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STUDY ON PRIMARY PRODUCTIVITY IN LOTIC WATER OF RIVER SARYU AND GANGA AT SARAN DISTRICT, BIHAR, INDIA

***Kumari Uma*[1] *& Dhruv Kumar Singh*[2]**

[1]*Research Scholar, Department of Zoology, Chapra University, Chapra, Bihar, India*

[2]*Assistant Professor, Department of Zoology, Chapra University, Chapra, Bihar, India*

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ABSTRACT

Primary productivity can be defined as the rate at which the solar energy is stored by the photosynthetic activities of primary producers. Primary productivity depends upon the photosynthetic activities of the autotrophic organisms which are capable to transfer carbon dioxide into organic matter. It helps in measuring the ability of a water body to support a biological phenomena on which the entire biodiversity is depended. Information on primary productivity of lotic ecosystem of our county is still scanty. The present study deals with the study of the primary production of different sites of rivers Saryu and Ganga in Saran district, Bihar as the stretch remained unexplored. The light and dark bottle method of Gaarder and Gran (1927) was used to determine the primary productivity of phytoplankton with the incubation of 4 hrs. In situ. The values of Gross Primary Productivity, Net Primary Productivity, NP/GP ratio and Respiration values parameters were higher in Ganga river than Saryu river. The present study would help in exploring the biodiversity of freshwater ecosystems.

KEYWORDS*: *Lotic Water, Saryu River, Ganga River, Gross Primary Productivity, Net Primary Productivity

INTRODUCTION

Primary productivity can be defined as the rate at which the solar energy is stored by the photosynthetic activities of primary producers. According to Raymount (1966) productivity in a broader sense is a concept of organic matter synthesis potential which measures the ability of an area to support a biological population and sustain a level of growth and respiration. Fixed carbon which is converted into the organic material through photosynthesis is assessed as total or gross primary production. Net production is the amount of organic substances remaining in plant bodies after respiratory processes. The primary productivity of an aquatic ecosystem is a quantitative index of the amount of energy available to support bioactivities to the ecosystem. It has been used as the potential index of productivity for many diverse ecosystems of the world (Wetzel; 1966).Primary productivity depends upon the photosynthetic activities of the autotrophic organisms which are capable to transfer carbon dioxide into organic matter. Photosynthetic fixation of carbon may occur in various kinds of freshwater communities, i.e., macrophyte, phytoplankton and periphyton. Generally macrophytic communities are more productive than phytoplankton communities under comparable condition on unit area basis, whereas in deeper lakes, ponds, oceans, deep and turbid rivers the macrophyte are confined to the littoral zone so their total production will be normally less than that of phytoplankton (Westlake, 1963) similar is the contribution of periphyton in the lotic system.

Nanoplankton and ultra plankton generally assimilate much more carbon per unit of biomass than net phytoplankton like large diatoms or blue-green algae (Qasim et al., 1974, Khan and Zutshi, 1979). Chemosynthesis of carbon may be significant in few rather specialized ecosystem like meromictic lake or reservoir (Culver and Brunskill, 1969) but may probably be ignored in terms of large-scale or regional productivity estimates.

The importance of primary productivity studies in an aquatic ecosystem is well recognized due to its potential value for secondary productivity. Phytoplankton constitutes the major segments of a primary producer in freshwater ecosystem. Phytoplankton occupies first trophic level phytoplankton constitutes the significant proportion of food items of fishes and plays a decisive role in organic production in long, deep and turbid riverine ecosystem (Lickens, 1975). Primary productivity depends upon various abiotic and biotic factors. Apart from light and temperature carbon dioxide concentration, the presence of certain metabolite, availability of necessary minerals, age and conditions of cells, a concentration of photopigments etc. influence primary production.

Gaarder and Gran (1927) were the first researchers to measure primary productivity in natural water bodies using light and dark bottles. Primary productivity of phytoplankton has been given due attention in limnological studies during past decades and has been estimated by several workers. The temperate systems of the world have been extensively investigated than that of tropics. Extensive investigations have been conducted in marine environments and lakes that the lotic environment Odum (1956, 1957) measured the primary productivity of thermal springs, Owen (1965) made such studies on streams, Venugopalan (1967) on the estuary and inshore waters at Porto Novo besides others.

In India primary productivity studies on the marine ecosystem by Prasad and Nair (1960), Hooghly Matlah estuarine system by Basu (1965), Cochin backwaters by Qasim et. al. (1969) is noteworthy. Such studies have been extensively made on lentic freshwater bodies, i.e., reservoir, pond, lake, wetland etc. by various workers. Sreenivasan (1963) made extensive studies on the limnology of some freshwater impoundments of Tamil Nadu. Nasar and Munshi (1975) studied primary productivity in a freshwater pond at Bhagalpur (Bihar). Kanan and Job (1979) made such studies in Sathiar reservoir while Saran and Adoni (1985) in Sagar lake (M.P.) & Sen et. al. (1992) in a Ranchi (Jharkhand) lake. Other important contributions are of Shukla and Pawan (2001), Sultan et. al. (2003), Kohli and Ranga (2011), Patel et. al. (2013) etc.

Information on primary productivity of lotic ecosystem of our county is still scanty. Some of them to be mentioned are of Sreenivasan et. al. (1979) on Kaveri river, Bilgrami and Munshi (1979, 1985), Singh (1980, 1993) on some stretches of river Ganga, Rajyalakshmi and Premswarup on river Godavari, Vasanth Kumar and Vijay Kumar (2011) on Bheema river (Karnataka). The present study on the primary production of different sites of rivers Saryu and Ganga in the district of Saran (Bihar) is important as the stretch remained unexplored before the present study.

MATERIAL AND METHODS

Study Area

Primary Productivity of lotic water of river Saryu (Site A) and Ganga (Site B) at Saran, Bihar, India was measured for a period of 12 months from January to December 2010 including winter, summer and rainy seasons. Four sampling stations were selected and established, two each in river Saryu and Ganga respectively. For the study, a

stretch of river Saryu and Ganga were undertaken which were quite virgin as well as almost unaffected by urbanization and anthropogenic activities to see the seasonal variation in the physico-chemical properties of water. Map of Saran district is shown in Figure 1. Photographs of Site A and B is shown in Figure 2 & 3.

Method

The light and dark bottle method of Gaarder and Gran (1927) was used to determine the primary productivity of phytoplankton with the incubation of 4 hrs. insitu. Two BOD bottles of 300 ml. capacity were selected of which one was pointed with the black color representing the black bottle while the other represents the light bottle. Both bottles were suspended in the water body at the same depth filled with water of that depth. Both bottles were tied with the help of bamboo poles. The initial concentration of oxygen in the water was estimated by filling one more bottle (initial bottle) from that depth. After the incubation of four hours, light and dark bottle were taken out and their oxygen content was determined with the help of Winkler's volumetric method as described earlier. The dark bottle gives the oxygen used up in respiration (by plankton, bacteria etc). While the light bottle gives the amount of oxygen added due to photosynthesis.

Calculation

Net Primary Productivity = [DL-DI]/h O_2mg/l/h

Gross Primary Productivity = [DL-DD]/h O_2mg/l/h

Community Respiration = [DI-DD]/h O_2mg/l/h

Where, DI = Dissolved oxygen in the initial bottle mg/l.

DL= Dissolved oxygen in the light bottle mg/l.

DD = Dissolved oxygen in the Dark bottle mg/l.

h = Duration of exposure.

The values can be converted to carbon by multiplying with 0.375.

Figure 1: Map of District Saran Showing Course of River Saryu and Ganga

Figure 2: Site A of Saryu River

Figure 3: Site B of Ganga River

RESULTS AND DISCUSSIONS

Results

The seasonal values of Gross Primary Productivity, Net Primary Productivity, NP/GP ratio and Respiration values are presented in Table 1. The values of above parameters were higher in Ganga river than Sarayu river. The values of Gross Primary Productivity varied between 0.0312 and 0.0585 mg c/m^3/hr in Sarayu river while it varied between 0.390 and 0.0936 mg c/m^3/hr in Ganga river. Net Primary Productivity was in the lower range 0.0195 – 0.0465 mg c/m^3/hr in Sarayu river than Ganga river where it fluctuated from 0.0234 to 0.0702 mg c/$m^{3/}$hr. Respiration value ranged between 0.0117 and 0.0156 in Sarayu river while it was in the higher range from 0.0078 to 0.0234 mg c/m^3/hr in Ganga river. NP/GP ratio was recorded highest 0.8750 in Ganga river during the winter season and lowest of 0.6000 in winter (Sarayu) and rainy (Ganga) river. A unimodal peak in the values of GDP, NDP and Respiration were observed during summer while minimum during rainy seasons in both the rivers. Comparative Seasonal Variations in GPP, NPP, NP/GP and Respiration at Site A & B during Jan- Dec 2010 is presented in Figure 4.

DISCUSSIONS

The values of GDP, NPP and Community Respiration were recorded maximum 0.0585 mg c/m^3/hr to 0.0465 mg c/m^3 hr and 0.0117 mg c/m^3/hr in river Sarayu while same values for river Ganga were 0.09336 mg c/m^3/hr, the during summer season. The minimum values of GPP, NPP & C. R. were 0.0312 mg c/m^3/hr, 0.0195 mg c/m^3/hr, 0.0117 mg c/m^3/hr, in river Sarayu while such values for river Ganga were recorded as 0.0390 mg c/m^3/hr, 0.0156 mg c/m^3/hr during rainy season. Maximum and minimum values of GPP, NPP, and CR were also recorded by Ganapati (1971) in river Godawari at Rajamundry, Sreenivasan (1979) in river Cauvery and Singh (1993) in river Ganga at Sahibganj (Jharkhand) during summer and rainy seasons respectively.

Low Gross Productivity in rainy season may be attributed to over caste sky, flooding, silting of the river and high turbidity. The primary production was maximum in summer which shows a direct relationship of light intensity and temperature while with turbidity the relationship was inverse. Gross Primary Productivity showed a positive co-relationship with the phytoplankton density and negative with turbidity. Nasar and Munshi (1975) and Siddiqui et. al. (1980) showed a positive co-relation with water temperature.

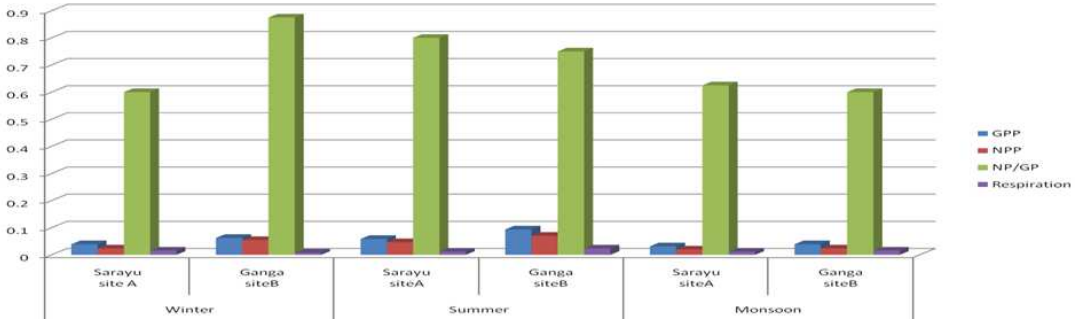

Figure 4: Comparative Seasonal Variations in GPP, NPP, NP/GP and Resp. at Site A & During Jan- Dec 2010

Table 1: Primary Productivity of River Saryu and Ganga(2010-11) in Mg C/M³/Hr

Season	Winter		Summer		Monsoon	
Parameter	**Saryu Site A**	**Ganga SiteB**	**Saryu SiteA**	**Ganga SiteB**	**Saryu SiteA**	**Ganga SiteB**
GPP	0.039	0.0624	0.0585	0.0936	0.0312	0.039
NPP	0.0234	0.0546	0.0465	0.0702	0.0195	0.0234
NP/GP	0.6	0.875	0.8	0.75	0.625	0.6
Respiration	0.0156	0.0078	0.0117	0.0234	0.0117	0.0156

CONCLUSIONS

The values of Gross Primary Productivity, Net Primary Productivity, NP/GP ratio and Respiration values parameters were higher in Ganga river than Saryu river. Seasonal variations in above parameters were observed in both the sites. The study of primary productivity would help in measuring the ability of a water body to support biological phenomena on which the entire biodiversity is depended.

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