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Primary production and fishery potential of the Panangad region in the Cochin estuarine system

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Abstract

The environmental parameters and primary production at selected stations in the Cochin Estuary, surrounding Panangad, are presented. This part of estuary becomes completely fresh water during southwest monsoon. Primary production showed a tri-modal annual variation with peaks during April, July and November. Maximum production was seen in November (183.33 mg $C/m^3/hr$) and minimum in June (52.08 mg $C/m^3/hr$). The production showed significant positive correlation with chlorophyll, but no correlation was found with environmental parameters. The fishery potential in the study region is estimated from the primary production and compared with available data on fish catch.

Keywords : Primary production, fishery potential, Cochin Estuary

Introduction

Vembanad Lake comprising of Cochin estuarine system is the largest one along southwest coast of India. There are several studies on primary production nearer to barmouth region and along the main arm of this estuary (Qasim *et al.*, 1969; Nair *et al.*, 1975; Kunjukrishna Pillai *et al.*, 1975; Gopinathan *et al.*, 1984; and Sreekumar and Joseph, 1997). However, such studies are not reported in the Panangad region, which is mainly an inner arm of the estuary. The present study area, which is situated about 10km from the bar mouth, surrounds the Nettoor and Panangad islands (Fig.1). The area includes portions of Nettoor Canal, Kumbalam *Kayal* and adjacent regions. This region, generally shallow, is presently under stress mainly due to the lateral expansion of the city of Cochin, widening of highways and many other developmental activities. The

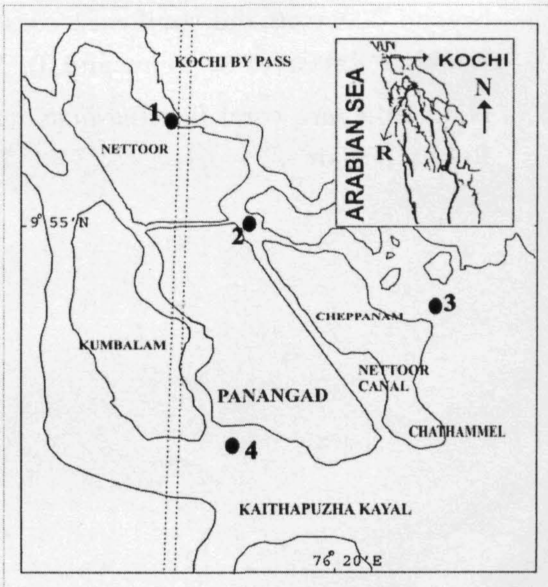

Fig. 1 *Area of study, marked as R in the inset.*

reclamation of low-lying areas contiguous to the estuary would also affect the eco-dynamics.

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Material and methods

Monthly observations and collection of samples were carried out from four stations around the Panangad region of Vembanad Lake from January to December 2003. Data collections were organized on days of higher tidal range (near spring tide). By and large, observations were made by travelling along with the rising tide so as to occupy all stations in similar tidal conditions. Data during May could not be collected and for June, a typical monsoon month, data for next year, *i.e.,* 2004, was used. Primary production was estimated using Gaarder and Graan's light and dark bottle method (Strickland and Parsons, 1972). The salinity and temperature data were collected from all stations at an interval of 0.5m using STD meter. Surface water samples were collected using a clean bucket and for near bottom sampling, Van Dorn sampler was used. Chemical parameters and chlorophyll were estimated by standard methods (Strickland and Parsons, 1972). Suspended sediments were analysed by standard filtration method using 0.45m filter paper. Turbidity was measured using a digital Nephlo-turbidity meter.

Results and discussion

Hydrography

The ranges of physico-chemical parameters are presented in Table 1. Salinity varied from fresh water condition to 27.5 ‰. During southwest monsoon when maximum river run off occurs, the entire study region was converted to a fresh water basin and stratification was absent during this period. Temperature varied between 28.4°C in July to 33°C in April. Secondary maximum was seen during northeast monsoon. A bimodal variation in salinity and temperature at a station near Panangad jetty was noticed by Varma *et al.* (2002), while analyzing long term daily data. Maximum suspended sediment, turbidity and nutrient concentrations were noticed during the southwest monsoon This showed that the main source of nutrients was from land run off. The general feature was that the nutrients decreased in September and a secondary increase occurred during northeast monsoon. As the run off slowed down afterwards, the nutrients also decreased and became very low during pre-monsoon months. Dissolved oxygen was higher during post-monsoon and monsoon seasons. The stations 1 and 2, which are located in the inner arms, showed higher levels of suspended matter and nutrients. One of the factors contributing to this could be the effect of turbulence and mixing in these shallower regions.

Table 1. *Annual range of different parameters in the study region (Near bottom values are shown in parenthesis)*

Stations/ Parameters	1	2	3	4
Salinity (‰)	0.4-23.0 (0.4-23.3)	0.4-22.7 (0.3-22.8)	0.1-22.9 (0.1-22.8)	0.1-22.5 (0.1-27.5)
Temperature (⁰C)	29.5-32.3 (29.5-32)	29-33 (29.1-32.3)	28.8-32.5 (28.7-31.9)	29.3-32.5 (28.5-32.2)
TSS (mg/l)	10-46.9 (13.4-39.9)	9-35 (4-37)	9.6-26.9 (7-41)	6-48 (11.9-29.9)
Turbidity (NTU)	0.2-17.9 (0.4-21.4)	0.1-24.7 (0.6-32.6)	0.2-28.7 (1.4-32.7)	0.2-11.8 (0.6-15.6)
Phosphate (μmol/l)	1.15-16.46 (0.56-7.3)	ND-7 (0.1-6.09)	ND-3.98 (ND-3.69)	ND-1.75 (ND-2.14)
Nitrite (μmol/*l*)	0.18-4.18 (ND-4.30)	ND-3.24 (0.02-2.43)	ND-2.57 (ND-2.69)	ND-1.71 (ND-1.57)
Nitrate (μmol/*l*)	1.67-11.24 (1.83-9.06)	0.19-9.41 (0.31-7.87)	0.07-13.75 (0.12-11.71)	0.73-14.42 (0.35-22.17)
Silicate (μmol/*l*)	4.70-197.08 (5.51-197.08)	5.34-186.88 (10.90-197.08)	6.96-122.26 (11.66-191.46)	5.05-120.12 (4.12-162.17)
DO (ml/l)	3.44-6.74 (2.52-6.17)	3.53-7.74 (3.46-7.07)	3.03 -6.81 (2.77-6.05)	2.77-6.77 (1.76-5.93)

ND=Not Detected

Primary production

The monthly variation of primary production, in general, showed a tri-modal pattern with maximum values during November, July and April (Fig.2). Maximum gross production was observed (183.33 $mgC/m^3/hr$) during November at station 2, while minimum (52.08 $mgC/m^3/hr$) was seen at the Station 4 during June. The corresponding maxima and minima of net productions were 111.46 and 26.04 $mgC/m^3/hr$, respectively.

Nair *et al.*, (1975) reported that the rate of primary production in the Vembanad Lake was uniformly high, the maximum being 3 $gC/m^2/day$ with an average of 1.2 $gC/m^2/day$. These values, in general, are in agreement with the present observations. The tri-modal pattern in the present study agrees with the earlier findings (Qasim *et al.*, 1969; Gopinathan *et al.*,1984) in Cochin backwaters. It was also pointed out that primary production occurred in small pulses and without any seasonal rhythm. The annual averages of gross and net productions were 99.36 and 65.12 $mgC/m^3/hr$ respectively. Average production for different seasons was slightly higher during post-monsoon. Stations 1 and 2 were found to be generally more productive and Station 4, which is in the open area recorded lowest annual average production. Thus, it appeared that

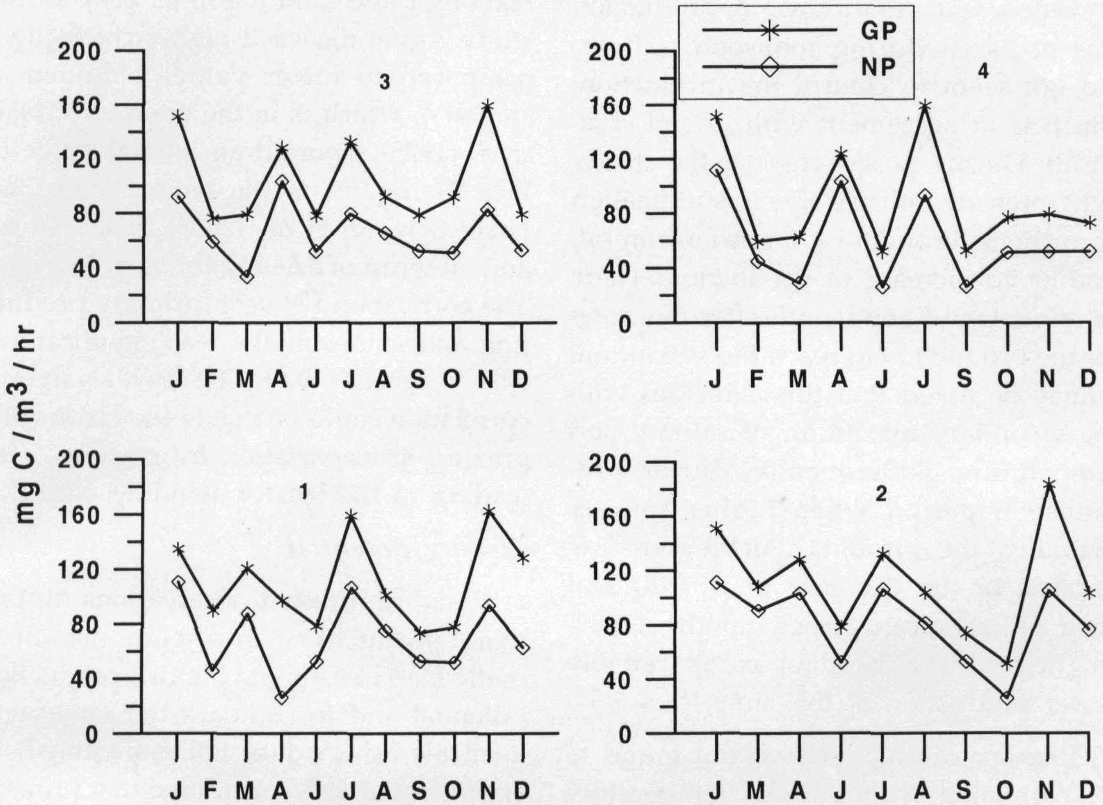

Fig. 2 *Monthly variation of primary production (Jan.-Dec. 2003) at four stations*

the inner arms of the estuary were more productive than the open areas. This might be due to the availability of nutrients from neighboring paddy/prawn filtration fields. Further, it is possible that the effect of increased turbulence in these narrow parts might be aiding in the release of nutrients from bottom sediments. Present pattern of seasonal variation agrees with the earlier studies (Kunjukrishna Pillai *et al.*, 1975; Selvaraj *et al.*, 2003). On the other hand, Nair *et al.*(1975) and Gopinathan *et al.*(1984) reported high production during monsoon and early post-monsoon periods when salinity was low or moderate in Cochin backwaters.

Study area being a tropical estuary, the prime factor determining the productivity would be the availability of nutrients. During southwest monsoon, light also can be a crucial factor. Because of this, lower production was expected during monsoon. However, in the present study, although lower production was observed during June, it was higher during July. This indicated that light could be critical only when very cloudy or overcast conditions prevailed. Since sharp drop in production was not seen during monsoon, salinity did not seem to control the production, which is in agreement with Qasim *et al.* (1972). During post-monsoon, the steady light intensity induces effective utilization of nutrients brought by monsoon run off, leading to increase in production. There is a time lag of one month after monsoon for the production to reach the maximum. It may be noted that this coincides with the secondary maximum of salinity and temperature. Subsequently, during pre-monsoon period when higher salinity prevailed, the nutrients avilable were low because of the decrease in run off and their utilization in earlier months, which might be the reason for comparatively lesser production at this time.

Primary production was not found to be correlated with salinity, temperature and nutrients. As mentioned earlier, salinity may not affect production while instantaneous concentration of nutrients may not have a direct bearing, as their regeneration also appeared to influence production. Spatial and temporal variation of primary production was analysed using analysis of variance. While monthly variations were statistically significant, station wise they were not so.

Chlorophyll-a

Chlorophyll-*a* ranged between 1 and 34.61mg/m^3 and the average was 9.83 mg/m^3. The chlorophyll distribution followed the same trend of primary production, showing a peak in November followed by April and July in all stations. Stations 1 and 2, in the inner arms of the study region recorded higher chlorophyll compared to lower values obtained at station 4, which is in the open area. Nair *et al.* (1975) reported an annual range of 2 to 21 mg/m^3 in the entire Vembanad Lake. Selvaraj *et al.* (2003) observed an annual mean of 6.64 mg/m^3 near Thevara. The correlation between primary production and chlorophyll-*a* was significant at 0.01 % level (r=0.6). The lower value of correlation could be due to the factors like grazing, transportation by currents, etc., leading to the loss of standing crop.

Fishery potential

Based on present observations on primary production, an attempt has been made here to estimate the fish production potential and to compare the same with available fishery data. For estimating fishery potential, it is considered that primary production occurs for 10 hours a day. The euphotic depth is taken as 2 m. This is because the average depth of the study area is only 2.5 m (Josanto, 1971). Although depths might vary at different parts, present assumption is justified because parts close to the banks are also considered in calculating the area. With these values of depth and duration, the annual column production estimated was 476 gC/m^2. Nair *et al.* (1975) recorded annual production between 150 to 650 gC/m^2 at different locations in the Vembanad Lake while an average production of about 300 gC/m^2 was reported by Qasim *et al.* (1969). Taking the total area of the study region to be about 6.25 km^2, we get a total annual production of

2,971 tonnes of carbon. This rate of production is of the same order of the total production of 1,00,000 tonnes of carbon for the entire Vembanad Lake (area ~300 km^2) by Nair *et al.* (1975). Based on the present estimate, the wet weight production comes to be about 22,030 tonnes by using a conversion factor 7.41 (Vinagradov, 1953), which was applied in Vembanad Lake by Madhupratap *et al.* (1977). According to Ware (2000), fish production varies between 0.3 to 0.6 % of the primary production, while Qasim *et al.* (1978) suggested 1% for coastal waters. We used the conversion rate 0.6% and the fishery potential of the study area worked out to be about 132 tonnes.

Fishery estimate of the study region was calculated from Kurup *et al.* (1989). Among the fish markets surveyed by them, those at Nettoor, Panangad and Champakkara were taken as relating to catch from the present area. However, as Champakkara market attracts fish catch from different areas, only 20% of the total arrival was taken as from the study area. Fish catch, therefore, worked out to be about 73 tonnes. Since the catch from this area is also sold through alternate ways, an additional 12 tonnes is also considered, making the total annual catch to be about 85 tonnes. Of the catch in Vembanad Lake only 45% is constituted by fishes and 7% are carnivorous catfishes (Kurup *et al.*,1989). Thus the total catch of plankton feeding fishes is about 32 tonnes. This indicated that primary production might not be fully converted directly to tertiary production. Qasim *et al.* (1969) suggested that a large surplus of basic food is available in the Vembanad Lake for alternate pathways in the food chain. One of the pathways suggested by Madhupratap *et al.* (1977) is in the form of detritus. Generally, 25 - 40% of the fish potential can be taken as sustainable catch (Qasim *et al.*,1978; Ware, 2000). Considering the estimated potential of 132 tonnes, the sustainable catch from study area is between 33 and 53 tonnes (average 43 tonnes), indicating that fishing efforts can safely be increased. It is worthwhile to note that the present estimates are tentative due to the assumptions and also because of the fact that this is an open system and fish will be moving in and out of boundaries of the area. Final conclusion on these lines must take into consideration the entire area of the lake.

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