

RELATIVE CONTRIBUTION OF NANNOPLANKTON TO THE PRIMARY PRODUCTION OF TWO ESTUARIES OF GOA

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ABSTRACT

The contribution of nannoplankton to the chlorophyll and primary production of the estuarine system of Goa has been described. The chlorophyll *a* concentration of nannoplankton ranged from 32.8 to 100% of the whole chlorophyll. The average organic production of nannoplankton is 271 in Cumbarjua Canal, 215 in Zuari and 209 ($\text{mgC m}^{-2}\text{d}^{-1}$) in Mandovi estuary. Average nannoplankton production consisted not less than 84.8% of the total primary production in any of the sectors of the system. The nutrient concentration was not found to be a limiting factor.

INTRODUCTION

Numerous investigations from neritic and oceanic waters of temperate and tropical regions have shown that nannoplankton contributes 80 to 100% of the total primary production Teixeira, 1963, (Anderson, 1965, Malone, 1971). Similar information was lacking from the seas around India until Qasim, Sumitra - Vijayaraghavan, Joseph and Balachandran (1974) studied the contribution of nannoplankters, to the organic carbon production in Cochin Backwater. These authors found that 45 to 96% of the production is due to nannoplankters and rest to microplankters. Sumitra Vijayaraghavan, Joseph and Balachandran (1974) reported that 36 to 94% of the photosynthetic carbon fixation from inshore regions of Cochin is due to nannoplankters. In order to obtain similar information from other areas the work was carried out in the waters around Goa. This paper presents information on the contribution of nannoplankters to the production and pigments of the Mandovi-Zuari estuarine system.

MATERIAL AND METHODS

Water sampling was done at fortnightly intervals from four depths representing 100%, 60%, 30% and 1% illumination levels. The observations were carried out at 5 stations during June-September (monsoon period) 1972. Stations 1 and 2 were in Mandovi, 3 in Cumbarjua and 4 and 5 in Zuari (Fig. 1). Production was measured by ^{14}C method. After incubation from midday to sunset the sample was passed through a 64 μm net before filtering on to a membrane filter paper. The radioactivity was estimated in a G.M. Counter. For estimating chlorophyll 0.5 l water screened through a 64 μm net was filtered on to a membrane filter. The chlorophyll was estimated by the method described by Strickland and Parsons (1968). Both ^{14}C uptake and chlorophyll concentrations were measured for the unscreened samples as well. Fortnightly values were pooled and averaged monthwise. Hereafter the nannoplankters will be denoted as filtered in comparison to the whole plankton as unfiltered.

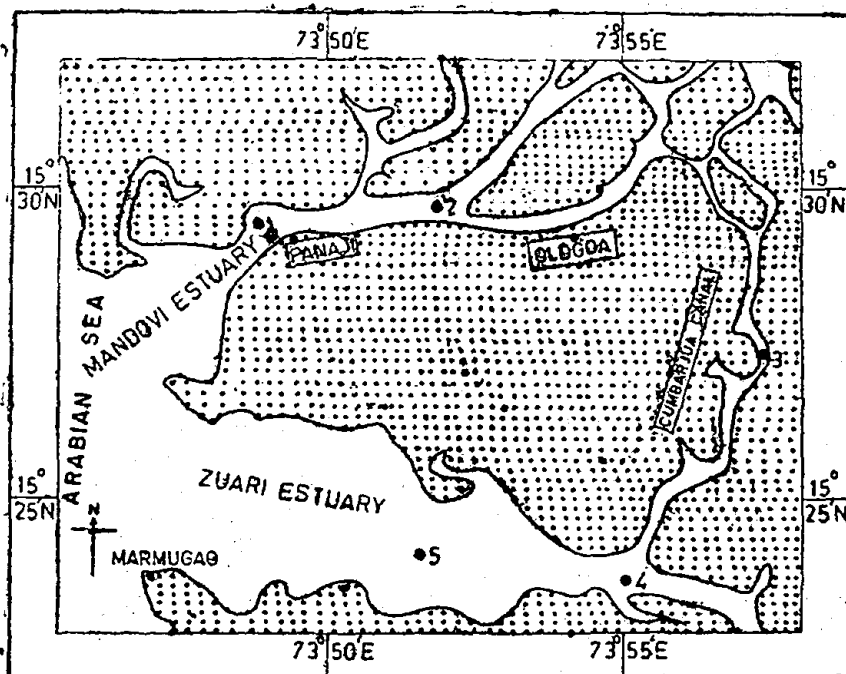


Fig. 1. Location of the 5 sampling stations in the estuarine system.

RESULTS

(a) Vertical distribution

The depthwise primary production and chlorophyll *a* concentration of the filtered and unfiltered samples are shown in Fig. 2. The nannoplankton production showed its maximum ($1122 \text{ mgC m}^{-3} \text{ d}^{-1}$) in Zuari during August and minimum (9.5) in Mandovi during July. In general production was at the minimum during July. The maximum production of chlorophyll was noticed at the surface (see Fig. 2)

(b) Column production and chlorophyll

The average column production of filtered samples is given in Table I. It is seen from the table that production at the estuarine mouths (stations 1 and 5) is generally less than that in mid-reaches (stations 2 and 4). The maximum production is in Cumbarjua Canal. The nannoplankton contributed 39 to 100% of the production in Mandovi, 72 to 100% in Cumbarjua and 70 to 100% in Zuari (see Fig. 3)

The chlorophyll *a* concentration ranged

Table I: The primary production ($\text{mgC m}^{-2} \text{ d}^{-1}$) due to nannoplankton in the Mandovi-Zuari estuarine system

Stations	M O N T H S				Average
	June	July	August	September	
1	261.30	26.66	137.83	220.58	161.59
2	693.28	32.26	90.27	213.10	257.23
3	348.40	127.19	424.32	184.94	271.21
4	129.19	63.15	644.28	197.62	258.56
5	90.60	150.13	272.48	175.57	172.24

Contribution of nanoplankton to the primary production

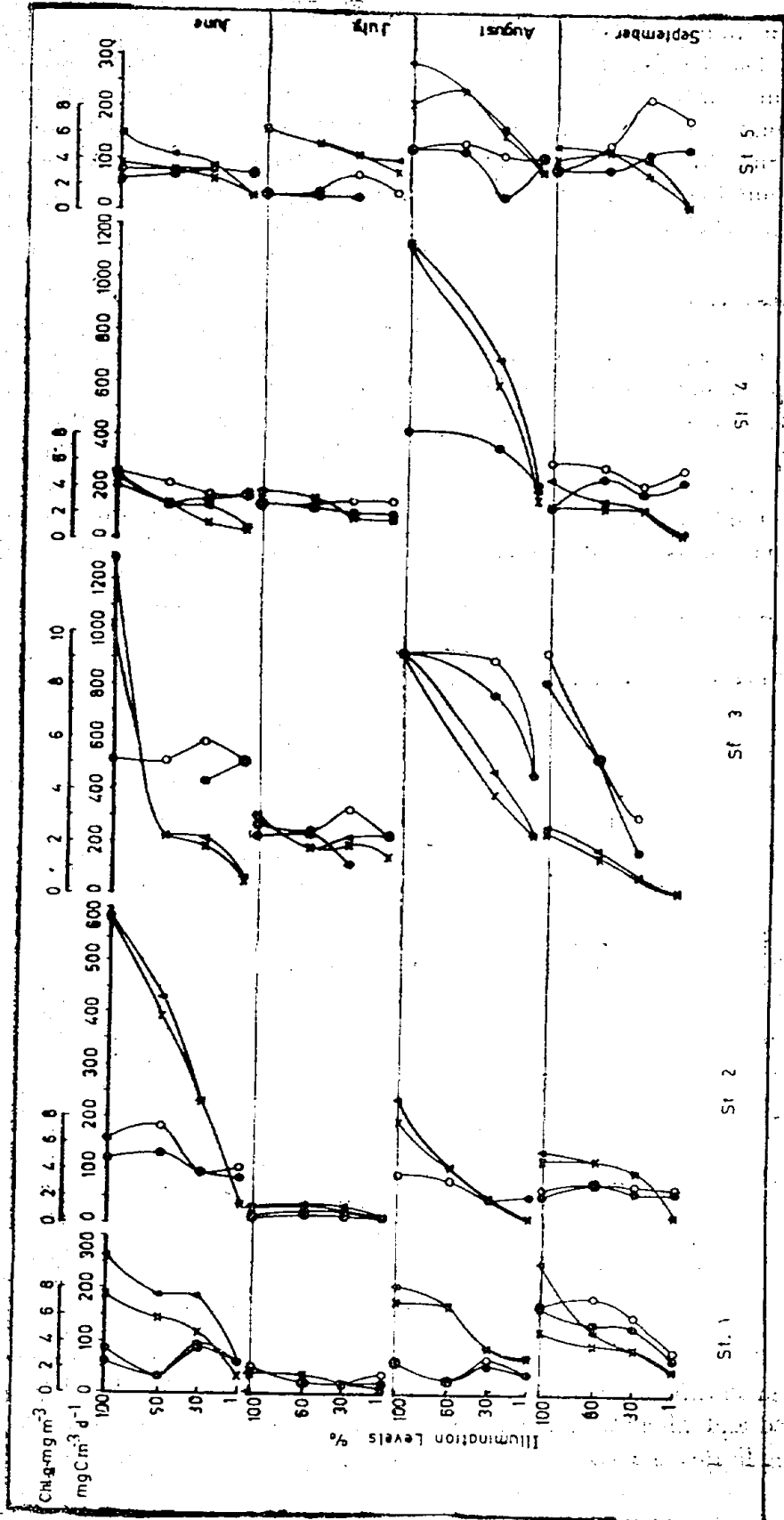


Fig. 2: Organic production and chlorophyll *a* concentration at 5 stations at different illumination levels during the four months: Production: Unfiltered (-▲-) and filtered (-×-) samples; Chl. *a*: Unfiltered (-O-) and filtered (-●-) samples;

from 0.96 to 10.57 in Mandovi, 1.28 to 9.05 in Cumbarjua and 1.64 to 11.21 mg m⁻² in Zuari. The minimum concentration was in July. Filtered samples contributed 81 to 97%, 45 to 91% and 87 to 100% of the chlorophyll from unfiltered samples from Mandovi, Cumbarjua and Zuari respectively.

DISCUSSION

The organic carbon production of the estuarine system is found to be mostly contributed by phytoplankters of small size (<64 μm). Since the average production (mgC m⁻²d⁻¹) of nannoplankters during monsoon is 209 in Mandovi, 271 in Cumbarjua and 215 in Zuari as compared to the

total production of 247, 316 and 249 respectively (Bhattathiri, Devassy and Bhargava, 1976), the nannoplankton production was not far from the total production. Similarly the chlorophyll concentration of the filtered samples show that nannoplankton contributes most of that from unfiltered samples. In this estuarine system it has been found that at the surface the contribution of nannoplankton to the total production vary from 49.3 to 100%. Most of the values are above 80%. Qasim, Sumitra - Vijayaraghavan, Joseph and Balachandran (1974) reported that in the Cochin Backwater the corresponding percentage ranged from 45-96. These indicate that in both the estuarine systems the contribution of nannoplankters is in the

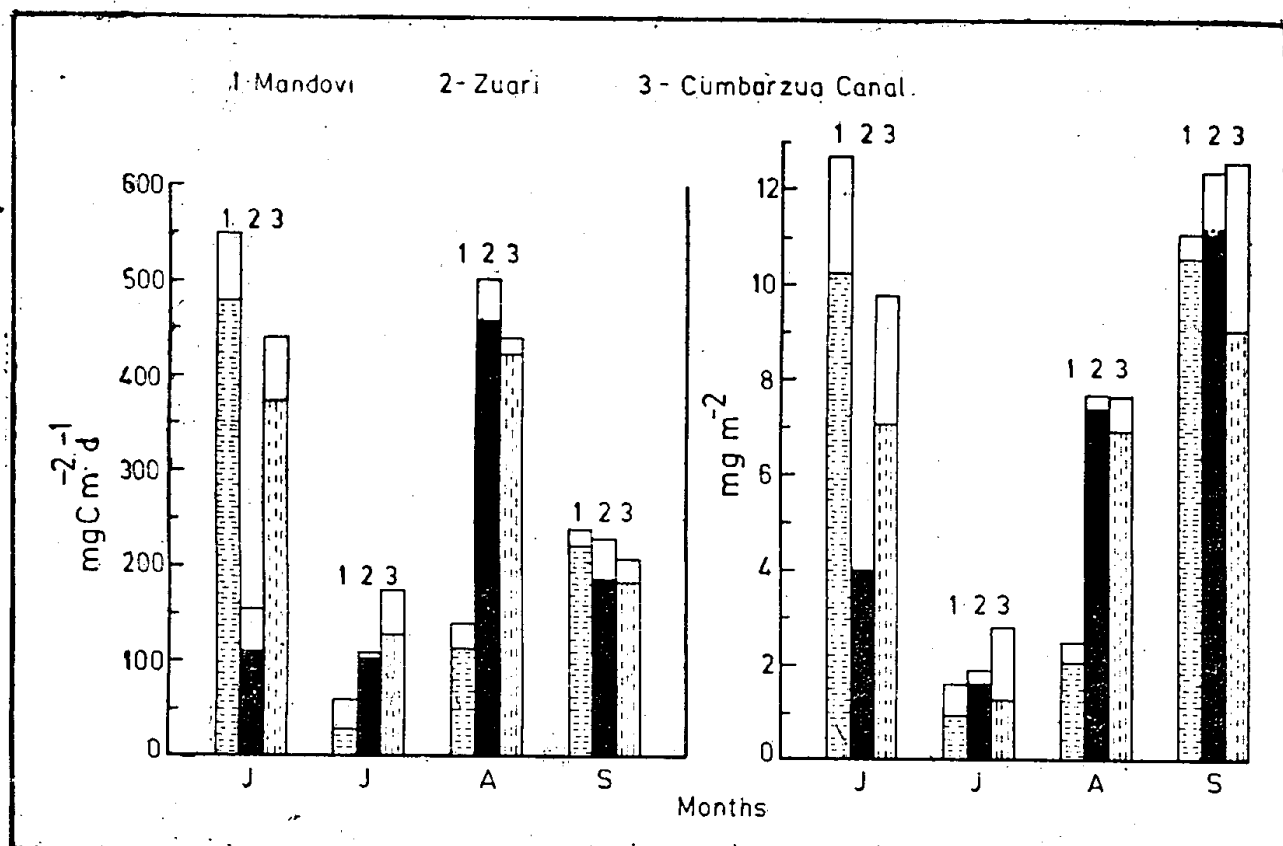


Fig. 3. Histogram showing the integrated values of organic production and chlorophyll a (unfiltered and filtered) in the three sectors of the estuarine system. The shaded portion indicates the contribution of filtered samples (nannoplankton).

Contribution of nannoplankton to the primary production

same range. Pant, Bhargava and Goswami (1976) put the share of nannoplankton to total production as 90% in the estuarine and neritic waters of Goa. This conclusion was arrived at from the diel studies. The contribution of filtered samples to chlorophyll from unfiltered sample was found to be between 42 to 100% with most of the values above 70. From Cochin Backwater it has been shown that chlorophyll from nannoplankton varies from 55 to 86% of the total. In both these estuaries if the production and the corresponding chlorophyll from nannoplankton are compared it is found to be different; this is because of the variations in the production capacity with the size of the plankton (phytoplankters).

The nannoplankton production showed very little correlation with either PO_4-P or NO_3-N . A scatter diagram showed that production did not depend on the instantaneous concentration of the nutrients and did not increase as found by Malone (1971). Despite the low nitrate concentrations on certain occasions the ratio of nanno to total production was high, which is because of the fact that half-saturation constant for nitrate uptake is low for small cell-sized phytoplankters (Eppley, Rogers and McCarthy, 1969). The different factors controlling the dominance or absence of different sized phytoplankters have been discussed by Semina (1972), and Parsons and Takahashi (1973). Thus it has been pointed out that the mean cell size depends upon the velocity of water movement upwards. The author states that the cells are smaller if water velocities are higher regardless of its direction. Hydrodynamic factors also play an important role in controlling the cell size. But Parsons and Takahashi (1973) state that many factors other than mentioned by Semina have also to be considered. According to these authors

the factors possibly contributing to the selectivity of size of the phytoplankters in an environment would be (i) the rate of nitrate or ammonium input to the cell, (ii) the extinction coefficient of the water, (iii) the mixed layer depth, (iv) the light intensity, (v) the sinking rate of phytoplankton and (vi) the upwelling velocity of the water.

During the present studies it has been found that the nitrate concentration from different location is always much more than $0.2 \mu g$ at/l (Bhattathiri, Devassy & Bhargava, 1976). Hence most of the time the nitrogen concentration is such as to promote the growth of larger phytoplankton, but this is not observed from the present values of production and chlorophyll. Further, the entire euphotic zone is well mixed and the attenuation coefficient is high as also the radiation values. Though most of the environmental factors are suitable for the growth of larger phytoplankton (see Parsons and Takahashi, 1973) it is noticed that in this estuarine system net plankton contributes very little to the production as well as to the chlorophyll concentration. Hence, there still may be some other factors which are decisive in the size of standing stock of phytoplankton and their contribution towards production and chlorophyll concentration.

As mentioned earlier nannoplankters are the major contributors for production and chlorophyll a . It is significant from the fact that the low area to volume ratio and smaller size of the nannoplankton enable them to utilize the nutrients and light in shallow turbid waters (Munk and Riley, 1952). However, it may be pointed that on the basis of food chain dynamics the efficiency of energy transfer to higher level will be less probably due to longer food chain which may affect the ecological efficiency in the estuarine system (Ryther,

1969). But it becomes easier for the organisms particularly larvae and filter feeders to consume these smaller cells which are distributed throughout the water column

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