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Primary Productivity of Phytoplankton of Mahakali River, Nepal

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Abstract

Present paper describes primary productivity of Mahakali river at four stations. The two years mean of net primary production was 96.80 mgC/m^3/day. The net primary production value of Mahakali river was less due to the low water temperature and less phytoplanktonic growth. Two years mean value of gross primary production of Mahakali river was 176.29 mgC/m^3/day, which is less than lentic water. It shows that the river is oligotrophic but developing a tendency as going towards mesotrophic.

Keywords: Mahakali River; Productivity; Phytoplankton.

1. Introduction

Phytoplankton, the minute chlorophyll bearing organisms, constitutes the most important component of the plankton and account for almost all the primary production in the water body. Plankton forms the base of food chain in most of the aquatic ecosystem, thus playing a vital role in fisheries. The productivity of a water body is characterized by the presence of living organisms in the natural environment. Among the biotic components of an aquatic ecosystem, plankton community plays a significant role in the productivity and the trophic balance of the system. Plankton constitutes the major source of energy in the food web of aquatic systems. Their population fluctuates, depending on the hydrological regime and saprobiotic condition of the water. Because of their short life cycles, plankton responds quickly to environmental changes. Water temperature, light intensity, velocity and discharge of water, turbidity and alkalinity have widely been reported to affect plankton density in flowing waters [1, 2]. Some extensive investigation on various aspects of productivity has been made by Dash et al. [3], Jabde and Rokade [4] and Sharma [5]. Planktonic fauna was abundant during the post-monsoon period, when the water temperature was moderate to low, current strength was feeble and the water was calm without turbidity. Plankton, particularly phytoplankton, has been used as indicators of water quality. Phytoplankton

productivity and biomass of river are dependent on several interrelated physical, chemical and biological factors. During the study period the Mahakali River was rapidly surveyed to evaluate their productivity in the context of plankton population.

Study Area

Mahakali River originates from Indo-Nepalese glaciers, Milan glacier of India and Lipu-lekh of Nepal. The river leaves the mountains near Tanakpur and is now known as Sarada in India. Later, it reaches Sharada barrage, where it is considerably wider. Mahakali then enters into Nepal at Chandani and flows through Nepal upto Dodhara, after which it enters into Indian Territory, finally confluencing with the Ghaghara.

The present studies were conducted at the Chandani and Dodhara V.D.C. (Village Development Committee). They are the V.D.C. of Kanchanpur district near the bank of Mahakali river. The study area lies between longitude $80^0 25^{'}$ East and latitude $28^0 35^{'}$ North.

Four stations (A, B, C and D) were selected. First station 'A' is an upper station, which is near at Purnagiri temple of Syavle Bajar. Second station 'B' is 4 kilometres from station A. Third station 'C', which is 4 kilometres from station B. Fourth station 'D' is a lower station, which is 4 kilometres from station C.

2. Materials and Methods

The present study was carried out for a period of two years from September 2003 to August 2005. This period was used to collect the quantitative data on various aspects of river ecology.

In the present investigations, samples were collected from the study area, every month at 15 days interval. Phytoplankton primary productivity was measured by "Light and Dark bottle" method [6]. Duplicate light bottles and a single dark bottle were used to determine productivity. Water from surface level was collected and filled in duplicate light and dark bottles. Another water sample (in light bottle) was also collected simultaneously for determination of initial oxygen concentration. Bottles were kept suspended into the water. After 4 - 5 hours, oxygen was determined with the help of changes in oxygen concentration in light and dark bottles, gross and net primary productivity and community respiration were determined. Oxygen values were converted to carbon values (mg C/m^3/d) by multiplying the values with 0.375 [7].

The productivity values were calculated using following equations:

(i) Gross primary productivity (mg C/m^3/d)

$$P_g = \frac{LO - DO \times 0.375}{T \times PQ} \times 1000$$

(ii) Net primary productivity (mg C/m^3/d)

$$P_n = \frac{LO - IO \times 0.375}{T \times PQ} \times 1000$$

(iii) Community respiration (mg C/m^3/d)

$$R = \frac{IO - DO \times 0.375}{T \times PQ} \times 1000$$

where, IO = initial oxygen concentration, LO and DO = concentrations of oxygen in light and dark bottle, respectively after incubation; T= time, PQ and RQ = photosynthetic and respiratory quotients, respectively, which were assumed to be 1.2 [8].

3. Results and Discussion

The values of primary productivity of phytoplankton were observed during the whole study period (September 2003 – August 2005). It was noticed that the net primary productivity values varied from month to month (Table 1). The net primary productivity of Mahakali river was 96.80 mgC/m^3/day on the basis of two years mean. The maximum value was recorded in April while lowest value was recorded in July in both years. Seasonally, the minimum and maximum values ranged from 10.93 – 164.00 mgC/m^3 /day during the first year and from 15.62 – 209.37 mgC/m^3/day during second year.

The community respiration values also varied from month to month. The value of community respiration was observed to be 79.49 mgC/m^3/day on the basis of two years mean. Community respiration values fluctuated from 18.75 – 321.87 mgC/m^3/day during first year while from 29.62 – 128.12 mgC/m^3/day during second year of investigation. The highest values were recorded in the month of February 2004 and April 2005 during the first and second years of investigation, respectively.

The values of gross primary productivity also varied from month to month as like net primary productivity and community respiration. The two years mean value of gross primary productivity was observed 176.29 mgC/m^3/day. The minimum and maximum values recorded from 78.11 – 356.24 mgC/m^3/day during first year while from 45.24 – 337.49 mgC/m^3/day during second year of study. The highest value was noticed in the month of February 2004 and April 2005 while lowest values were observed in the month of September 2003 and July 2005 during the first and second year of study.

Among the biotic components of an aquatic ecosystem, plankton community plays an important role in the productivity of any water body. The water temperature is one of the most important factor which influences the production of phytoplankton in a river system. Das and Srivastava [9] pointed out the role of temperature as limiting factor for phytoplanktonic production. Khanna et al. [2]and Joshi et al. [10]are of the same view that the planktonic production was mainly influenced by temperature. During the present investigation, maximum phytoplankton was observed during summers.

During the present investigation, the two years mean of net primary production was 96.80 mgC/m^3/day which was less than value of net primary production of lentic water. The net primary production value of lotic water (Mahakali river) is less due to the low water temperature and less phytoplanktonic growth. Baduni [11] and Pathani [12] also recorded low rates of productivity in Alaknanda river in Garhwal Himalayas and Sarju river in Kumaun Himalayas, respectively.

Two years mean value of gross primary production of Mahakali river was 176.29 mgC/m^3/day, which is less than lentic water. This result is confirmed by other workers like Baduni (11) and Pathani (12). The monthly values of gross primary production varied from 78.11 mgC/m^3/day to 356.24 mgC/m^3/day and 45.24 mgC/m^3/day to 337.49 mgC/m^3/day during first and second year of investigations.

Table 1: Primary productivity of phytoplankton of Mahakali River.

(2003/04)

Month	**Net Primary Production mgC/m^3/day**	**Community Respiration mgC/m^3/day**	**Gross Primary Production mgC/m^3/day**
Sep. 2003	42.18	35.93	78.11
Oct.	75.00	18.75	93.75
Nov.	75.00	59.37	134.37
Dec.	89.06	67.18	156.24
Jan.2004	98.43	82.81	181.24
Feb.	34.37	321.87	356.24
Mar.	121.87	220.31	342.18
Apr.	164.00	179.68	343.68
May	101.56	114.06	215.62
Jun.	89.06	18.75	107.81
Jul.	10.93	93.75	104.68
Aug.	35.93	57.98	93.91
	Mean 78.11	**105.87**	**183.98**
	S.D. 42.65	**91.43**	**106.17**

(2004/05)

Sep. 2004	62.50	29.68	92.18
Oct.	81.25	31.25	112.5
Nov.	121.87	42.18	164.05
Dec.	117.18	100.00	217.18
Jan.2005	187.50	40.62	228.12
Feb.	178.12	54.68	232.8
Mar.	189.06	62.50	251.56
Apr.	209.37	128.12	337.49
May	132.81	40.62	173.43
Jun.	62.50	32.84	95.34
Jul.	15.62	29.62	45.24
Aug.	28.12	45.31	73.43
Mean	**115.49**	**53.11**	**168.61**
S.D.	**66.11**	**30.74**	**87.44**

Vollenweider [13] classified the fresh water bodies as oligotrophic (GPP, 65 - 300 mgC/m^3/day) mesotrophic (GPP, 250 - 1000 mgC/m^3/day) and eutrophic (GPP, 1000- 8000 mgC/m^3/day). The gross primary production value of Mahakali river shows that the river is oligotrophic but developing a tendency as going towards mesotrophic.

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