within the DOM (dissolved organic matter) pool<sup>3</sup>. In spite of low concentrations, these organic compounds are of major functional and ecological significance for the metabolism of the ecosystem.