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Studies on Primary Productivity of Bay of Bengal at Chandrabhaga Sea-Shore, Konark , Odisha

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Abstract- Primary production refers to estimation of the ability of an ecosystem to fabricate, at the expense of external energy both radiant and chemical, primary organic compounds of high chemical potentials for further transformation and flow to higher system levels. In the present investigation the light dark oxygen method was followed in order to assess the of primary productivity of Bay of Bengal at Chandravaga, Konark, Odisha, Seasonally, the maximum Gross Primary Production and Net Primary Production were recorded in summer due to clear weather and high atmospheric temperature and minimum during Monsoon season due to cloudy weather . On the other hand, Community respiration was found to be higher during summer season and lower during winter season.

Index Terms- Primary production, gross primary production, net primary production, Community Respiration, Bay of Bengal and Chandrabhaga.

I. Introduction

Primary productivity is the route by which simple organic compounds are manufactured by living organisms from various inorganic forms of carbon available on earth such carbon dioxide (CO_2), bicarbonate (HCO_3^-), and carbonate ($CO_3^{2-)}$. These Inorganic oxidized forms of carbon are chemically reduced to form the organic molecules, which are the building blocks of life, and the mechanism by which energy is stored in living organisms and is utilized in driving cellular process(Daniel). The process of reduction of inorganic carbon is dependent on the light energy or from energy stored in some reduced inorganic compounds. Autotrophs are organisms capable of fixing inorganic carbon. Photoautotrophs use light energy to fix carbon, whereas chemoautotrophs use the energy released through the oxidation of reduced inorganic substrates to fix carbon into organic compounds. Both photosynthesis and chemosynthesis contribute to the primary production of the oceans, however oxygenic photosynthesis is by far the dominant process in terms of the amount of carbon fixed and energy stored in organic compounds. Generally, photosynthesis occurs in all parts of the ocean where there is sufficient light.

So briefly, it can be said that the primary productivity of a water body is the manipulation of its biological production (Mohanty *et al.,* 2014). 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). 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).

The present study deals with gross, net and community productivity of marginal seawater of Bay of Bengal at Chandrabhaga, Konark, Odisha.

II. MATERIAL AND METHODS

The water samples were collected from 50 cm. depth from the sea-shore and analyzed for primary productivity. The study was conducted for the year that is 2013-14. Different techniques have been used by different workers viz. Radioactive Carbon (C^{14}) (Slumann-Nielson, 1952), Chlorophyll method (Ryther and Yentsch, 1957) and oxygen method by light and dark bottle (Gaarder and Gran, 1927, Vollenweiden, 1969) for estimation of primary productivity. Among them, the light dark oxygen method is a simple and standard approach for measuring photosynthesis in aquatic systems and therefore the said method was adopted for analysis of primary productivity during the present investigation.

Water samples were collected in triplicates around the middle of every month (Mohanty *et al.*, 2014, Mohapatra *et al.*2010). The sample in the first bottle was used immediately to determine the initial level of dissolved oxygen following Wrinklers Volumetric method (APHA, 2008). Dissolved oxygen values obtained were converted to carbon values by multiplying with the factor 0.375 (Odum, 1956, Mohapatra and Patra, 2012). The second bottle was painted with black color to prevent light penetration and hence served as a control to measure respiration. The third light bottle was treated as a test to measure the net production. The last two bottles were incubated under water in the euphotic zone for a period of twenty four hours at 50 cm. depth and then oxygen content was measured and then the DO. values were converted to gCm^{-2} day^{-1} multiplied by average water depth. Oxygen values mgl-1 were converted to carbon values by applying the equation suggested by Thomas et al, 1980 and Ahmed *et al.*, 2005.

Primary Production gC = mg l^{-1} x 0.375/PQ
Where PQ = 1.25

PQ represents respiratory quotient = respiration/photosynthesis and a compromised value of 1.25 was used which represent metabolism of sugars, some fats and proteins.

III. RESULTS AND DISCUSSION

The experimental data of Monthly and seasonal variations of gross primary productivity (GPP), net primary productivity (NPP) and community respiration (CR) along with mean standard deviation are shown in Table No.1 and Table No.2 respectively.

The community respiration (CR) exhibited a higher value during the June and lower value on December(Table no.1). On seasonal basis, the value was found to be maximum (91.16 ± 5.94) $gCm^{-2}day^{-1}$ during summer and minimum during winter (46.2 ± 3.92) $gCm^{-2}day^{-1}$ (Table No. 2) (fig.1).The decreased value during winter may have resulted due to low water temperature and reduced light (Ahmed and Singh, 1987 and Dash *et al.*, 2011).

Seasonally, maximum GPP and NP value were documented during summer 246.18 ± 4.93 and 155.02 ± 3.01 $g\ C\ m^{-2}\ day^{-1}$ respectively likewise the minimum value of GPP (166.31 ± 6.44g $C\ m^{-2}\ day^{-1}$) and NP (111.67 ± 3.76g $C\ m^{-2}\ day^{-1}$) was recorded in monsoon season and an intermediate value in winter season(Table No.2 and fig.2). From this, it may be concluded that the weather condition has an significant effect on the productivity in aquatic ecosystem. This statement hold good as the higher values of net, gross primary productions were reported from October to June when weather condition was bright and clear and this allowed to better penetration of light into water body and facilitated the higher rate of planktonic photosynthesis and thus ultimately the productivity of the marine system (Madhupratap, 2001). Lower Production value during rainy season may be due to cloudy weather, organic affluent in water, low transparency and high water current (Hutchinson, 1957, Mohapatra *et al.*2012).

The ratio of net and gross primary production is essential for the evaluation of the amount of gross production available to the consumers (Singh and Singh, 1999). In our study we noticed that the ratio between NPP : GPP as well as NPP : CR was highest (0.764, 3.274) during winter and lowest (0.629, 1.706)(Table No.2) during summer. The community respiration accounted 20 to 40% of GPP during all the months of year (Table No.1), which shows good index (Muraleedharan, 2001).

The NPP : CR value > 1 (3.274) in winter which accounts for more penetration of light into water body as well as suitable temperature which favors abundance of planktons and more photosynthetic activities (Das, Patra and Adhikary, 2011, Mohanty *et al.*, 2014)

Higher production is not governed by a single factor as stated by Singh and Singh, (1999), Moharana and Patra (2013). There are several physicochemical and biological factors, which in fact manage the rate of production in marine ecosystem (Mohanty *et al.*, 2000). Hence, it comes into view that there is a direct correlation between temperature and production, which is in agreement with Srinivasan (1964), Hall & Moll (1975), Goldman and Wetzel (1963), Mohanty *et al.*,2000, Pauly & Christensen (1995) and Thomas *et al.*, 1980. In the present study the same observation was noticed that is the productivity is high at high temperature, while in winter as the temperature is low the productivity is also low.

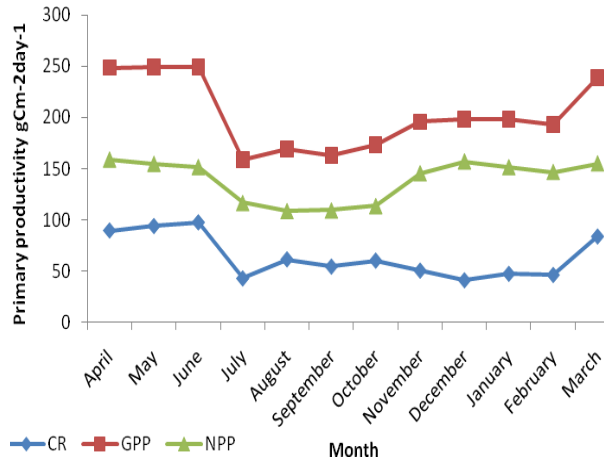

Figure1: Monthly variations in Primary Productivity (GPP, NPP and CR) of Chandrabhaga– on – Sea during 2013-2014 in ($gC\ m^{-2}\ day^{-1}$).

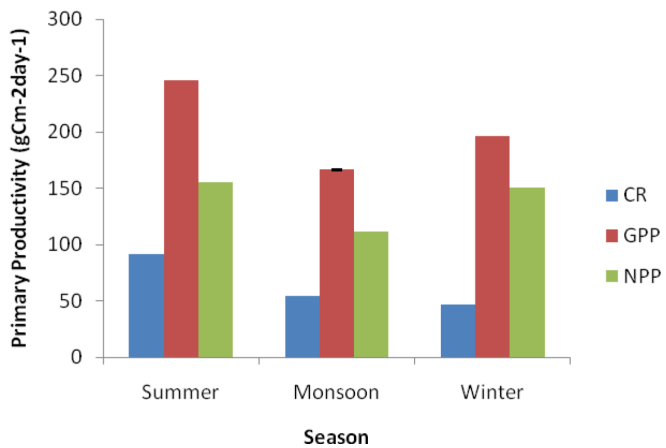

Figure 2: Seasonal variations in Primary Productivity (GPP, NPP and CR) of Chandrabhaga– on – Sea during 2013-2014 in ($gCm^{-2}\ day^{-1}$).

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Table1: Mean Monthly Variations of GPP, NPP and RES Values in gC m^{-2} day^{-1} (Mean ± S.D.) At Chandrabhaga During The Year 2013-2014 (n = 3).

Month	RES(CR) ($gCm^{-2}day^{-1}$)	GPP ($gCm^{-2}day^{-1}$)	NPP ($gCm^{-2}day^{-1}$)	NPP/GPP	NPP/CR	CR % of GPP
April	89.55	248.4	158.85	0.639	1.77	36.05
May	93.9	248.55	154.65	0.622	1.64	37.77
June	97.5	249	151.5	0.608	1.55	39.15
July	42.75	159	116.25	0.731	2.71	26.88
August	61.35	169.65	108.3	0.638	1.76	36.16
September	54.3	163.2	108.9	0.667	2.005	33.27
October	60.15	173.4	113.25	0.653	1.88	34.68
November	50.4	195.75	145.35	0.742	2.88	25.74
December	40.95	198	157.05	0.793	3.83	20.68
January	47.25	198.6	151.35	0.762	3.20	23.79
February	46.2	192.9	146.7	0.760	3.17	23.95
March	83.7	238.8	155.1	0.649	1.85	35.05

Table2: Mean Seasonal Variations of GPP, NPP and RES Values in (mean ± SD) in g C m^{-2} day^{-1} at Chandrabhaga during The Year 2013-2014.

Season	RES(CR) ($gCm^{-2}day^{-1}$)	GPP ($gCm^{-2}day^{-1}$)	NP ($gCm^{-2}day^{-1}$)	NPP/GPP	NPP/CR
	Mean ±SD	Mean ±SD	Mean ±SD	Mean	Mean
Summer	91.16 ± 5.94	246.18 ± 4.93	155.02 ± 3.01	0.629	1.706
Rainy	54.63 ± 8.50	166.31 ± 6.44	111.67 ± 3.76	0.672	2.093
Winter	46.2 ± 3.92	196.312± 2.58	150.98 ± 5.29	0.764	3.274