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Rabi Rajbongshi
4th Semester PG Student, Department of Zoology, Pandu College, Guwahati, Assam, India.

Latashri Dutta
4th Semester PG Student, Department of Zoology, Pandu College, Guwahati, Assam, India.

Parag Deka
Assistant Professor (Sr.), Department of Zoology, Pandu College, Guwahati, Assam, India.

Correspondence:
Parag Deka
Assistant Professor (Sr.), Department of Zoology, Pandu College, Guwahati, Assam, India.

Primary productivity assessment at Dharapur area near to the channel Khonajan of Deepar beel (wetland) with reference to physicochemical parameters

Rabi Rajbongshi, Latashri Dutta and Parag Deka

Abstract
The variation of primary productivity in terms of NPP and GPP along with CRV of water was studied at Dharapur area of Deepar Beel near to Khonajan, the channel connecting the beel with the river Brahmaputra. The adjoining area of the beel at the experimental site and the channel were observed to fill with domestic households and sometimes dumping of garbage was also observed near the experimental site from where effluents were observed to be entered through surface runoff water during heavy rains thus creating imbalance in the chemistry of water which affect the primary productivity. The high rainfall observed in March following a dry season in winter has elevated total alkalinity to 124 mg.l^{-1} and total hardness to 215 mg.l^{-1} along with organic matter. The rainfall creates dilution of water thus decreasing the phytoplankton density. Moreover high rainfall initiates influx of effluents and organic matter that increase the turbidity of water resisting sunrays to penetrate into the water which is evident in the present study where the value of GPP and NPP are observed to decrease from February to March. However, in other months, the gross primary productivity (GPP) of the experimental site is found to be higher than those of other lentic waters in India.

Keywords: productivity, physicochemical parameters, Deepar Beel, Khonajan Channel

Introduction
Primary productivity is defined as the rate at which organic matter is created by producer in an ecosystem. In the process of primary productivity, inorganic carbon is converted to an organic form. The chlorophyll bearing microscopic organisms such as phytoplankton, periphyton, and macrophytes serve as primary producer in the aquatic food chain and act like a keystone species in the ecosystem. The primary producers produce a wide range of organic compounds by the mechanism of photosynthesis along with release of oxygen and depletion of carbon dioxide in the surrounding waters, thus contributing congenial environmental condition of aquatic ecosystem. In other word the rate at which this energy accumulates as a means of photosynthesis is called primary productivity. In any water system the rate of organic carbon fixed through the chlorophyll bearing phytoplankton provides the basic information for assessing the productive function of the system (Odum, 1971) [15].

A number of environmental factors influence the rate of photosynthesis and determine the productivity of an aquaculture system. For Thornton *et al.*, 1990 [19], two primary factors controlling phytoplankton productivity are light and nutrient availability. Apart from the nutrient factors, seasonality and climatological parameters like air temperature, rainfall, relative humidity, sunshine hours etc. also influence the quality of water and soil, thus influencing the primary productivity through phytoplanktonic growth. Romaire and Boyd, 1979 [16] showed that cloudy days cause a decrease in photosynthetic rates.

Thus autotrophic production in ecosystem constitute the basis of the intricate food webs, providing energy for the primary and secondary consumers and act as an important contributors for the production of the human diet in the form of fish. All other living forms at higher trophic levels are directly or indirectly dependent on phytoplankton for energy supply and, therefore, performing vital function.

In view of the importance of primary productivity in freshwater ecosystem in relation with physicochemical parameters, the present work has been carried out in Deepar Beel at Dharapur area near Khonajan, the channel connecting the river Brahmaputra.

2. Materials and Methods

2.1 Study site: The present work deals with the monthly fluctuation of Net Primary Productivity, Gross Primary Productivity and Community Respiration Value of water in Deepar Beel at Dharapur area near to Khonajan, the lone channel connecting the Deepor Beel with the mighty river Brahmaputra. The Khonajan channel is approximately 5 km in length and is surrounded by many families. The adjoining areas of the beel at the studied area and the channel are appeared to be filled with domestic households. The effluent of those families and the factories present at nearby areas is observed to release directly into the channel. Even garbage dumping is also observed sometimes near the experimental site.

2.2. Sampling: For the study of physicochemical parameters of water, the samples were collected weekly from February 2016 to May 2016 from both surface and bottom layers of the randomly selected spots following the sampling procedure of Jhingran *et al*., 1969 [4]. As the properties of surface and bottom water samples are variable, so both surface and bottom samples were mixed to represent the sample as a whole. The water samples were collected in the morning between 8.00 A.M. and 8.30 A.M. The parameters were analysed at the laboratory of Zoology Department, Pandu College following “Standard Methods for Examination of Water and waste Water”, A.P.H.A., 1988 [1] and “Manuals on Water and Waste Water Analysis”, N.E.E.R.I., 1988 [14]. To study the physicochemical properties of water, the most significant parameters like p^H, dissolved oxygen, free carbon dioxide, total alkalinity as $CaCO_3$, total hardness as $CaCO_3$. The rainfall data was collected from Weather Underground, a commercial weather service which provides real-time weather information via the internet.

The Net Primary Productivity, Gross Primary Productivity and Community Respiration Value were estimated following light and dark bottle method of Gaarder and Gran, 1927 [3]. For this purpose, two sets of bottles were prepared, having one light bottle (LB) and one dark bottle (DB) in each set. The darkened bottles were prepared by black painting and thereafter wrapped by aluminium foil to make the bottles 100% light proof. The light and dark bottles sets were fixed at two different depth zones within the euphotic zones measured by Sacchi disc. Of the two sets, one set was placed just beneath the surface of water while other was placed at the point of disappearance of Sacchi disc. Three replications of such sets at each zone were used. All the experimental sets were set off in the morning hours at 8 A.M. and allowed to incubate for 4 hours i.e. up to 12 P.M. The dissolved oxygen values of both sets of bottles were recorded at the beginning of the experiment and after four hours of solar incubation.

3. Result and discussion: The observed variation in physicochemical parameters of the water at the experimental site of Deepor Beel is depicted in the Table-1 citing their respective range, average value and Standard Deviation (SD).

The observed seasonal variation of pH in the studied site is depicted in Table-1(a). The p^H values show a mild acidic range (5.8-6.8) during the study period. The monthly average with standard deviation is depicted in Table-1(a) with the lowest value recorded in April.

The estimation of dissolved oxygen concentration has been depicted in Table-1(b). The dissolved oxygen value shows a low to moderate range (3.8 $mg.l^{-1}$ to 10.4 $mg.l^{-1}$). The fluctuation of dissolved oxygen concentration is observed with prominent change with the highest value recorded in February (10.4 $mg.l^{-1}$) and the lowest in April (3.8 $mg.l^{-1}$), which may be due to the combined influence of fluctuation of phytoplankton density, submerged vegetation density, temperature of water and organic matter fluctuation affected by surface runoff water during rainfall through washing of garbage present near the experimental site.

Free carbon dioxide (FCO_2) performs as a limiting factor and metabolic carbon dioxide is a stimulating factor in productivity (Kuentzel, 1969 [5]) which accumulates due to microbial activity and community respiration (Trivedy *et al.*, 1987 [19]). However, during the study period the value of FCO_2 ranges from 6.5 to 17.0 $mg.l^{-1}$ [Table-1(c)].

The total alkalinity (TA) of water has been depicted in Table-1(d), which fluctuates in a range between 80 and 124 $mg.l^{-1}$. However P-Alkalinity is absent throughout the study period. The high total alkalinity so observed in March and April is very interesting and may be attributed to high rainfall in that period (Figure-1) which initiates allochthonous input of organic litter to the water through surface runoff water from the garbage present in the nearby area. Alkalinity is an important factor for fish and other aquatic biota, as it buffers p^H changes (Wetzel, 1983 [20]) which occur due to chlorophyll bearing vegetation and act as an important indicator of productivity.

The value of total hardness as $CaCO_3$ (TH) is interestingly found between 72 to 215 $mg.l^{-1}$ [(Figure-1(e)]. The fluctuation of hardness starting from the month of February, 2016 to May, 2016 is very amazing as the same culminates from 72 $mg.l^{-1}$ recorded in February to as much as 215 $mg.l^{-1}$ recorded in the month of March. This may be attributed to the leaching of allochthonous nutrient flux through surface runoff water during high rainfall experienced in that particular period (Figure-1).

Table 1 (a): A summary of p^H of water showing the ranges, average and Standard Deviation (SD)

p^H	Ranges	Average ± SD
February	6.4-6.8	6.6±0.18
March	6.3-6.7	6.4±0.17
April	5.8-6.2	6.0±0.17
May	5.9-6.3	6.0±0.17

Table 1 (b): A summary of DO of water showing the ranges, average and Standard Deviation (SD)

DO	Ranges	Average ± SD
February	9.8-10.4	10.17±0.26
March	6.2-6.9	6.7±0.33
April	3.8-4.4	4.0±0.27
May	5.7-6	5.85±0.13

Table 1(c): A summary of FCO_2 of water showing the ranges, average and Standard Deviation (SD)

FCO_2	Ranges	Average ± SD
February	8-9	8.5±0.14
March	6.5-10	8.6±1.54
April	13-17	14.75±1.70
May	12-14	13±0.82

Table 1 (d): A summary of TA of water showing the ranges, average and Standard Deviation (SD)

TA	Ranges	Average ± SD
February	80-86	83±2.58
March	115-124	119.25±3.77
April	108-118	111.75±4.35
May	80-98	91.25±7.80

Table 1 (e): A summary of TH of water showing the ranges, average and Standard Deviation (SD)

TH	Ranges	Average ± SD
February	72-79	75.25±2.99
March	201-215	207.25±6.13
April	206-212	209.25±2.5
May	150-172	159.25±9.42

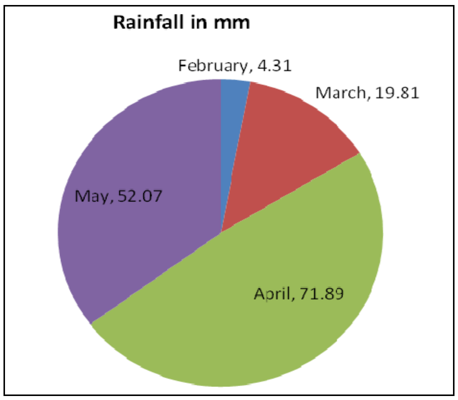

Fig 1: Monthly variation of total rainfall in mm (From February, 2016 to May, 2016)

During the investigations period for four months, the average Gross Primary Productivity (GPP) are recorded as 145.05±47.32 $g.C.m^{-3}.hour^{-1}$ in February with a range from 101.66 to 195.50 $g.C.m^{-3}.hour^{-1}$; 90.63±16.60 $g.C.m^{-3}.hour^{-1}$ in March (range 78.2 to 109.48 $g.C.m^{-3}.hour^{-1}$); 170.56±35.44 $g.C.m^{-3}.hour^{-1}$ (range 132.94 to 203.32 $g.C.m^{-3}.hour^{-1}$) in April and 153.19±45.47 $g.C.m^{-3}.hour^{-1}$ in May (range 101.66 to 187.68 $g.C.m^{-3}.hour^{-1}$). GPP shows the highest value during April, which results in higher productivity in the experimental site of the beel. It is interesting to note that the GPP exhibits unstable conditions throughout the study period. However, in March an exceptionally lower value of GPP is observed followed by sharp inclination in April.

The Net Primary Productivity (NPP) is varies from 46.92 to 117.30 $g.C.m^{-3}.hour^{-1}$ with an average of 79.02±35.60 $g.C.m^{-3}.hour^{-1}$ in February; from 15.64 to 39.1 $g.C.m^{-3}.hour^{-1}$ ($\bar{x}$=25.08±12.38) in March; from 109.2 to 156.4 $g.C.m^{-3}.hour^{-1}$ ($\bar{x}$=127.63±25.24) in April and from 64.13 to 156.4 $g.C.m^{-3}.hour^{-1}$ ($\bar{x}$=117.97±48.03) in May. During the investigation period, NPP exhibits a prominent peak during April and interesting minima in the month of March.

The Community Respiration Value (CRV) has been recorded almost same both in February (66.28±11.73 $g.C.m^{-3}.hour^{-1}$) and March (65.55±4.22 $g.C.m^{-3}.hour^{-1}$). However, the CRV decreases to 42.93±25.53 $g.C.m^{-3}.hour^{-1}$ in April and 35.21±3.42 $g.C.m^{-3}.hour^{-1}$ in May. It is very interesting to note that the CRV has been gradually decreasing from February to May.

The primary productivity of a water body is a function of autotrophs associated with utilization of radiant energy. The solar energy that required for biological activities is first converted to chemical energy by the process of photosynthesis primarily executed by phytoplankton and macrophytes. The gross primary productivity (GPP) of the experimental site is found to be higher than those of other lentic waters in India (Sreenivasan, 1964 [18]; Mathew, 1975 [7]; Singh and Desai, 1980 [17]; Lahon, 1983 [6]). During the present study, the sharp decrease of GPP and NPP value from February to March is governed by heavy rainfall (Figure-1). The rainfall results in allochthonous input of nutrients and organic matter originating from the garbage dumped near to the experimental site through surface runoff water. Lower rate of primary production during rainy season is the result of limitation of sunshine period and low light energy due to interruption of clouds. Subsequently, the dilution effect of rain on phytoplankton density as well as the increased in allochthonous turbidity are the prime cause of lowering primary productivity during rainy season (Deka, 2012 [2]). However, the concomitant increase of NPP and GPP during April month corresponds to the high intensity of light energy and attaining stability of water.

Table 1: Gross Primary Productivity (GPP), Net Primary Productivity (NPP) and Community Respiration values (CRV) expressed as $g.C.m^{-3}.hour^{-1}$ with Average and SD

		GPP	NPP	CRV
February	1	101.66	46.92	54.74
	2	195.5	117.3	78.2
	3	138	72.83	65.89
	Average	145.05	79.02	66.28
	SD	47.32	35.60	11.73
March	1	78.2	15.64	62.56
	2	84.2	20.5	63.56
	3	109.48	39.1	70.38
	Average	90.63	25.08	65.55
	SD	16.60	12.38	4.22
April	1	203.32	156.4	46.92
	2	175.43	109.2	66.23
	3	132.94	117.3	15.64
	Average	170.56	127.63	42.93
	SD	35.44	25.24	25.53
May	1	101.66	64.13	37.53
	2	187.68	156.4	31.28
	3	170.23	133.4	36.83
	Average	153.19	117.98	35.21
	SD	45.47	48.03	3.42

4. Conclusion: The fluctuation on the chemistry of the water and primary productivity in terms of GPP and NPP so observed is very interesting. During the rainy season there is surface run-off of water to the beel which creates an imbalance in the chemistry of the water which reduce the primary productivity to great extend. The elevation of total alkalinity to 124 $mg.l^{-1}$ and total hardness to 215 $mg.l^{-1}$ in March is appeared to be governed by rainfall. The high rainfall observed in March after comparatively dry season in winter has changed the property of water by nutrient influx through surface runoff water coming from the peripheral area where garbage has been observed to dump. The high concentration of TA and TH along with effluents and organic matter increases the turbidity of water resisting sunrays to penetrate into the water. Moreover, dilution of water through rainfall decreases the phytoplankton density which is the prime cause for lowering of primary productivity.

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