CHAPTER 10

Seasonal Fluctuations of Productivity of Lonar Meteoritic Lake (Maharashtra) India

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Abstract: Primary productivity pertains to the quantity of energy accessible to sustain the biological functions of aquatic ecosystems. The current study seeks to evaluate the productivity conditions in Lonar Lake. The standard Light and Dark bottle experiments with the ^{14}C method, as recommended by APHA (1991) and Trivedy and Goel (1987), were carried out monthly for a one-year duration from April 2009 to March 2010. Productivity rose from January to June but fell once more from July to December. The peak productivity levels were observed in May and June.

Introduction

The rate at which producers (such as phytoplankton, algae, and microphytes in aquatic environments) convert solar radiation into organic matter through photosynthetic and chemosynthetic processes is known as primary productivity Odum (1971). Biological output in any aquatic environment correlates directly with its physicochemical condition and the potential for fisheries resources. Studying primary production is essential for understanding how pollution affects the efficiency of ecosystems. A significant degree of output in both natural and cultural ecosystems occurs when the physicochemical conditions are favorable (Sultan et al., 2003)

The ecology and biogeochemistry of the ecosystems depend on primary output. Understanding primary production is essential to predicting how ecosystems will respond to global change and comprehending the factors that influence them. A comprehensive conceptual framework for comprehending the variables affecting pelagic gross primary production (GPP) in lake ecosystems is offered by the nutrient-color paradigm (NCP; Williamson et al., 1999). This approach emphasizes the combined influence of nutrients and dissolved organic matter (DOM) in controlling pelagic GPP, integrating two traditional master variables in limnology. (Dillon & Rigler, 1974; Jones, 1992; Naumann, 1921; Thienemann, 1925; Vollenweider, 1968; Williamson et al., 1999). The nutrient-color paradigm (NCP) specifically examines how the input of nutrients and DOM affects the light and nutrient limitation patterns of pelagic producers. According to Webster et al. (2008), lakes situated along gradients in nutrient availability and colored DOM inputs are essential for identifying trophic states, which can predict a number of characteristics of lake ecosystems, including biotic communities and overall productivity. While dark or green waters typically indicate higher nutrient levels due to an abundance of organic matter (dystrophic), algae (eutrophic), or a combination of both (mixotrophic; Figure 1), cleaner and more translucent waters generally indicate lower nutrient levels (oligotrophic). The NCP offers a comprehensive framework for understanding various limnological trends, emphasizing the significance of managing nutrients to combat eutrophication and the effect of light limitation on food web productivity in humic environments. (Karlsson et al., 2009; Maberly et al., 2020; Schindler, 1977).

Materials and Methods

From April 2009 to March 2011, samples were taken every month from the three sites that were chosen. Lake productivity was evaluated via the Light and Dark bottle experiments employing the 14C method as suggested by APHA (1991), Trivedy and Goel (1987), Walker (1975), and Nair (1970). In this approach, the sample was contained in a bottle and held underwater for 5-6 hours. Subsequently, the dissolved oxygen levels were measured from the bottles using the Winkler

method, and the results were noted. The oxygen levels were anticipated to rise in the light bottle because of photosynthesis, whereas they were expected to drop in the dark bottle due to oxygen consumption. When excluding other processes like photorespiration, the variation in oxygen levels between the light and initial bottles indicated net photosynthesis or productivity. The distinction between the initial and dark bottle represented total photosynthesis or Gross Primary Productivity.

Assuming that one atom is added for every oxygen molecule (32g) released for every carbon molecule (12g) collected, productivity was assessed. (APHA, 1991), which was used to gauge primary productivity (GPP, NPP, and Community Respiration). The experiment was conducted over 6 hours from 9:00 am to 3:00 pm. The factor 0.375 (12/32) was used to convert the DO values into g C/m3/h, and the hourly figures were multiplied by 12 to derive the daily productivity values (Nair, 1970).

Result and Discussion

Venugopalan (1969) researched primary production in Porto Novo's nearshore and estuary waterways, finding productivity rates of 35.5 and 45.99 mg C/m3/hr. Krishnamurthy et al. (1973) examined the environmental characteristics of the estuarine system and noted that the average gross production rate in the Pichavaram mangrove was 7.56 g C/m3/day, with a net average rate of 6.29 g C/m3/day. Walker (1975) investigated the seasonal phytoplankton cycles of two saline lakes in central Washington and noted that the 1,622 mg cm-2 day-1, with a minimum of 650 in October and a maximum of 2,919 in September, indicated that Soap Lake is very productive. Mohamed et al. (1976) investigated the primary productivity of lake Manzalah in Egypt using the C14 method and found the average productivity to be 182.5 mg C/m3/h, with a standard deviation of ± 98.70, indicating that this lake is highly productive. Nair et al. (1983) investigated primary productivity in the tropical backwater along India's south coast and found that the annual average net production was 84.28 mg C/m3/hr, with gross production at 152.33 mg C/m3/hr, NPP ranged between 0.72 and 4.99 g C/m2/day, while community respiration fluctuated from 0.26 to 3.6 g C/m2/day. In this research, Gross primary productivity (GPP), Net primary productivity (NPP), and Community respiration were analyzed. The Gross Primary Productivity (GPP) varies from 0.825 to 1.623 g C/m3/day at station-B. The figures for Gross Primary Productivity are shown in Table 01 and illustrated in Fig. 01. At station-B, the Net Primary Productivity (NPP) ranges from 0.342 to 1.379 g C/m3/day. Table 01 displays the Net Primary Productivity values, which are illustrated in fig. 01. The Community Respiration (CR) at station-B ranges from 0.243 to 0.478 g C/m3/day, with the data shown in Table 01 and illustrated in Fig. 1. Productivity increased from January to June, but it then fell until December. The highest level of Productivity was seen in May and June

Table 1. Monthly Variation of GPP, NPP and CR gC/m2/day

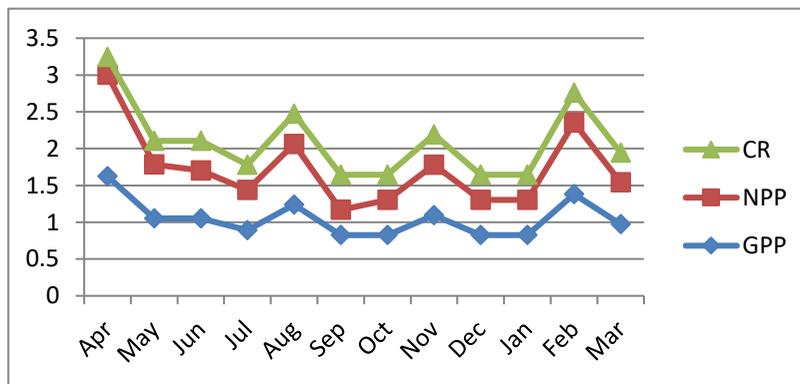| Months	GPP (g C/m²/day)	NPP (g C/m²/day)	CR (g C/m²/day)
April	**1.623**	**1.379**	**0.243**
May	1.053	0.731	0.321
June	1.053	0.648	0.404
July	0.891	0.548	0.342
August	1.237	0.825	0.412
September	**0.825**	**0.342**	**0.478**
October	0.825	0.478	0.342
November	1.097	0.684	0.412
December	0.825	0.478	0.342
January	0.825	0.478	0.342
February	1.379	0.975	0.404
March	0.975	0.565	0.404
Mean	1.050	0.677	0.370

Fig. 1. Monthly Variation of Gross Primary Productivity (GPP) g C/m²/day

Table 2. Principal Component Analysis GPP, NPP and CR gC/m²/day

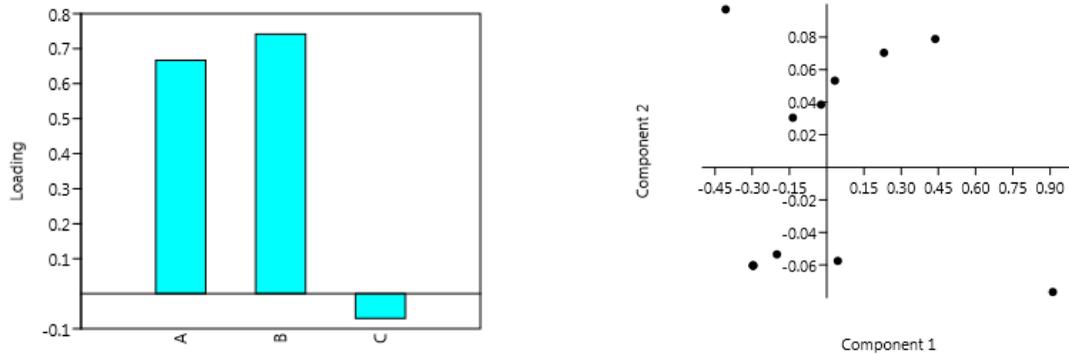|	PC 1	PC 2	PC 3
1	0.91101	-0.076616	-0.00097932
2	0.044683	-0.057545	0.001033
3	-0.022759	0.038526	0.00081734
4	-0.20059	-0.053477	0.001608
5	0.23068	0.070432	0.00065846
6	-0.40703	0.097062	-0.0007966
7	-0.29653	-0.060355	-0.00044324
8	0.032723	0.053283	0.00062557
9	-0.29653	-0.060355	-0.00044324
10	-0.29653	-0.060355	-0.00044324
11	0.43721	0.078913	0.00012744
12	-0.13634	0.03049	-0.0017641

Fig. 2. Principal Component Analysis Plot

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