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Phytoplankton Primary Production in the river Jharahi at Mairwa, India

Shahi Rudra Pratap[1] and Hamidi Md. Khatibullah[2]
[1]Department of Botany, Z.A.Islamia Cellege, Siwan, Bihar, INDIA
[2]Department of Botany, Dr.R.M.L.S.College, B.R.A.Bihar University, Muzaffarpur, U.P., INDIA

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Abstract

Phytoplankton Primary production in the river Jharahi at Mairwa was studied in 2008 and 2009. Gross Primary Productivity (GPP) of the river water at the different sites ranged from 0.044 mgC/l/hr to 0.422 mgC/l/hr in the first year and 0.037 mgC/l/hr to 0.394 mgC/l/hr in the second year. Net Primary Productivity (NPP) ranged from 0.021 mgC/l/hr to 0.314 mgC/l/hr in the first year and 0.021 mgC/l/hr to 0.297 mgC/l/hr in the second year of observation. The NPP/GPP value of the river ranged from 0.469 to 0.799 in the first year and 0.427 to 0.754 in the second year and Community Respiration (CR) ranged from 0.023 mgC/l/hr to 0.108 mgC/l/hr in the first year and 0.026 mgC/l/hr to 0.097 mgC/l/hr in the second year of observation. CR as percent of GPP ranged from 20.109 to 53.125 in the first year and from 24.619 to 57.292 in the second year.

Keyword: Primary productivity, Jharahi, GPP, NPP, CR.

Introduction

Determination of primary production is a good measure of new organic matter created in the water body[1]. As the phytoplankton constitute a major segment of the primary producers, studies on the phytoplankton primary production in the fresh water ecosystems acquire immense importance. The river Jharahi (figure-1) is an important river of North Bihar, India. In the present study, gross primary productivity (GPP), net primary productivity (NPP) and community respiration (CR) of the river Jharahi were determined at Mairwa on seasonal basis. The ratio of net and gross primary productivity (NPP/GPP) and community respiration as percent of gross primary productivity were also computed.

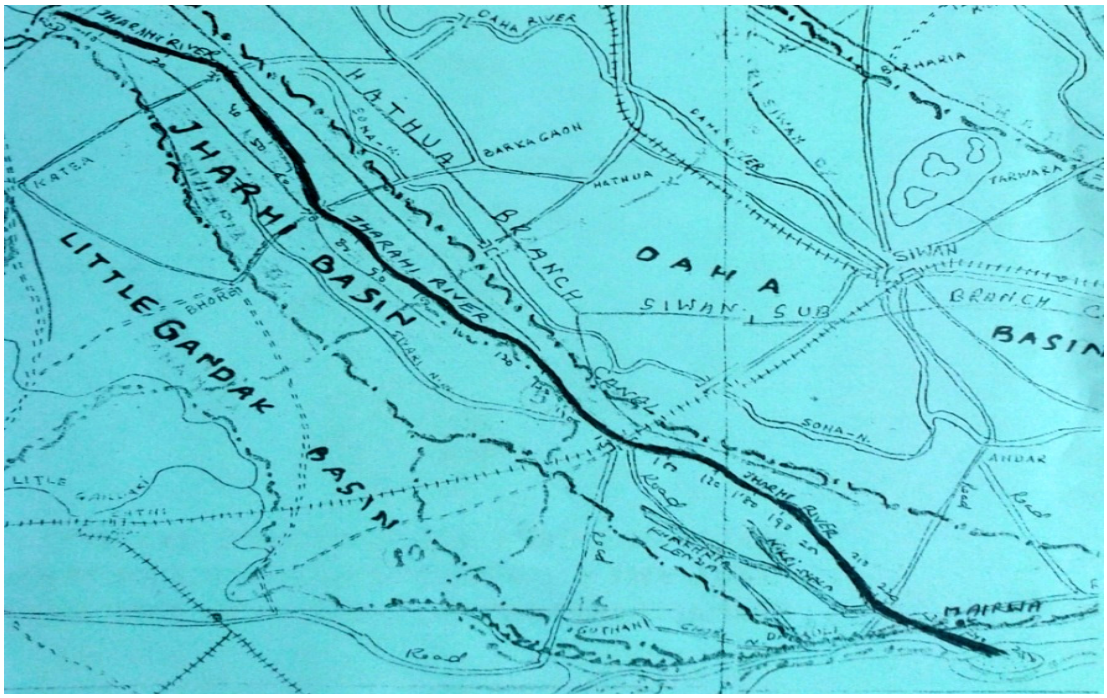

Figure-1
Map showing course of the river Jharahi and the experimental site Mairwa

Material and Methods

This work was a seasonal study carried out for a period two years, 2008 and 2009, designated as the first and the second year of observation respectively. Three different points viz., Site-A, Site-B and Site-C were selected as the sampling sites. Site-B is the middle point receiving domestic effluents from the town through a canal. Site-A is 500 meters upstream from Site-B and Site-C is 500 meters downstream from Site-B. As the present study was seasonal, the samples were collected in the month of May for summer season, in the month of August for rainy season, and in the month of December for the winter season from the three sampling sites. Primary production was determined by the oxygen method[2].

Results and Discussion

The observations made on the primary production of the river Jharahi at Mairwa have been summarized in the tables 1 to 5 and figures 2 to 6.

Table-1
GPP (mgC/l/hr) of the river Jharahi at Mairwa

Year	Season	Site A	Site B	Site C
2008	Summers	0.184	0.422	0.214
	Rains	0.044	0.054	0.048
	Winters	0.112	0.195	0.128
2009	Summers	0.196	0.394	0.215
	Rains	0.047	0.048	0.050
	Winters	0.096	0.226	0.113

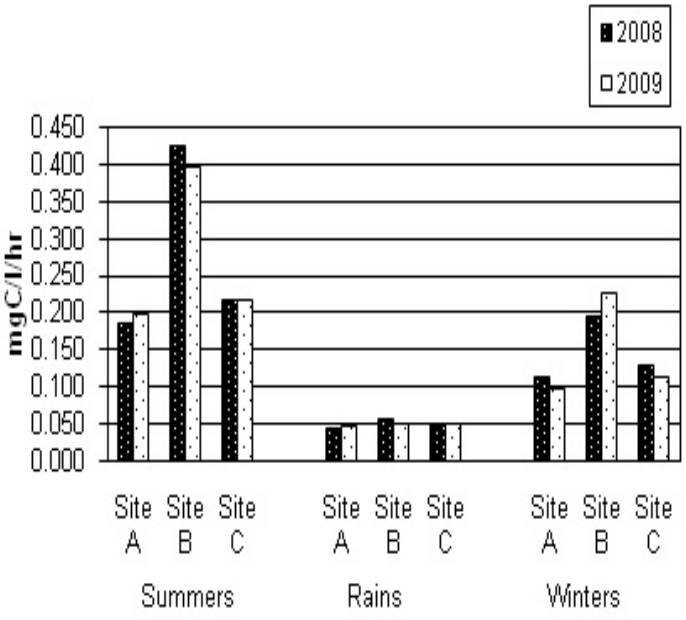

Figure-2a
GPP of the river Jharahi at Mairwa

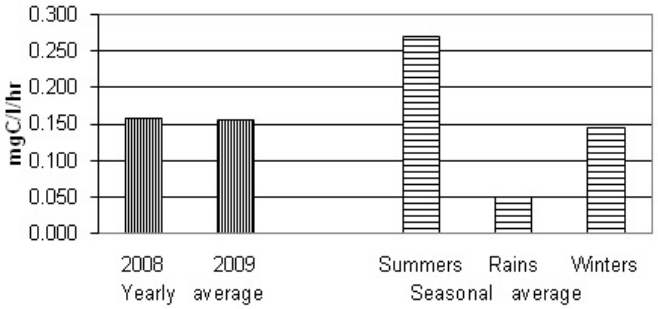

Figure-2b
Yearly and Seasonal averages of GPP of the river Jharahi at Mairwa

Table- 2
NPP (mgC/l/hr) of the river Jharahi at Mairwa

Year	Season	Site A	Site B	Site C
2008	Summers	0.147	0.314	0.133
	Rains	0.021	0.028	0.023
	Winters	0.053	0.128	0.060
2009	Summers	0.138	0.297	0.152
	Rains	0.021	0.021	0.024
	Winters	0.041	0.135	0.054

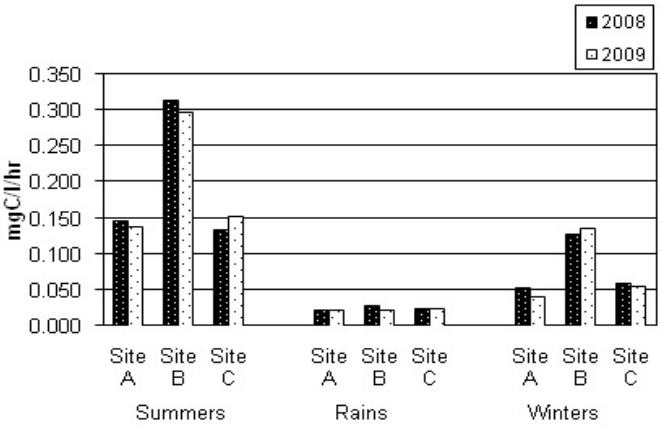

Figure-3a
NPP of the river Jharahi at Mairwa

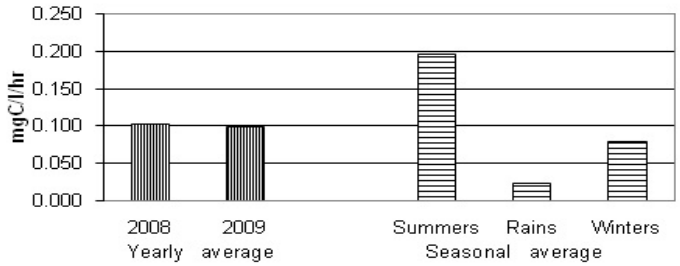

Figure-3b
Yearly and Seasonal averages of NPP of the river Jharahi at Mairwa

Table-3
NPP/GPP of the river Jharahi at Mairwa

Year	Season	Site A	Site B	Site C
2008	Summers	0.799	0.744	0.621
	Rains	0.477	0.519	0.479
	Winters	0.473	0.656	0.469
2009	Summers	0.704	0.754	0.707
	Rains	0.447	0.438	0.480
	Winters	0.427	0.597	0.478

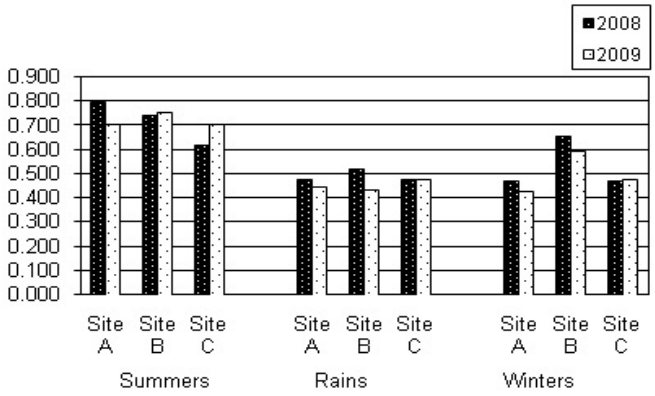

Figure-4a
NPP/GPP of the river Jharahi at Mairwa

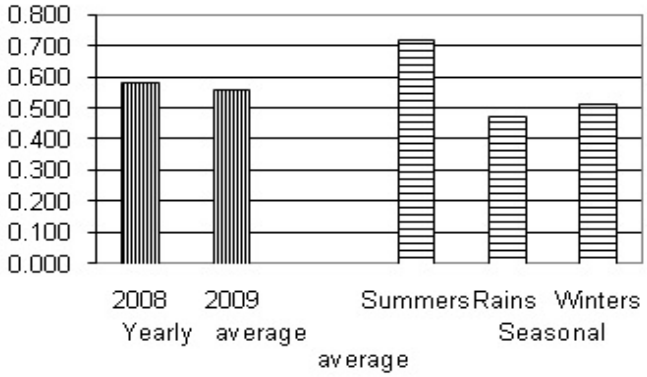

Figure-4b
Yearly and Seasonal averages of NPP/GPP of the river Jharahi at Mairwa

Table-4
CR (mgC/l/hr) of the river Jharahi at Mairwa

Year	Season	Site A	Site B	Site C
2008	Summers	0.037	0.108	0.081
	Rains	0.023	0.026	0.025
	Winters	0.059	0.067	0.068
2009	Summers	0.058	0.097	0.063
	Rains	0.026	0.027	0.026
	Winters	0.055	0.091	0.059

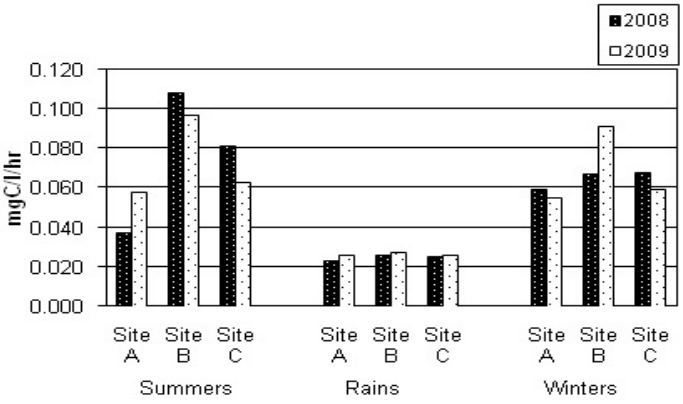

Figure-5a
CR of the river Jharahi at Mairwa

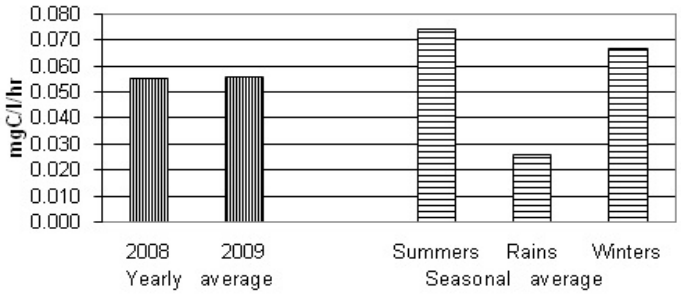

Figure-5b
Yearly and Seasonal averages of CR of the river Jharahi at Mairwa

Table-5
CR as percent of GPP of the river Jharahi at Mairwa

Year	Season	Site A	Site B	Site C
2008	Summers	20.109	25.592	37.850
	Rains	52.273	48.148	52.083
	Winters	52.679	34.359	53.125
2009	Summers	29.592	24.619	29.302
	Rains	55.319	56.250	52.000
	Winters	57.292	40.265	52.212

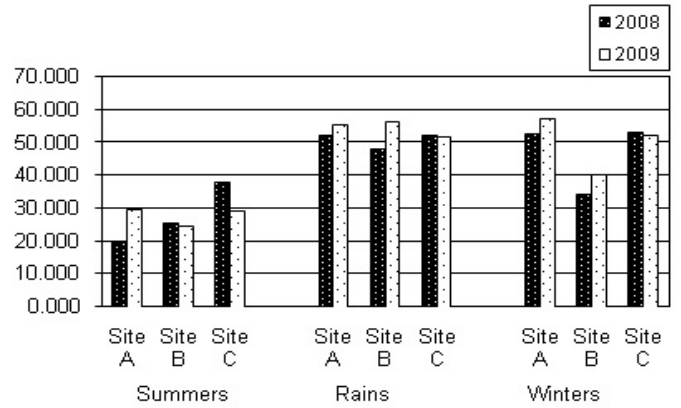

Figure-6a
CR as percent of GPP of the river Jharahi at Mairwa

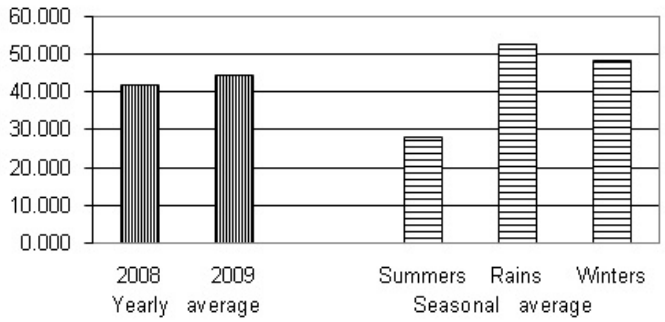

Figure-6b
Yearly and Seasonal averages of CR as percent of GPP of the river Jharahi at Mairwa

GPP of the river water at the different sites ranged from 0.044 mgC/l/hr to 0.422 mgC/l/hr in the first year and 0.037 mgC/l/hr to 0.394 mgC/l/hr in the second year. The range of GPP during the summers was 0.184 mgC/l/hr to 0.422 mgC/l/hr, during the rains 0.037 to 0.054 mgC/l/hr, and during the winters 0.096 mgC/l/hr to 0.226 mgC/l/hr. The maximum values of GPP in the first year (0.422 mgC/l/hr) and also in the second year (0.394 mgC/l/hr) were observed at Site B during the summers, whereas the minimum GPP in the first year (0.044 mgC/l/hr) as well as in the second year (0.037 mgC/l/hr) was observed at Site A during the rains. The yearly average of GPP showed little fluctuation being 0.156 mgC/l/hr in the first year and 0.153 mgC/l/hr in the second year. The seasonal average was maximum during the summers (0.271 mgC/l/hr), followed by the winters (0.145 mgC/l/hr) and minimum during the rains (0.049 mgC/l/hr).

NPP ranged from 0.021 mgC/l/hr to 0.314 mgC/l/hr in the first year and 0.021 mgC/l/hr to 0.297 mgC/l/hr in the second year of observation. The range of NPP during the summers was 0.133 mgC/l/hr to 0.314 mgC/l/hr, during the rains 0.021 mgC/l/hr to 0.028 mgC/l/hr, and during the winters 0.041 mgC/l/hr to 0.128 mgC/l/hr. The maximum values of NPP in the first year (0.314 mgC/l/hr) and also in the second year (0.297 mgC/l/hr) were observed at Site B during the summers. The minimum NPP value (0.021 mgC/l/hr) was same in both the years of observation being recorded at Site A in the first year and at Site A and Site B in the second year during the rains. The yearly average of NPP showed little fluctuation being 0.101 mgC/l/hr in the first year and 0.098 mgC/l/hr in the second year. The seasonal average was maximum during the summers (0.197 mgC/l/hr), followed by the winters (0.079 mgC/l/hr) and minimum during the rains (0.023 mgC/l/hr).

The NPP/GPP value of the river at the different sites ranged from 0.469 to 0.799 in the first year and 0.427 to 0.754 in the second year. The range of NPP/GPP during the summers was 0.621 to 0.799, during the rains 0.438 to 0.519, and during the winters 0.427 to 0.656. The maximum value of NPP/GPP in the first year (0.799) was observed at Site A and in the second year (0.754) at Site B during the summers, whereas the minimum NPP/GPP value in the first year (0.473) as well as in the second year (0.427) was observed at Site A during the winters. The yearly average of NPP/GPP showed little fluctuation, being 0.582 in the first year and 0.559 in the second year. The seasonal average was maximum during the summers (0.722), followed by the winters (0.517) and minimum during the rains (0.473).

CR ranged from 0.023 mgC/l/hr to 0.108 mgC/l/hr in the first year and 0.026 mgC/l/hr to 0.097 mgC/l/hr in the second year. The range of CR during the summers was 0.037 mgC/l/hr to 0.108 mgC/l/hr, during the rains 0.023 mgC/l/hr to 0.027 mgC/l/hr, and during the winters 0.055 mgC/l/hr to 0.091 mgC/l/hr. The maximum values of CR in the first year (0.108 mgC/l/hr) and also in the second year (0.097 mgC/l/hr) were observed at Site B during the summers. The minimum value of CR in the first year (0.023 mgC/l/hr) was observed at Site A, whereas in the second year (0.026 mgC/l/hr) was observed at Site A and Site C during the rains. The yearly average of CR was almost identical, being 0.055 mgC/l/hr in the first year and 0.056 mgC/l/hr in the second year. The seasonal average was maximum during the summers (0.074 mgC/l/hr), followed by the winters (0.067 mgC/l/hr), and minimum during the rains (0.026 mgC/l/hr). The value of community respiration as percent of GPP was also computed. This value ranged from 20.109 to 53.125 in the first year and from 24.619 to 57.292 in the second year. The values ranged from 20.109 to 37.850 during the summers, from 48.148 to 56.250 during the rains, and from 34.359 to 57.292 during the winters. The highest value in the first year (53.125) was observed at Site C during the winters and the lowest (20.109) at Site A during the summers. The highest in the second year (57.292) was observed at Site A during the winters and the lowest value (24.619) at Site B during the summers. The yearly average was 41.802 in the first year and 44.095 in the second year. Seasonal average was highest for the rains (52.679), followed by the winters (48.322), and minimum during the summers (27.844).

The phytoplankton primary production in the river water exhibited appreciable seasonal variation. Maxima of seasonal mean of the GPP, NPP and CR were observed during the summers and the minima during the rains. Bilgrami *et al*.[3,4] and Singh[5] have also reported maximum production during the summers in the river Ganges. However, Saha and Pandit[6] reported maximum production in the river Ganges in February and March and lowest in September and November. Bilgrami *et al*.[4] reported lowest production during the rains. Patra[7] reported lowest production in the month of September in the river Mahanadi. Descy *et al*.[8] also reported an increase of production during the summer months from mid-June to mid-August and low production in September and October. They also found significant production during the month of November. The aforesaid variations regarding the month of maxima of productivity may be attributed to the variations in the multiple physico-chemical as well as biological factors[9-12]; climatic as well as seasonal variations[13,14]; and specific dominance of the

variable group of algae[15]. The widespread assumption that winter productivity is insignificant is not always true. Ghosh *et al*.[16] and Kumari *et al*.[17] reported that GPP values were higher in winter season compared with summer production ranges. As per the explanation of Reid and Wood[18], cold inhibits respiration and provides the optimum condition for photosynthesis. This observation is of considerable importance in applied aquatic ecology.

It was observed that the maximum and minimum of the seasonal mean of primary production usually coincided with those of the phytoplankton density. Such association of the seasonal variation of the phytoplankton primary production and its density has also been observed by Bilgrami *et al*.[4] and Descy *et al*.[8] The NPP/GPP value in the river water ranged from 0.591 to 0.869 during the observation period. Bilgrami *et al*.[3] found the NPP/GPP value ranging from 0.27 to 0.87, Siddiqui *et al*.[19] from 0.36 to 0.5, Bilgrami *et al*.[4] from 0.571 ti 0.875, and Saha and Pandit[6] from 0.4 to 0.79 in the river Ganges. Ketchum *et al*.[20] have pointed out that in a healthy population the NPP/GPP ratio tends to approach unity.

The magnitude of annual fluctuation in the primary productivity is supposed to be direct reflection of seasonal impact. In the present study the maximum gross productivity was recorded almost ten times greater than the minimum. Vijayaraghawan[9] has reported the ratio of minimum: maximum as 1:10 in Othakadai pond, 4 times in Teppakulum tank and 5 times in Yanamalai pond of South India. Nasar[21] recorded the aforesaid ratio as only three times in Bharwa as well as T.N.B. College pond, and as 4 times in Bhatta pond at Bhagalpur. Nasar and Nasar[12] observed the maximum productivity in a sewage fed pond about 6 times greater than the minimum. Dutta and Choudhary[22] noted the ratio of the two extremes of production in a sewage-fed impoundment as 1:8. Singh[23]in a fresh water lake at Muzaffarpur, Bihar, has recorded the maximum production to be 5 times greater than the minimum. Studies on phytoplankton primary production are crucial for aquaculture activities[24].

Conclusion

NPP/GPP ratio tends to approach unity in a healthy aquatic ecosystem. The range of this ratio in the river Jharahi at Mairwa indicates the presence of a healthy phytoplankton population. This is also supported by the values of respiration expressed as percentage of the GPP.

References

1. Wetzel R.G., Limnology, 3rd Ed. Academic Press, California **(2001)**

2. Gaarder T. and Gran H.H., Investigations of the production of phytoplankton in Oslo Fjord, *Rapp. Proc. Verb. Cons. Prem. Inst. Explor. Mer*., **42**,1-48 **(1927)**

3. Bilgrami K.S., Munshi Dutta J.S., Siddiqui E.N. and Singh N.K., Primary productivity of phytoplankton of the river Ganga, *Biol Bull India.,* **1**, 39-42 **(1979)**

4. Bilgrami K.S., Datta Munsi J.S., Bhowmick B.N., Yadava R. N., Singh A.K., Singh D.K. and Pandit B., Ecology of River Ganges: Impact of human activities and conservation of aquatic biota (Patna to Farakka), Final technical report, MAB project., 97 **(1985)**

5. Singh N.K., Phytoplankton productivity, impact of some ecological factors, *Nat Aademic Sci. Lett.,* **4**, 227-230 **(1981)**

6. Saha L.C. and Pandit B., Dynamics of primary productivity between lentic and lotic system in relation to abiotic factors, *J. Indian Bot. Soc*., **69(III &IV)**, 213-217 **(1990)**

7. Patra A.K., Studies on the primary production of river Mahanadi at Sambalpur, *Proc. Nat. Acad. Sci. India.,* **4***,* 290-294 **(1985)**

8. Descy J.P., Servais P., Smitz J.S., Billen G. and Everbecq E., Phytoplankton biomass and production in the river Meuse (Belgium), *Wat. Res.,* **21(12)**, 1557-1566 **(1987)**

9. Vijayraghvan S., Seasonal variations in primary productivity in three tropical ponds, *Hydrobiol.,* **38**, 395-408 **(1971)**

10. Hickman M., The standing crop and primary productivity of the phytoplankton of Abot's pond, North Somerset, *J. Ecol*., **66**, 269-287 **(1973)**

11. Nasar S.A.K. and Munshi J.D., Study on primary production in a fresh water pond, *Jap J. Ecol*., **25**, 21-32 **(1975)**

12. Nasar S.A.K. and Nasar T.A.K., Primary productivity of phytoplankton in a sewage fed pond, *Phykos,* **17(1&2)**, 51-54 **(1978)**

13. Krishnamoorthy T.M. and Vishwanathan, Primary Productivity studies in Bombay Harbor Bay using 14c, *Indian. J. Exp. Biol.*, **6**,115-116 **(1960)**

14. Kumaran S. and Rao T.S.S., Phytoplankton distribution and abundance in the Cochin back waters during 1971-1972, *Bull. Dept. Mar. Sci. Univ. Cochin*, **7**, 791-799 **(1975)**

15. Pradeep H.S. and Gupta T.R.C., Primary production of brackish water ponds at Mulki, Daksina Kannada, *Environ &Ecol*., **4(2)**, 277-280 **(1986)**

16. Ghosh C., Jayaraman G. and Mittal, M., Biomonitoring of freshwater ponds- A mathematical model and a biochemical analysis. *In*: Proceedings of the International Conference, WAPDEC Dec. 11-13, New Delhi, India, 455-464 **(2002)**

17. Kumari P., Dhadse S., Chaudhari P.R. and Wate S.R., Bioindicators of pollution in lentic water bodies of

Nagpur city, *J. Environ. Sci. Eng*., **49(4)**,317-24 **(2007)**

18. Reid G.K. and Wood R.D., Ecology of inland waters and estuaries. Book Publication, D.Van Nostrand Company, 233-275 **(1986)**

19. Siddiqui E.N., Singh N.K., Bilgrami K.S. and Munshi Datta J.S., Algae of the river Ganga, India I, Chlorococales, *Nova Hedwigia,* **32**,789-796 **(1980)**

20. Ketchum B.H., Ryther J.H., Yentch C.S. and Corwin N., Productivity in relation to Nutrients, *Rapp. P.V. Reun . Cons. Perm. Int. Explor. Mer.,* **144**,132-140 **(1958)**

21. Nasar S.A.K., Studies on some aspects of pond ecosystem at Bhagalpur, Ph. D. Thesis, Bhagalpur University **(1975)**

22. Dutta N.C. and Choudhary, S., Primary productivity and its correlation with physico-chemical parameters of fresh water sewage fed Impoundment near Calcutta, *Environ. and Ecol.*, **2(1)**,65-68 **(1984)**

23. Singh M.P., Limnological studies of Sikandrapur Ox-bow Lake with reference to algal diversity. Ph. D. Thesis, B.R.A. Bihar University **(1992)**

24. Ajayan K.V. and Parameswara Naik T., Phytoplankton primary productivity in lentic water bodies of Bhadravathi Taluk, Shimoga district, Karnataka, India, *Int. Res. J. Environment Sci.,* **3(4)**, 34-41 **(2014)**