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Limnological studies of Muntjibpur pond of Prayagraj (U.P.) in relation to planktons

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Abstract
The limnological condition of water plays a vital role in aquatic ecosystem. The various physico-chemical parameters of water of pond have been studied during July, 2018 to June, 2019 to find out its impact on fish food production (plankton) of Muntjibpur pond located in Prayagraj district of Uttar Pradesh, India. Various physico-chemical factors such as temperature, transparency, pH, dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, nitrates and phosphate fluctuate within a range conducive to high biological productivity. Total 16 species of phytoplankton and 16 species of zooplankton were recorded. In the present study, the maximum density of plankton was recorded in summer followed by monsoon and winter season. The physico-chemical and biological conditions were also found suitable for fish culture.

Keywords: Physico-chemical parameters, Phytoplankton, Zooplankton, Muntjibpur pond

Introduction
Limnology is derived from Greek word 'Lime'= lake; o-logy=study, meaning study of physical phenomenon of lake or pond or pond life. According to Hutchinson (1967), limnology is the study of whole sequence of geological, chemical and biological events that operate together into a pond, lake or stream basis and dependent on one another. The physico-chemical and biological conditions of the water body can be used to assess its ecological nature. Freshwater habitats such as lakes, ponds, dams, reservoirs are known as lentic (still) while running water such as rivers, mountain streams are known as lotic (flowing). The term 'pond' refers to a relatively shallow body of water usually smaller than a lake, contained in an earthen basin retaining sewage or organic wastes. One of the most important features of ponds is the presence of standing water, which naturally provides habitat for aquatic plants and animals. A large number of invertebrates feed on the decaying plants and these invertebrates in turn provide food for aquatic organisms including fishes. Pond water is useful for fish farming (Verma, 2019a) [32] but climate change (Prakash and Srivastava, 2019) [36] influences the farmers' practices (Mandal and Singh, 2020) [25] related with fresh water.
A large number of workers have studied the limnological parameters of lentic water bodies of India (Singh, 1983; Goel *et al.*, 1986; Singh, 1990; Abbasi *et al*., 1996; Ansari and Prakash, 2000; Kumar *et al*., 2015; Prakash *et al.*, 2015a, 2015b; Singh and Verma, 2016; Verma, 2019b; Verma *et al*., 2016a, 2016b, 2018 and 2020; Singh and Singh, 2020) [2, 1, 11, 6, 33, 23, 24, 25]. The said pond is although studied by Verma (2016a, 2016b, 201a, 2017b and 2018) [27, 28] for various parameters but it was the first systematic study related with plankton. The present work was undertaken for studying the limnological characteristics of Muntjibpur Pond of Prayagraj (U.P.) in relation to plankton.

Study area
Muntjibpur pond is a natural pond, located on north side of village Muntjibpur. This pond is surrounded by agricultural fields. garden, road and covers more than 5000 square meters. It is located in Pratappur block of Phoolpur tahsil of Prayagraj district of Uttar Pradesh. This village is surrounded by Miraipur in east, Fatuhan in west, Saidpur in north and Fulahan in south. The month of March marks the start of summers and it lasts till June. Monsoon generally starts in the last week of June and lasts till October. November to February is the winter season in and around this village.

Materials and methods

Water samples were collected fortnightly during July, 2018 to June, 2019 in a plastic stoppered bottles, both from the surface and bottom layers between 8 and 10 am. The transparency, temperature, dissolved oxygen, free carbon dioxide and pH were recorded on spot by using Secchi disc and water quality analyser kit. The total alkalinity, total hardness, nitrates, and phosphates analysis were made at field as well as in laboratory as per standard methods (APHA, 2005) [3]. In biological parameters, plankton productivity was measured by using Sedgewick Rafter plankton counting cell and quantities are expressed here as units per litre of the pond water. Planktons were identified with the help of standard literature (Needham and Needham, 1962) [15].

Results and Discussion

Physico-chemical Parameters (Table1): The parameter wise results obtained are elaborated and discussed below.

Water Temperature: Water temperature is responsible for not only high biological productivity but also influences the physiological activities of aquatic organisms. The water temperature of pond ranged between 30.4 and 34.5^{0}C in monsoon season, 18.5 -22.4^{0}C in winter and 24.8 -33.8 ^{0}C in summer season. The range of water temperature is suitable for culture of Indian major carps and exotic carps (Jhingran, 1988) [9].

Table 1: Seasonal variations in physico-chemical properties of Muntjibpur Pond.

Parameters	Monsoon season	Winter season	Summer season
Temp (ºC)	30.4 - 34.5	18.5 -22.4	24.8 -33.8
Transparency (cm)	61.5 -85.4	145.2 -153.8	92.4 -135.5
pH	7.7- 8.9	8.4-8.7	7.5 -8.2
DO (mg/l)	8.5 – 10.7	9.8 -10.2	7.7 -9.8
FCO_2 (mg/L)	8.4 -15.2	4.8 -5.4	5.0 – 14.5
Total Alkalinity (mg/L)	99.6 -117.8	96.4 107.2	132.0 -145.5
Total Hardness (mg/L)	78.0 -88.0	92.0 -98.0	104.0 – 117.0
Nitrate (mg/L)	0.34 -0.82	0.23 -0.42	0.17 -0.36
Phosphate (mg/L)	0.07 -0.12	0.05 -0.09	0.07 -0.08

Transparency

The average depth at which Sachhi disc disappears and again reappears from open surface of water is called transparency of water. It is inversely proportional to the turbidity of water (Kumar *et al*., 2015) [11]. Water transparency controls the energy relationship at different trophic levels in food chain (Kumari and Jha, 2015) [11]. Apparent changes were recorded in the transparency of the pond water during different seasons. Maximum transparency was noted during winter, low in summer and lowest in the rainy months. Maximum transparency recorded during winter months may be attributed to sedimentation of suspended matter (Chaurasia and Adoni, 1985) [5].

pH

The pH is an indicator of overall environmental condition of the aquatic system. The pH of pond water ranged between7.5 and 8.9 which is suitable for aquatic life (Singh, 1990) [24]. The decline in pH values during summer is associated with the dissociation of carbonic acid (formed by surplus free carbon dioxide) into H^+ and $HCO3^-$ ions. These H+ ions declined the pH of water in summer. Alkaline range of pond water is indicative of the fact that photosynthetic activity has dominance over the respiratory activity of the biota.

Dissolved Oxygen (DO)

The DO of any water body is an important parameter as it is an indicator of aquatic productivity. The oxygen concentration in water body is a function of the temperature as well as the photosynthesis and community respiration. The range (7.7-10.7 mg/L) of DO shows that pond water was saturated with oxygen in all the seasons. The highest dissolved oxygen was recorded during winter season may be attributed to low temperature which enables to hold more oxygen. Hazelwood and Parker (1961) [7] stated that, the highest dissolved oxygen in winter may be due to low atmospheric temperature and high photosynthetic activity. Oxygen depletion in summer months may be due to high temperature and rapid oxidation of organic matter. The dissolved oxygen concentration above 5.0 mg/L throughout the year shows that the pond is very much productive (Ansari and Prakash, 2000) [2].

Free Carbon dioxide

Free carbon dioxide in a water body is generally derived from the atmospheric sources, biotic respiration and decomposition of organic matter by saprophytes. The FCO_2 concentration in the pond was maximum during monsoon season and minimum during winter season. The appearance of high concentration of free carbon dioxide during monsoon could probably be associated with rapid decomposition of organic matter in the sediments owing to low depth, greater intensity and longer duration of sun light and ultimately more heat budget in the ecosystem. The present finding is similar to that of Kumar *et al*., (2015) [11].

Total Alkalinity

Alkalinity is directly related to the productivity of water bodies because it regulates the pH and free carbon dioxide of the water bodies. In natural water, alkalinity is generally caused by carbonates and bicarbonates of calcium and magnesium. The maximum alkalinity was in summer, low in monsoon and lowest in winter. According to Welch (1952) [39], free carbon dioxide released by the decomposition of organic matter in the sediments combines with bottom carbonate deposits in direct contacts with overlying water forming bicarbonates. Thus the range (96.4-145.5mg/L) of total alkalinity indicates that the pond water is hard type and is indicative of high fish production (Singh, 1983; Singh, 1990; Ansari and Prakash, 2000) [2, 23, 24].

Total Hardness

The hardness of water primarily depends upon salts of calcium and magnesium ions in water, mainly the carbonates and sulphates (Wadia, 1961) [38]. It is an index of fertility of the aquatic ecosystem. Moyle (1946) [14] suggested 40 ppm of hardness as a natural separation point between soft and hard waters. The total hardness ranged from 78-117 mg/L indicates that pond water is suitable for fish culture (Jhingran, 1988) [9]. The highest hardness was noticed in summer and lowest in winter seasons. The peak value of total hardness present during summer in this study may be attributed to decrease in water level or volume and increased rate of evaporation at high temperature. Again, the present finding suggests that the pond water is moderately hard. Since water with a hardness of up to 75mg/L is treated as soft from 75-150 mg/L moderately

hard and 150-300 mg/L as hard and above that very hard (Kiran, 2010) [10].

Nitrate

The most chemically stable available form of nitrogen is nitrate. High nitrate concentration is responsible for algal blooms in water body. Surface runoff, decayed vegetations and animal matter are the main sources of nitrates in water body. The nitrate content of the water ranged between 0.17 and 0.82 mg/L. Its maximum concentration was observed in the post monsoon season.

Phosphate

Phosphate is considered as the most critical nutrient substance in the maintenance of aquatic productivity. These are essential for the growth of organisms and a nutrient that limits the primary productivity of the water body. In the present study, the phosphate content was ranged between 0.05 and 0.12 mg/L. It was minimum during winter season and maximum during the summer. Low phosphate contents during winter season and high during summer or post monsoon months may be due to low decomposition of organic matters during summer seasons (Prakash, 2001b) [17].

Natural water bodies *viz.*, lakes and ponds receive their nitrates and phosphate supply from agricultural runoff, sewage effluents and decomposed organic matters. When algae and other micro-organisms die and settle to the bottom of any water body, they carry their cellular nitrogen and phosphorus with them. During decomposition, these nutrients are released and become available for subsequent growth of aquatic flora. In relation to nutrients status, the pond falls into medium to high productive group (Banerjea, 1967) [4].

Productivity of Plankton (Table. 2)

In the present study, 16 species of phytoplankton were found. Of these 6 belong to Chlorophyceae (*Coelastrum, Scenedesmus, Colosterum, Crucigenia, Ulothrix* and *Chlorella*); 5 to Bacillariophyceae (*Synedra, Navicula, Cymbella, Pinnularia* and *Asterionella*); 4 to Cyanophyceae (*Anabaena, Spirulina, Cloecapsa*, and *Oscillatoria*) and 1 to Euglenophyceae (*Euglena*). Apart from this 16 species, species of zooplankton were found. Of these 6 species were Rotifers (*Asplanchna, Brachinous, Keratella, Notholca, Polyarthra* and *Lecane*); 5 to Cladocerans (*Bosmina, Bosminopsis, Chydorus, Daphnia* and *Sida*), 3 to Copepods (*Cyclops, Diaptomus*, and *Nauplius* larva) and 2 Ciliates (*Paramecium* and *Vorticella*). Most of these species were present in fresh water bodies of eastern Uttar Pradesh (Prakash, 2001a; Prakash *et al*., 2002 and Sinha *et al*., 2002) [2, 16, 26]. Presence of 23 species of phytoplankton and 20 species of zooplankton shows that the pond is rich in planktonic diversity.

Table 2: Seasonal variation in Planktonic Population (Units /L) of Muntjibpur Pond.

Parameters	Monsoon season	Winter season	Summer season	Total	%age
Phytoplankton					
Chloro-phyceae	537	398	497	1432	31.91
Cyaono-phyceae	502	523	654	1679	37.41
Bacillariophyceae	403	398	393	1194	26.60
Euglenophyceae	53	51	79	183	4.08
Total Phytoplankton	1525	1370	1623	4488	-
Zooplankton					
Rotifera	650	617	595	1862	37.93
Cladocera	543	317	519	1379	28.09
Copepods	504	214	416	1134	23.10
Ciliates	195	98	241	534	10.88
Total Zooplankton	1592	1246	1771	4909	-

The annual periodicity of phytoplankton shows that Cyanophyceae dominated and constituted 37.41% of the total phytoplankton followed by Chlorophyceae (31.91%), Bacillariophyceae (26.60%) and Euglenophyceae (4.08%). In the present study, the maximum density of phytoplankton was recorded in summer (1623 units / L) and minimum in winter (1370 units / L). The annual productivity of zooplankton shows that Rotifers dominated and constituted 37.93% of the total zooplankton followed by Cladocerans (28.09%), Copepods (23.10%) and Ciliates (10.88%). In the present study, the maximum density of zooplankton was recorded in summer (1771 units / L) and minimum in winter (1246 unit / L). Similar observation were made by Ansari and Prakash (2000) [2], Prakash (2001a) [16] and Sinha *et al.*, (2002) [26].

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