THE SIGNIFICANCE OF NANNOPLANKTON IN PRIMARY PRODUCTION IN PORTO NOVO WATERS

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ABSTRACT

The relative significance of nannoplankton production in the Vellar estuary, Killai backwater and Pichavaram mangrove was studied, during pre-monsoon and monsoon seasons of 1974. Of the total production, nannoplankton contributed between 55.4 and 100% in the mangroves, 32.9 and 100% in the backwater and 44.8 and 100% in the estuary. The higher rate of nannoplankton production in the mangrove waters could be attributed to restricted light penetration. Relatively higher percentages of nannoplankton production were observed in the monsoon period than in the pre-monsoon period.

INTRODUCTION

In aquatic systems major portion of the primary production is chiefly due to nannoplankton (Teixeira *et al.* 1967; Tundisi, 1970; Malone, 1971a, c; Gelin, 1971 and Mommaerts, 1973). The relative importance of nannoplankton in aquatic production has been well established by many workers like Riley (1941), Wood and Davis (1956), Steemann Nielsen and Aabye Jensen (1957), Yentsch and Ryther (1959), Teixeira (1963), Holmes and Anderson (1963), Saijo and Takesue (1965), Semina (1969), Malone (1971a, b, c), Mommaerts (1973), Qasim *et al.* (1974) and Sumitra *et al.* (1974). As nannoplankters possess high surface area-to-volume ratio (Odum, 1956; Zeuthen, 1970) higher productivity index has been observed (Mommaerts, 1972). When compared to oceanic and coastal waters relatively very few works have been carried out in estuarine and mangrove systems. The present study is intended to show the relative significance of nannoplankton production in three ecologically significant biotopes namely the Vellar estuary, Killai backwater and Pichavaram mangroves during the pre-monsoon (July, August and September) and monsoon (October, November and December) seasons of 1974.

MATERIALS AND METHODS

The present study was carried out in three stations in Vellar estuary (Fig. 1., 1, 2 & 3) one station in Killai backwater (Fig. 1., 4) and one station in Pichavaram mangrove (Fig. 1., 5). All the sampling stations were shallow and the depths of stations 4 and 5 were, 1.5 mts. and 1.25 mts. respectively. For the estuary the average depth was 1.5 mts. All the samplings were carried out during high tide and surface samples in all the five stations were collected by means of a clean plastic bucket. The bottom samples were collected using a horizontal water scoop.

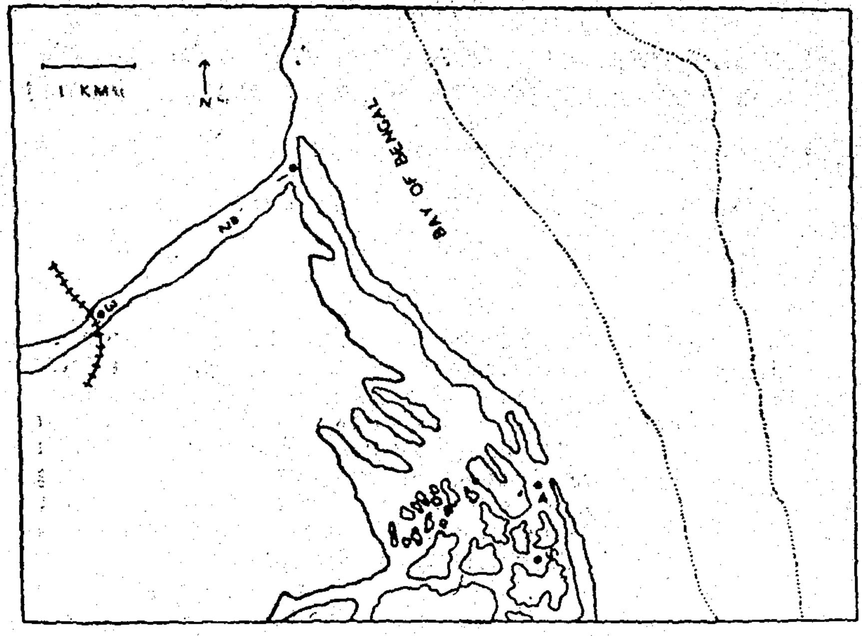

Fig. 1. Location of various stations in Vellar estuary (1, 2 & 3), Killai Backwater (4) and Pichavaram mangrove (5).

Primary production was measured by the light and dark bottle method of Gaarder and Gran (1927) as modified by Strickland and Parsons (1968). By adopting fractional filtration making use of a very fine mesh net (20 μ - Nytex), the nannoplankton production was seperately determined besides total plant production. The use of fractional filtration in primary production measurements was preferred since it is the best method available to understand the "metabolic structure" of the phytoplankton community (Mommaerts, 1973).

RESULTS

The mean values of the various parameters observed in the three estuarine stations were taken to represent the esturine environment. Variations in temperature, salinity and light penetration are given in Table I for the three biotopes.

While considering the nannoplankton production in the surface waters, the mangrove waters showed two peaks and both were observed in the pre-monsoon months viz. July and September (Fig. 2a). Backwater had a major peak in August (Fig. 2a) whereas in the estuary only one peak was observed (July) (Fig. 2a).

In the case of bottom waters the mangrove station showed higher production in July and during August and September the values decreased only slightly. In the backwater peak production was observed in September, whereas in the estuarine waters two peak values in production were observed

TABLE I—*Monthly variations in Temperature, Salinity, Light penetration and Monsoonal variations in Net / Nanno ratio*

		Temperature °C			Salinity ‰			Light Ex. Coefficient				Net/Nanno ratio		
Month	Depth	Mangrove	Backwater	Estuary	Mangrove	Backwater	Estuary	Mangrove	Backwater	Estuary	Period	Mangrove	Backwater	Estuary
July	Surface	30.0	27.5	28.0	32.5	32.5	30.8	4.2	2.75	2.10	Pre-monsoon	0.35	1.02	0.79
	Bottom	29.0	26.0	27.5	33.4	33.0	31.5							
August	Surface	30.0	28.0	30.0	33.5	34.0	32.5	6.8	4.35	2.21				
	Bottom	28.7	27.0	29.2	33.8	34.5	33.4							
September	Surface	29.0	26.5	30.5	15.0	34.2	13.6	5.8	1.85	3.15				
	Bottom	27.0	26.5	30.3	16.0	34.8	16.1							
October	Surface	26.5	26.8	28.0	9.5	32.0	16.3	4.8	1.15	2.78	Monsoon	0.19	0.44	0.45
	Bottom	27.5	26.8	28.0	13.1	32.5	18.5							
November	Surface	28.5	26.3	29.0	25.3	27.0	14.3	4.2	2.80	2.18				
	Bottom	28.0	26.3	29.0	27.6	27.5	18.2							
December	Surface	27.0	26.0	30.1	21.5	28.0	16.6	3.4	2.00	2.00				
	Bottom	26.0	25.5	29.2	26.3	28.0	19.5							

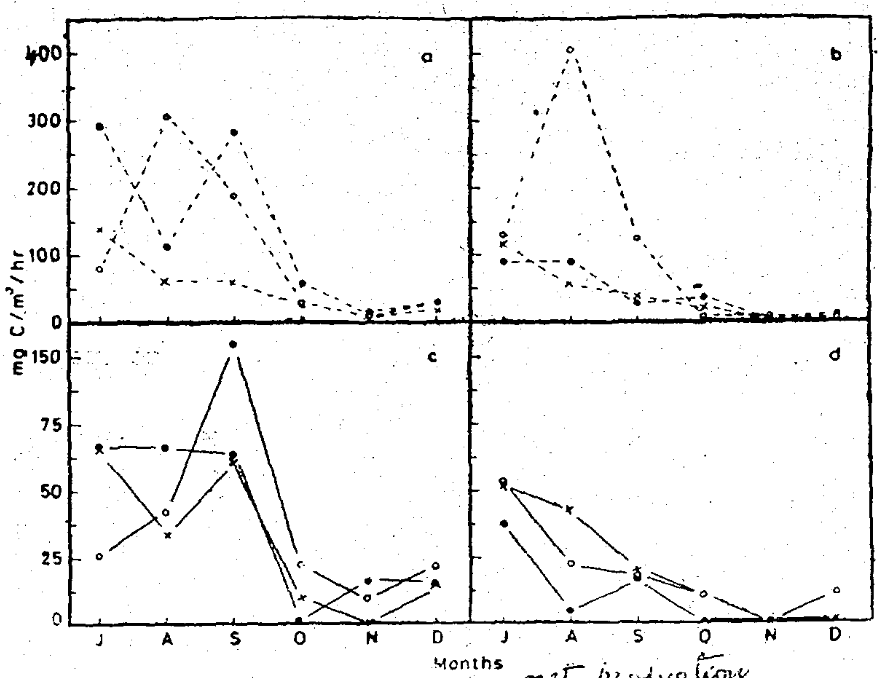

Fig. 2 Monthly variations in Nannoplankton ~~netproduction~~ net production in Surface (2a); and bottom waters (2c); monthly variations in ~~Netplankton~~ net plankton net-production in Surface (2b); and bottom waters (2d).

● Mangrove
O Backwater
X Estuary

during the pre-monsoon months of July and September (Fig. 2c).

Netplankton production also showed some variations. The surface waters of the mangrove showed higher production in July and August, but it decreased during the subsequent months (Fig. 2b). Backwaters showed peak production in August and the estuary in July (Fig. 2b). In the case of bottom waters the mangrove station showed a major and minor peak during July and September respectively (Fig. 2d). In the backwater and estuary high values were observed during the pre-monsoon month of July. No netplankton production in the bottom waters of all the three biotopes (Fig. 2d) was recorded during November.

In all the three biotopes, both the fractions of phytoplankton showed higher rates of production in the pre-monsoon season and always surface waters showed higher rates of production in both the fractions than the bottom waters (Fig. 2).

Irrespective of surface and bottom waters nannoplankters were responsible for as much as 55·4 to 100% of total plant production in the mangroves, whereas the range was between 32.9 and 100% for the backwater and from 44.8 to 100% for the estuary.

Regarding surface waters, the nannoplankton contributed between 60 and 100% (mean 74.7%) in the mangroves, 37.8 and 75% (mean 58.3%) in the backwater and 51.8 and 74.5% (mean 60.1%) in the estuary.

In the case of bottom waters 64.2 to 100% (mean 87%) of total production was due to nannoplankton in the mangrove and for the backwater and estuary the ranges were between 32.9 and 100% (mean 66%) and 44.8 and 100% (mean 67.5%) respectively.

DISCUSSION

Wood and Davis (1956), Holmes and Anderson (1963), Saijo (1964) and Saijo and Takesue (1965) observed that nannoplankters contributed 50 to 80% of the plant production in tropical waters. Malone (1971a & c) in his recent works showed that in tropical neretic and oceanic water the nannoplankton production ranged between 66 to 99%. Teixeira (1963) observed a range of 87 - 93.6% for the coastal and oceanic waters of an equatorial region. Teixeira et al. (1967), Tundisi and Teixeira (1968), Loftus et al. (1972) and Qasim et al. (1974) who investigated nannoplankton production in mangroves and estuaries showed that there was no well marked seasonal variation in nannoplankton production; but it contributed a very high percentage to total plant production as reported by Yentsch and Ryther (1959).

In the present study mangrove waters showed a very high proportion of production due to nannoplankton when compared to the backwater and estuary. On the basis of quantitative assessment of nannoplankton production the three biotopes could be arranged in the following descending order:

Mangrove —> Backwater —> Estuary

In shallow waters like estuaries and mangroves, eutrophic condition of the water favours the production of phytoplankton of larger size, having higher rates of nutrient uptake (Dugdale, 1967; Eppley et al., 1969). Parsons and Takahashi (1973) showed that besides nutrients higher light intensity would bring about faster growth of these larger forms. They also established that extinction coefficient of light was one of the chief factors controlling the abundance of larger or smaller forms of phytoplankters. Tundisi (1970) showed that even in eutrophic tropical estuaries with appreciable amounts of particulate matter such a limitation could be imposed by light. Colman and Cooper (1954) reported that light extinction values in some of the shallow, tropical tidal estuaries were quite unfavourable for photosynthesis by larger phytoplankters. Possibly, the restricted light penetration might have been the chief reason why most of the estuaries are highly productive due to nannoplankters (90 - 100%) as pointed out by Yentsch and Ryther (1959), Teixeira et al (1967) and Mommaerts (1973). The biotopes studied in the present investigation were shallow and rich in nutrients (Table II). In such systems, agitation of

TABLE II—*Monthly variations in Net and*

Month		Mangrove							Back-		
		Nanno. Chl. a. mg/m^3	Net Chl. a. mg/m^3	Ammonium µgat NH_4-N/L	Nitrite µgat NO_2-N/L	Nitrate µgat NO_3-N L	Phosphate µgat PO_4-P/L	Silicate µgat Si O_3-Si/L	Nanno. Chl. a. mg/m^3	Net Chl. a. mg/m^3	Ammonium µgat NH_4-N/L
July	S	20.62	6.52	0.53	0.15	1.20	0.30	20.15	5.25	8.05	0.81
	B	4.86	3.64	0.62	0.19	2.40	0.42	16.21	1.92	3.82	1.10
August	S	7.52	5.98	0.33	0.11	2.10	0.39	22.25	20.50	22.8	0.86
	B	3.7	0.42	0.63	0.05	1.80	0.47	18.05	2.82	0.96	1.50
September	S	20.1	3.21	0.50	0.38	3.50	0.67	56.50	12.5	8.28	0.79
	B	4.05	0.92	0.59	0.14	3.30	0.71	41.35	6.82	1.20	0.88
October	S	4.25	3.05	0.61	0.40	4.45	1.31	71.00	2.85	0.52	0.76
	B	0.0	0.0	0.68	0.38	3.40	1.36	45.06	1.22	0.62	0.80
November	S	1.22	0.0	0.72	0.25	2.65	0.45	27.5	0.69	0.78	0.78
	B	0.92	0.0	0.74	0.27	3.65	0.51	27.5	0.62	0.0	0.76
December	S	2.15	1.45	0.82	0.14	2.10	0.70	33.09	2.09	0.62	0.80
	B	1.05	0.0	0.84	0.17	1.75	0.85	28.05	1.09	0.59	0.80

Nannoplankton chlorophyll 'a' and nutrients

water				Estuary						
Nitrite μgat NO_2-N/L	Nitrate μgat NO_3-N/L	Phosphate μgat PO_4-P/L	Silicate. μgat Si O_3-Si/L	Nanno. Chl. a. mg/m^3	Net Chl. a. mg/m^3	Ammonium μgat NH_4-N/L	Nitrite μgat NO_2-N/L	Nitrate μgat NO_3-N/L	Phosphate μgat PO_4-P/L	Silicate μgat Si O_3-Si/L
0.43	5.60	0.45	10.10	8.84	6.35	0.84	0.25	1.53	0.49	16.0
0.61	5.80	0.36	8.55	4.58	2.95	2.94	0.27	3.40	0.32	14.3
0.43	5.00	0.40	9.52	4.02	4.20	0.39	0.13	5.50	0.67	29.3
0.41	5.90	0.35	8.10	2.05	2.82	0.65	0.15	6.00	0.75	15.0
0.23	2.80	0.62	19.00	3.96	3.01	0.38	0.56	3.50	0.71	81.8
0.23	3.80	0.89	18.00	4.87	1.46	0.53	0.64	2.10	0.77	68.0
0.36	1.60	0.72	9.50	1.88	1.82	1.07	0.46	4.50	0.99	76.0
0.32	1.20	0.68	7.50	0.76	0.75	1.20	0.37	4.40	1.03	57.6
0.38	2.45	1.05	22.25	0.95	0.32	1.23	0.30	17.00	1.31	86.0
0.41	3.00	1.25	22.25	0.0	0.0	1.29	0.35	14.25	1.40	39.6
0.15	2.70	0.98	18.00	1.74	1.26	1.40	0.22	4.71	0.82	43.0
0.18	2.70	1.15	16.00	1.08	0.0	1.63	0.23	5.83	0.75	49.3

the bottom sediments by tide induced currents would aggravate the process of restricting light penetration. When compared to other biotopes, the mangrove environment showed very much restricted light penetration (Table I). Mangroves the tropical counterparts of temperate marshes are quite noteworthy for their high detritus content. Thus, the restricted light penetration (as indicated by secchi disc values - Table I), observed for mangrove waters would have favoured relatively higher production by nannoplankton in the present study. Parsons and Takahashi (1973) stated that at times of restricted light penetration and low light intensity, production by nannoplankton would surpass that by net phytoplankton. The decrease in the amount of nannoplankton production in the bottom waters observed in the present study might be due to the restricted sinking of smaller cells with high A/V ratio (Munk and Riley, 1952; Smayda and Boleyn, 1966a; Eppley et al, 1967) and the aggregation of the active swimming nannoflagellates (Eppley et al., 1968 and Loftus et al., 1972) near regions of light saturated levels. However at very low light intensity nannoplankton production is also affected but its relative production would surpass that of net phytoplanktons (Parsons and Takahashi, 1973).

It has been observed by Teixeira *et al.* (1967) and Loftus et al. (1972) that local rainfall and the consequent decrease in salinity would favour the production of nannoplankton in relatively higher numbers. In the present study also it was observed that though plant production in general was low during the monsoon period, nannoplankton showed higher percentage of production when compared to premonsoon period with restricted rainfall and higher salinity. In all the three biotopes net/nanno ratio was very low during monsoon period (Table I), the mangrove waters showing lower values of this ratio when compared to the other two biotopes, thereby indicating very high percentage of contribution by nannoplankters.

Thus the present study substantiates the observations of Teixeira et al. (1967) that during periods of higher salinity the contribution to total plankton production by net plankton would be relatively higher when compared to the period of low salinity periods as examplified by the three biotopes.

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