

## Estimation of Primary Productivity of Shivaganga Pond of Baidyanathdham- Deoghar, Jharkhand [India]

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### ABSTRACT

Primary productivity is an important parameter to assess the quality of water. High productivity nature of water indicates greater degree of pollution. Phytoplankton productivity of Shivaganga pond of Baidyanathdham, Deoghar, Jharkhand was estimated at monthly intervals in the year 2002-2003. Noticeable data were collected. Minimum G. P. P. (0.0525mgc/l/hr) was observed in winter (December) and maximum (0.5625 mgc/l/hr) in summer (May), N.P.P. was assessed highest (0.4425mgc/l/hr) in March (summer) and lowest (0.015mgc/l/hr) in December (winter) Ratio of N.P.P. and G.P.P. was found lowest in July and highest in March. Community respiration was minimum in November and maximum in June. Ratio of G.P.P and respiration<sup>®</sup> was analyzed minimum (1.285) in July and maximum (30.5) in March, which reflects the degree of pollution.

**Keywords :** Primary productivity, parameter, quality of water, pollution, phytoplankton, Gross primary productivity (G.P.P), Net primary productivity (N.P.P), community respiration, Limnology, Ecosystem, Biomass, Biotic factor, Abiotic factor.

### INTRODUCTION

Primary productivity is as important parameter in respect of limnology. The energy available to support the bio-activities of aquatic ecosystem may be quantitatively assessed by primary productivity (Ohle, 1956). Productivity of aquatic environment may be greatly influenced by weather conditions (Agrawal, 1980, Thomas *et al.*, 1980 and Kaul, 1985). Phytoplankton comprises most important and major group of primary producers in water bodies. Bio-physiological activities of aquatic ecosystems can be assessed by regular evaluation of its primary productivity. Siddiqui *et al.*, (1980), Patra (1985), Chopra *et al.*, (1990), Kundu and Jana (1994), Kumar (1996), Florin and Montes (1998), Harikrishnan and Azis (2000), Kumar (2000,2001) and Dutta (2003) have made significant contribution in respect of primary productivity of aquatic ecosystems.

Primary production refers to all or any part of the energy fixed by green plants (Dash 1993). Productivity refers to the rate of production on a unit area basis. The total amount of solar energy converted (fixed) into chemical energy by green plants is called gross primary production (G.P.P). A certain portion of Gross Production is utilized by plants itself for maintenance (largely respiratory energy loss) and the remainder is called Net Primary Production (N.P.P), which appears as new plant biomass. Thus  $N.P.P = G.P.P - \text{Autotrophic respiration}^{\circ}$ . Primary production of Phytoplankton is an integral manifestation of biotic factors, which have an important role in the tropic structure through its significant contribution of energy input in water bodies (Datta, 2003). Production in natural water is dependent on the incident radiation energy, the carbon supply, the nutrient and the trace elements.

Shivganga is a large, perennial, historical and mythological pond of Baidhyanathdham, Deoghar, Jharkhand, India. It is a fresh water lentic, aquatic ecosystem. It is located near the famous "Dwaadash Jyotirling" temple of "Lord Shiva" commonly called as Rawaneshwar Baidhyanathdham, Temple of Baidhyanathdham, Deoghar. This town is located at 14° 27" North latitude and 86° 39" East longitudes. Shivganga pond is almost rectangular and measures about 244 meter in length, 152 meter in width and 18 meter in depth. Lakhs of pilgrims use to take holy dip in this pond before offering in the famous Baidhyanathdham temple of "Lord Shiva" throughout the whole year. In the month "Shrawan" of Hindu calendar (July- August) one month long "Shrawani mela", the largest fair of Asia, is held every year since long back. During this fair, more than 50 Lacks of pilgrims in Orange or Safron coloured dresses called as "Kanwaria" use to walk on bare foot chanting "Bol Bam, Bol Bam..." From the Ganges at Sultanganj, Bhagalpur to Baidhyanath, Deoghar. They use to carry the "Kanwar" on their shoulder with two pots full of "Ganga – Jal", which is offered to "Lord Shiva" in the Baidhyanath temple. Before offering "Ganga- Jal" in the temple every pilgrim takes a holy dip in the Shivganga pond. Its water is used by hotel and motel owners in cooking food taken by pilgrims. More than ten thousand local inhabitants use to take bath and wash their clothes every day throughout the whole year. Washing of utensils in huge number is also regular phenomenon of this pond. Immersion of idols and images of Gods and Goddesses in huge numbers is also regular feature of this pond. The pond water is stinking and blooming exhibiting heavy algal mat on the surface of its water giving greenish appearance. Its water appears to be denatured i.e. polluted which may cause harm to all. Keeping this view in mind the present work was undertaken which may provide some valuable information of scientific interest.

## MATERIALS AND METHODS

To analyze the primary productivity of the pond, Light and Dark bottle method was employed as suggested by Gardner and Gran (1927) with an incubation period of four hours. Initial and final readings (after

completion period) of dissolved Oxygen (DO<sub>2</sub>) were estimated by modified Winkler's method (Ellis et al., 1948). Following formulae were employed for the calculation of primary productivity:

$$(i) \text{ G.P.P} = [(DO_2 \text{ of LB} - DO_2 \text{ of DB}) / \text{Time}] \times F$$

$$(ii) \text{ N.P.P} = [(DO_2 \text{ of LB} - DO_2 \text{ of IB}) / \text{Time}] \times F$$

$$(iii) \text{ Community respiration} = (\text{G.P.P} - \text{N.P.P})$$

Where,

G.P.P = Gross Primary Production.

N.P.P = Net Primary Production.

L.B = Net increase in Dissolved oxygen due to photosynthesis in Light Bottle.

D.B = Dissolved Oxygen decrease in Dark Bottle.

I.B = Initial DO<sub>2</sub> in water of Initial Bottle.

F = Ratio of molecular weight of carbon and oxygen (0.375 = Factor). All oxygen values were converted to carbon values by multiplying with factor 0.375.

The value of G.P.P and N.P.P were determined in mgc / l / hour.

## RESULTS AND DISCUSSIONS

Gross Primary Productivity (G. P. P) :

The Primary Productivity (G.P.P) of phytoplankton of Shivganga pond of B. Deoghar was largely variable both spatially and seasonally. Table -1 displays the monthly fluctuation in the amount of G.P.P of Shivganga pond. It ranged between 0.0525 mgc / l / hr to 0.05625 mgc / l / hr (Table -1). Its minimum value was analyzed in the month of December while the maximum in May. Comparatively lower amount of G.P.P was observed during winter season. Which is in conformity with the findings of Chopra *et al.*, (1990), Kundu and Jana (1994), Kumar (2000) and Datta (2003). Its maximum value was observed in the month of May (summer) which supports the reports of Chopra *et al.*, (1990), Kundu and Jana (1994) and Datta (2003).

Net Primary Productivity (N. P. P) :

Net Primary Productivity (N.P.P) is the remaining amount of food deposited in the plant body, after the utilization of food in its respiration out of the total amount of food produced (G.P.P) by the autotrophs.  $N.P.P = G.P.P - R$  (Respiration of autotrophs). Primary productivity is the rate at which the solar energy is stored by the photosynthetic activity of producers in the form of organic substances which can be used as food material. The photosynthetic production of new organic matters by plants converts the sun's radiant energy into a form, which can be used by heterotrophs. The increase plant biomass over a period plus any loss during that period is the primary production (NET) and it is the basis of whole metabolic cycle in natural aquatic ecosystem (Kumar *et al.*, 2001).

Table -1 exhibit the Net Primary Productivity (N.P.P) of Shivganga pond with its monthly variation. It is measured in milligram Carbon per liter per hour (mgC / l /hr). It fluctuated in between 0.015 and 0.4425 mgC / l /hr. The higher amount of N.P.P was found during summer months, high tapered in monsoon and got minimum in winter. It supports the reports of Kundu and Jana (1994), Florin and Montes (1998), Harikrishnan and Abdul Azis (2000), Kumar *et al.*, (2001) and Datta (2003). Its lower values were found in winter and rainy season, which might be due to greater turbidity and lesser light penetration. The present finding is also in conformity with Saha and Pandit (1985). Its lesser amount may also be attributed to lower phytoplankton density, which is in conformity with the findings of Harikrishnan and Azis (2000). Higher amount of N.P.P was observed in summer, which attributes to lesser turbidity as it permitted greater light penetration for rapid rate of photosynthesis by phytoplankton.

#### **Ratio of Net Primary Productivity and Gross Primary Productivity (N. P.P / G. P. P)**

Table displays the monthly fluctuation in the amount of N.P.P and G.P.P, which ranged between 0.2217 and 0.9672 respectively. Its maximum value (0.9672) was estimated in March whereas the minimum (0.2217) value in the month of July. Its lower values were observed in rainy season as well as in winter while the

higher values during summer, which is in conformity with findings of Singh (1981). Its higher value depicts greater respiration than the production, which is the sign of unhealthy condition of water (Ketchum *et al.*, 1958).

#### **Community Respiration (G.P.P – N.P.P)**

Community Respiration is referred to the utilization of Oxygen by the biotic components in metabolic activities. Respiration is the most important physiological phenomenon of all living things, which continues throughout the whole life irrespective of day and night. It ceases only at the end of life.  $G.P.P - N.P.P$  indicates the community respiration ( R ). It is represented in  $mgC/m^2 / day$ .

Table -1 shows monthly, variation in the amount of community respiration which fluctuated in between 0.0125 to 0.0937  $mgC / m^2 / day$ , in Shivganga pond. Its maximum amount was found in June while minimum in November. Its lower values were analysed during winter and higher during summer, which supports the reports of Saha and Pandit (1985). Its higher amount might be due to greater biotic composition.

#### **Respiration as Percentage of gross primary production (GPP)**

It can be assessed as :  $[(Respiration / G.P.P) \times 100]$

Table- 1 exhibits the monthly variation in the amount of respiration as percentage of Gross which fluctuated in between 3.27% and 77.82%. Its highest value was observed in July and Lowest in March comparatively their higher percentages were analyzed during monsoon month followed by winter and lower in summer.

#### **Ratio of Photosynthesis (G.P.P) and Respiration (P / R)**

Ratio of Photosynthesis and respiration (P/R) as an excellent functional index of the relative maturity of the ecosystem. Table -1 displays the monthly fluctuation in the amount of ratio of photosynthesis and respiration (P/R) which ranged between 1.285 and 30.5. Its fluctuation was irregular showing its lower values during monsoon which increased in winter. Its higher values were recorded in summer. Its

**Table-1. Primary Productivity of Shivaganga Pond of B. Deoghar**

Parameter / Unit	July 2002	Aug	Sept	Oct	Nov	Dec	Jan 2003	Feb	Mar	Apr	May	June 2003
G.P.P (mgC/l/hr)	0.077	0.21	0.203	0.127	0.075	0.052	0.0806	0.097	0.457	0.05	0.056	0.146
N.P.P (mgC/l/hr)	0.017	0.12	0.128	0.037	0.062	0.015	0.0356	0.065	0.442	0.03	0.322	0.052
N.P.P/ G.P.P	0.221	0.57	0.630	0.295	0.833	0.285	0.4416	0.666	0.967	0.71	0.573	0.359
RmgC/l/hr	0.06	0.09	0.075	0.089	0.012	0.037	0.045	0.032	0.015	0.01	0.24	0.093
Respiration (%)	77.82	42.1	37.03	77.47	16.66	71.42	55.83	33.33	3.27	28.5	42.66	64.09
G.P.P/ R	1.285	2.33	2.70	1.418	6.00	1.4	1.791	3.00	30.5	3.5	2.343	1.56

minimum value was analyzed in the month of July while maximum in March. It is in conformity with the findings of Saha and Pandit (1985). Its higher value indicates extremity of heterotrophic metabolism in aquatic systems as respiratory demand of oxygen often greatly exceeded the photosynthesis (Jana *et al.*, 1982).

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