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PRIMARY PRODUCTIVITY OF BAY OF BENGAL AT DIGHA IN WEST BENGAL, INDIA

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ABSTRACT

The primary productivity of Bay of Bengal at Digha has been assessed both spatially and seasonally. The maximum GPP was noted during summer season and minimum in rainy season. The annual mean GPP varied from 0.079 + 0.008 g^c m^3 h^{-1} to 0.998 + 0.15 g^c m^3 h^{-1}. The NPP value varied from 0.015 + 0.002 g^c m^3 h^{-1} to 0.845 + 0.072 g^c m^3 h^{-1} and showed an increasing trend from the month of September 2011 to February, 2012. The community respiration (CR) ranged from 0.029 + 0.003 g^c m^3 h^{-1} to 0.499 + 0.046 g^c m^3 h^{-1} and exhibited a systematic seasonal variation with maximum and minimum value during summer and winter respectively. The Correlation coefficients(®) of NPP, GPP and CR with certain physicochemical parameters have also been established.

KEYWORDS : Primary Productivity, Bay of Bengal, Digha, West Bengal

The primary productivity of a water body is the manipulation of its biological production. It forms the basis of the ecosystem functioning, (Odum, 1971). It plays an important role in energy and organic matters available to the entire biological community (Ahmed et al, 2005). Primary productivity at each level can be distinguished further into gross primary production i.e the total amount of organic matters produced and net primary production or the amount of organic matter produced of a particular level (Yeragi and Shaikh, 2003). The estimation of primary productivity is predicted on the relationship between oxygen evolution and carbon fixation (Dash et al., 2011). Primary productivity varies from fresh-water to estuarine and from estuarine to marine water body (Dash et al., 2011). Most of the organic matters of an aquatic ecosystem are produced within the water by phyto-plankton (=primary producer) which is utilized by the consumer (Goldman and Wetzel, 1963).

The area under study is Bay of Bengal at Digha in West-Bengal. The Digha beach stretches nearly 30 Km. along the Bay of Bengal and it is a noted visiting place of national and international repute. Further, it is an important fish landing centre of varieties of edible and commercially as well as economically important fin-fish, shall fish species. The drastic reduction is marine edible fin-fish and shall fish fauna and diversity along the Digha sea-beach calls for immediate analysis and intermation.

MATERIALS AND METHODS

For the analysis of primary productivity Light and Dark bottle method of recommended by Vollenweiden (1969), was followed. Gaarder and Gran (1927) first proposed the technique of using light and dark bottles and winkler's titration to measure the production and consumption of oxygen.

Water samples were collected in triplicate in the middle of each month between 10.00 AM to 12.00 Noon. The sample in the first bottle was used immediately to determine the initial level of dissolved oxygen content following modified winkler's volumetric method (APHA, 1998). Dissolved O_2 values obtained in the present study were converted to carbon values by multiplying with the factor 0.375 (Odum, 1956). The second bottle was pointed with black color (dark bottle) to prevent light and hence serve as control to measure respiration. The third bottle (light) was treated as a test to measure the net production. The last two bottles were incubated under water in the emphatic zone for a period of six hours by suspending it in water after which, dissolved oxygen content of each bottle was estimated.

Gross primary production (GPP) and the net primary production (NPP) were calculated in the following manner.

GPP (O_2 mg l^{1+} h^1) = (D_1-D_i)/h

NPP (O_2 mg l^{1+} h^1) = (D_1-D_i)/h

Community Respiration

Community Respiration O_2 mg C^{-1} h^{-1} = (D_1-D_i)/h

Where, D_1 = O_2 (mg C^{-1} h^{-1}) in the higher bottle

D_i = O_2 (mg C^{-1} h^{-1}) in the initial bottle

D_d = O_2 (mg C^{-1} h^{-1}) in the dark bottle

h = Duration of exposure in hours.

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The hourly rate can be converted to daily rates by multiplying with duration of sunshine on that day. Oxygen values (mg C^{-1} were converted to carbon value by applying the equation suggested by Thomas et al., (1980).

Primary production (gc) = (O_2 (mg C^{-1}) x 0.375) / PQ

Where PQ = 1.25

PQ represents respiratory gradient = respiration / photosynthesis and a comprised value of 1-25 was used which represents metabohim of sugar, fat and proteins. The value 0.375 represents a constant to convert oxygen value to carbon value (Thomas et al., 1980).

RESULTS AND DISCUSSION

The seasonal variation of gross primary productivity (GPP), net primary productivity (NPP) and community respiration (CR) of Bay of Bengal at Digha is given in Table 1. The mean stand and deviation of GPP, NPP and CR of three different season are also presented in Table.

Seasonally, the minimum GPP was recorded in rainy season and maximum GPP value was recorded during summer season. On monthly basis, minimum value during August and maximum value during March were recorded.

The minimum value of NPP was recorded during rainy season but the maximum value was associated with summer. No particular trend was observed in seasonal variation of NPP. On comparison of the monthly variations, an increasing trend was found from the month of September to February.

Decreased value of NPP and GPP during the rainy season might be due to the fact that high suspended solids in the flood water restrict light penetration into the water and thereby results in less photosynthetic activities and productivity. At the same time the phenomenon of organic matter entering the marine system, through reverine system, causing increased demand of oxygen for the oxidation of allochthorous organic matter cannot be ruled out.

The higher valued of GPP and NPP during the summer season may be due to penetration of more light, intensity which facilitates higher rate of photosynthesis and ultimately the productivity of the marine system.

The community respiration (CR) exhibited a systematic seasonal pattern with a maximum value during summer and maximum value during winter. A higher community respiration value during summer is possibly due to increased water temperature which stimulates the growth of microtial population which in turn utilities more oxygen for their metabotic activities. The decreased respiration rate during winter was linked with low water temperature and reduced light which affects the rate of photosynthetic efficiency (Ahmad and Singh, 1987 and Dash et al., 2011).

The ratio of net and gross primary production is important for the evaluation of the amount of gross production available to the consumer (Singh and Singh, 1999). Table, 1 represents the ratio between the mean and seasonal values of NPP, GPP and CR-The GPP-NPP as well as NPP-CR ratio was highest during winter and lowest in summer season while the CR percentage of GPP was found to be highest during rainy season and lowest during winter season.

The NPP : CR of value > 1 during winter could be attributed to clarity of water as well as suitable temperature which favours abundance of phytoplankton and mere photosynthetic activities. During the rainy season, the ratio was < 1, which may be due to less penetration of light into water because of suspended particles resulting in poor photosynthetic activities and thereby decrease in productivity. However, increase in community respiration, due to the flow of organic detritus along with flood water, cannot be ruled out.

Higher production is not governed by a single factor as stated by Singh and Singh, (1999). There are several environmental factors acting simultaneously while must be taken into consideration while evaluating the production capacity of a marine ecosystem. There are certain physic-chemical and biological factors which infact control the rate of production in a marine ecosystem. The paired sampled correlations among GPP, NPP and CR with other water quality parameters were carried out and the results along with significance levels were represented in table, 1, 2 and 3. The paired correlations between the valuables having significant levels less than 0.05 were considered for discussion.

Table 1: Mean Seasonal Variations in GPP, NPP and Community Respiration (mean ± SD) in g^c m^3 h^{-1} at Digha

Season	GPP	RES	NPP
Summer	0.797±0.136	0.287±0.06	0.59±0.171
Rainy	0.196±0.074	0.049±0.04	0.088±0.065
Winter	0.597±0.133	0.039±0.015	0.595±0.235

Table 2 :Mean monthly narrations of GPP, RES and NPP values in g^c m^3 h^{-1} (mean ± SD) at Digha

Months	GPP	RES	NPP
January	0.68 ± 0.055	0.038 ± 0.005	0.789 ± 0.057
February	0.69 ± 0.058	0.035 ± 0.003	0.863 ± 0.082
March	0.95 ± 0.105	0.179 ± 0.018	0.789 ± 0.068
April	0.875 ± 0.139	0.297 ± 0.045	0.599 ± 0.047
May	0.737 ± 0.066	0.199 ± 0.025	0.571 ± 0.055
June	0.66 ± 0.054	0.298 ± 0.036	0.379 ± 0.048
July	0.28 ± 0.03	0.079 ± 0.008	0.138 ± 0.007
August	0.199 ± 0.027	0.049 ± 0.006	0.049 ± 0.004
September	0.078 ± 0.008	0.036 ± 0.003	0.029 ± 0.005
October	0.29 ± 0.028	0.048 ± 0.005	0.183 ± 0.016
November	0.398 ± 0.065	0.059 ± 0.006	0.371 ± 0.036
December	0.528 ± 0.048	0.029 ± 0.004	0.498 ± 0.045

Table 3 : Total and Seasonal Ratio Between Different Productivity Parameters of Bay of Bengal at Digha

Total						Seasonal					
NPP: GPP	NPP: CR	CR% of GPP	NPP : GPP			NPP : CR			CR % of GPP		
			S	R	W	S	R	W	S	R	W
0.83	3.96	20.45	0.73	0.49	1.13	2.48	1.79	16.16	28.9	26.68	6.48

During summer positive correlation between GPP and NPP ($r = 0.918$, $P<0.001$) demonstrated that high GPP is responsible for high NPP. A negative correlation between GPP and EC ($r = 0.405$, $P=0.046$) and GPP and transparency ($r=0.463$, $p=0.022$) was established. The above findings are in agreement with that of Ahmed et al., (2005) and Dash et al., (2011) where they reported a moderate correlation between EC and GPP and NPP.

A positive relationship between GPP and BOD ($r=0.425$, $p=0.005$) indirectly states that the growth of phytoplankton and their increased productivity is due to organic wastes, containing high nutrient values. In summer season, BOD plays a major role in controlling GPP, NPP and CR.

Positive relationships between GPP with CR ($r = 0.655$, $P<0.001$) and GPP with NPP ($r=0.761$, $P<0.001$) were observed. Higher alkalinity and harders are favourable for increase in GPP and NPP during rainy season. The findings of goldman and Wetzel (1963), Singh (1999) and Dash et al., (2011), support the above finding, positive correlation between alkalinity and GPP, during rainy season was also reported by Yeragi and Shaikh ,(2003) and Dash et al.,(2011).

During winter a negative relationship between GPP and CR ($r = -0.53$, $p = 0.005$) and GPP with water temperature ($r = -0.497$, $p = 0.013$) was noted in the current study. An inverse relationship between GPP and alkalinity and NPP with water temperature was recorded. Nitrate being he most essential nutrient for the growth of agnatic organism supports the positive relation between CR and nitrate during this season.

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