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Variation in plankton in relation to physicochemical parameters of water of Hasanpur Barahi Chaur

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ABSTRACT

A study was conducted on plankton dynamics of from the Hasanpur Barahi chaur of Madhepura, Bihar from the period of August 2019 to July 2020. Total ten sampling stations were chosen based on water characteristics. Overall water quality parameters (Temperature, DO, CO_2, TH, TA, Nitrate, Phosphate and pH) were found in the limits suggested for aquaculture practices except few station like STN 1, 4, and 5 shown poor water quality, this may be due to domestic sewage and organic matter load released from local communities. Fifty genera of phytoplankton were identified, of which 24 genera of Chlorophyceae, 12 Bacillariophyceae, 11 Cyanophyceae, 2 Euglenophyceae and 1 of Dinophyceae. The phytoplankton abundance shows sharp increase from January to April (pre-monsoon) with Chlorophyceae as the most dominant group. All group of zooplankton showed very low abundance during monsoon, however, there was an increase in abundance during pre-monsoon, and highest abundance value was recorded during post-monsoon months. The findings of this study will serve as a baseline data for further investigations, comparing the future changes in this chaur and to conserve this ecosystem

Key Words - Ecosystem, Physicochemical parameters, Primary productivity, Hasanpur, Barahi chaur

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INTRODUCTION

The phytoplankton community form the base of trophic level on which whole aquatic population depends and this community is also largely influenced by the interaction of a number of physicochemical factors. The dynamic characteristics of a Lake like water colour, transparency, trophic state, and zooplankton and fish production fundamentally depend on the phytoplankton diversity and their availability (Goldman and Horne, 1983). According to Davis (1955) many water quality parameters including biological factors working simultaneously, and those factors must be considered for better understanding of the phytoplankton population dynamics. Karr *et al.* (2000) reported that the biotic community of any water body is product of interaction between the physicochemical parameters along with geo-morphological characteristics of any water body. According to Cetin and Sen (2004) the distribution and variation of phytoplankton in freshwater lake primarily depend on its environmental parameters. Phytoplankton communities are the primary producer and play a pivotal role in food chain of an aquatic ecosystem (Khan, 2003).

Zooplankton community act as an interlinking chain between the autotrophs and other heterotrophs, occupies the central position and forms an important part in the food-web of a freshwater ecosystem. There are many reports available

related to various ecological aspects of zooplankton and have been studied by several workers in India (Somashekar *et al.,* 1994; Annapurna *et al.,* 1999). Pawar and Pulle (2005) suggested that the occurrence and abundance of zooplankton basically depend on its productivity, which in turn, is influenced by the environmental parameters and nutrients availablity in the water body. Zooplankton is considered as one of the most important biotic components of an aquatic ecosystem which influences all functional aspects like food chains and trophic networks, energy flow, and the circulation of matter of that water body. The occurrence and distribution of planktonic community depend on several factors viz., biotic factors, habitat physicochemical properties, and climate change (Cottenie *et al.,* 2001; Rajagopal *et al.,* 2010; Ahmad *et al.,* 2011; Alexander, 2012). According to Paturej *et al.* (2017) the physicochemical properties of a water body played a key role in forming zooplankton species structure and could also significantly impact on the entire zooplankton population. The present study has been conducted in Hasanpur Barahi chaur of Madhepura, Bihar

MATERIALS AND METHODS

Study was carried out from period of August 2019 to July 2020. Total ten sampling stations were chosen based on water characteristics. Water samples collected on bimonthly basis from all the sampling stations between 9.00 am to 03.00 pm. Temperature and pH were measured at the site itself. For DO estimation 250ml DO bottles were used, fixed at the site itself and samples brought to the laboratory for estimation of DO concentration. For study of other hydrological parameters like CO, , TA, TH, nitrate and phosphate water samples collected separately in wide mouth 500ml polyethylene bottles following the APHA (2005) guidelines for sample collection and preservation.

Plankton samples were collected using bolting silk cloth plankton net of 20 cm diameter with mesh size 20 micrometer, qualitative and quantitative analysis was performed. Samples were collected in duplicate and concentrated to 50 ml filtering 50 liter of water from the respective stations. After collection of zooplankton samples preserved in 5% formalin and phytoplankton in 4% Lugol's Iodine solution for further qualitative and quantitative analyses (Pennak, 1978). Plankton were observed and identified under different magnifications using the HUND inverted microscope. Photographs of major plankton were captured using Olympus FX100 Microscope. Measurement of morphometric features of plankton was done using Biowizard software. Observed plankton were identified using keys and monographs given by Edmondson (1992), Lund and Lund (1998), Desikachary (1959), Graham *et al.* (2008), Fresh water biology (Ward and Whipple, 1992). Enumeration of plankton was carried out using a Sedgwick-Rafter counting cell method the procedure outlined by Welch (1948). Average of three samples was taken into consideration and the results are given in terms of no/litre.

RESULTS

Physiochemical parameters

The physicochemical parameters of the Chaur showed spatial and temporal variation in the values of the parameters following a seasonal and site-specific pattern. Detailed information of physicochemical parameter of Hasanpur Barahi chaur is summarized in Table 1.and 2. (Station-wise variation) and Table 3. (Month-wise variation).

In the present study, air temperature ranged from 24.5 to 34.8°C. Minimum temperature (24.5°C) was recorded in January at station 1, which coincided with the winter season. Maximum temperature (34.8°C) was recorded in May at the station 7 indicating the peak of summer season. Spatially, there was an insignificant variation in water temperature however a time specific variation showing an increasing trend from January to May, followed by a significant decrease up to November was noticed. Minimum temperature (22.5°C) was recorded in month of January at station 1, during winter season and maximum water temperature (31.6°C) was recorded in the month of May at the station 6 and station 7, during the peak of summer season. A significant variation in the values of DO

was also recorded, with minimum value in January at station 1 (4.0 mg/l) and maximum value in November at station 10 (7.8 mg/l). The results followed the general; pattern of the inverse relation of DO on temperature where the decrease in temperature increase the DO level due to higher solubility of oxygen at lower temperatures. The concentration of free carbon dioxide varied significantly (3.1 to 5.4 mg/l). There was a significant temporal variation in CO_2 level during different months. Minimum free CO_2 level was recorded in November at station 8 (3.1mg/l) and maximum in January at station 4 (5.4 mg/l).

The values of total alkalinity showed variations in a wide range of 120.66 to 130.42 mg/l) as CaCOƒ alkalinity. The minimum value was recorded at station 1 (120.66 mg/l as $CaCO_3$) whereas, the maximum value was noticed at the station 6 (130.42 mg/l as $CaCO_3$). Temporally, lowest and highest values for $CaCO_3$ alkalinity was recorded in January at station 1, and maximum in July at station 6.The values of total hardness varied significantly from 51.48 to 80.23 mg/l as $CaCO_3$. The minimum value of was noted at station 4 (51.48 mg/l as $CaCO_3$) and station 10 exhibited the highest value during the study months (80.23 mg/l as $CaCO_3$). Temporally, the lowest value of total hardness was recorded in January at station 4 and maximum value in July at station 10.The concentration of nitrate-N varied from 1.31 to 2.96 mg/l. The minimum value of nitrate-N was recorded at station 8 (1.31 mg/l) and highest value was measured at station 1 (2.96 mg/l). The values showed a temporal variation. The lowest value of nitrate-N was recorded in March at station 8 and maximum value in September at station 1. The concentration of phosphate showed a significant variation in the rage of 1.73 to 3.15 mg/l. The minimum value of phosphate was recorded at station 9 (1.73 mg/l) however, the maximum value was noticed at the station 10 (3.15 mg/l). Temporally, station 9 exhibited lowest concentration of phosphate in January. Highest vale for this parameter was recorded in July at station 10. The pH value varied significantly from 6.4 to 8.3 during different sampling period in Hasanpur Barahi chaur

The maximum pH value recorded was 8.3 at stations 6 and minimum value of 6.4 was measured at station 1. Temporal variation in pH is evident from a lower value in January at station 1 and maximum in July at station 6.

Table 1. Station-wise variation in the physicochemical parameters of Hasanpur Barahi chaur

	STN 1	STN 2	STN 3	STN 4	STN 5
Air temp. (°C)	24.5*- 29.5	24.7-31.5	25.4-31.5	26.4-32.7	26.6 -32.7
Water temp. (°C)	22.5*-27.5	22.6-29.4	23.6-29.6	25.6-30.5	25.6-30.5
Dissolved oxygen	4.0*-5.5	4.5-6.4	4.6-6.8	4.1-5.6	5.5-7.3
Carbon dioxide	3.5-5.3	3.5-5.1	3.5-4.1	3.4-5.4**	3.3-5.1
Total Alkalinity	120.66*-127.46	121.14-126.87	120.81-129.75	121.97-127.54	121.74-129.94
Total Hardness	72.40-76.84	73.27-76.71	73.49-77.94	51.48*-77.53	73.50-79.85
Nitrate-N	2.84-2.96**	1.62-1.93	1.59-1.96	1.82-2.93	1.96-2.88
Phosphate	1.82-2.14	1.76-2.09	1.77-2.53	1.82-2.32	1.77-2.92
pH (No unit)	6.4*-7.4	6.5-7.6	7.3-7.5	7.0-7.5	7.3-7.7

(* Minimum value between the stations; ** Maximum value between the stations; Units other than mentioned are in mg/l)

Table 2. Station-wise variation in the physicochemical parameters of Hasanpur Barahi chaur

	STN 6	STN 7	STN 8	STN 9	STN 10
Air temp. (°C)	24.5- 29.5	24.7-34.8**	25.4-31.5	26.4-32.7	26.6 -32.7
Water temp. (°C)	25.6-31.6**	25.6-31.6**	25.4-30.7	23.5-30.7	23.4-29.4
Dissolved oxygen	4.6-7.5	5.1-7.2	4.8-7.2	4.7-6.7	6.1-7.8**
Carbon dioxide	3.3-5.3	3.4-4.5	3.1*-5.1	3.2-5.1	3.3-3.8
Total Alkalinity	122.73-130.42**	122.76-129.82	121.48-128.92	121.30-129.24	122.54-130.23
Total Hardness	72.65-79.75	72.30-80.22	72.62-79.67	72.56-79.56	74.51-80.23**
Nitrate-N	1.66-1.85	1.55-1.96	1.31*-1.86	1.60-1.95	1.60-1.95
Phosphate	1.74-2.83	1.76-3.12	1.74-2.82	1.73*-1.84	1.86-3.15**
pH (No unit)	7.3-8.3**	7.3-7.7	7.3-7.7	7.3-7.5	7.6-8.2

(* Minimum value between the stations; ** Maximum value between the stations; Units other than mentioned are in mg/l)

Table 3. Month-wise variation in the physicochemical parameters of Hasanpur Barahi chaur

	Sept.	Nov.	Jan.	Mar.	May
Air temp. (°C)	27.3-30.6	25.5-28.7	24.5*-27.6	25.3-29.5	29.5-34.8**
Water temp. (°C)	25.7-28.5	23.5-26.8	22.5*-24.8	23.5-27.5	27.5-31.6**
Dissolved oxygen	4.1-6.7	5.3-7.8**	4.0*-6.1	5.2-6.6	5.5-7.5
Carbon dioxide	3.4-5.3	3.1*-3.5	3.8-5.4**	3.3-4.0	3.3-3.8
Total Alkalinity	123.26-127.46	121.49-126.51	120.66*-122.73	122.31-124.45	125.44-129.23
Total Hardness	73.62-75.11	71.50-77.50	51.48*-74.51	73.11-75.63	75.65-78.65
Nitrate-N	1.33-2.96**	1.62-2.93	1.85-2.95	1.31*-2.91	1.71-2.88
Phosphate	1.75-1.93	1.74-1.96	1.73*-1.88	1.77-1.95	1.76-2.07
pH (No unit)	7.1-7.5	7.2-7.7	6.4*-7.6	7.2-7.6	7.3-7.7

(* Minimum value between the stations; ** Maximum value between the stations; Units other than mentioned are in mg/l)

Phytoplankton variations

Phytoplankton occupy the base of any aquatic trophic web and considered as primary producers. In present study, total 50 genera of phytoplankton were identified. It included 24 genera of Chlorophyceae, Bacillariophyceae, 11 genera of Cyanophyceae, 2 genera of Euglenophyceae and 1 genus of Dinophyceae.

Abundance of group

Chlorophyceae > Bacillariophyceae > Cyanophyceae > Euglenophyceae > Dinophyceae

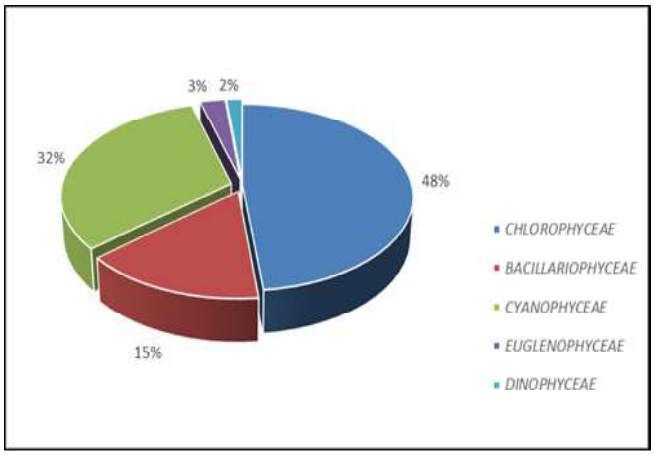

Fig.1. Percentage composition of phytoplankton group

Analysis of group-wise contribution of phytoplankton showed that Chlorophyceae formed 48%, Cyanophyceae 32%, Bacillariophyceae 15%, Euglenophyceae 3% and Dinophyceae 2% of total phytoplankton recorded (Fig.1.).

Zooplankton variations

In any aquatic food web, zooplankton occupy the place next to the base of trophic level (primary producers) and they are considered as primary consumers or secondary producers. In the present study, total 13 genera of zooplankton were identified. It included 6 genera of Rotifera, 4 genera of Cladocera and 3 genera of Copepoda.

Abundance of family

Rotifera > Cladocera > Copepoda

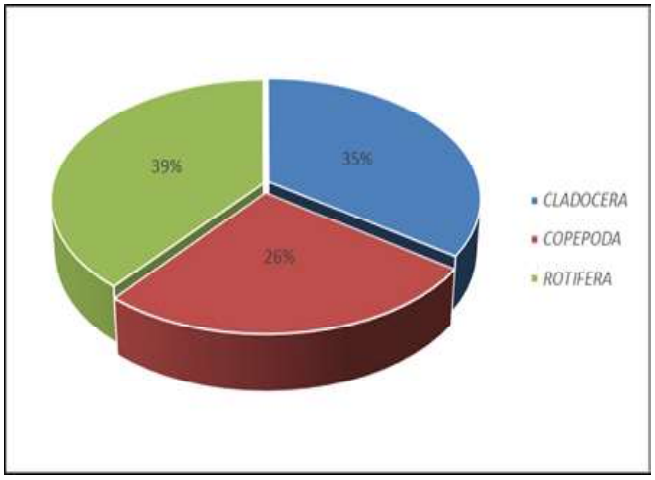

Fig.2. Percentage composition of zooplankton group

Analysis of group-wise composition of zooplankton showed that Rotifera formed 39%, Cladocera 35% and Copepoda 26% of total zooplankton recorded (Fig.2).

Interaction between selected physicochemical water parameters and plankton

The correlation matrix between selected physicochemical parameters and plankton of the Hasanpur Barahi chaur showed a significant correlation (Table 4.1). A significant positive correlation between CO_2, nitrate and phytoplankton is evident from the data. The groups like Dinophyceae, Euglenophyceae and Cyanophyceae showed a significant and positive correlation with phosphorus. Similarly, zooplankton also showed significantly positive correlation with nitrate. A different phenomenon was noticed for Significant positive correlation was also obtained the correlation between Cladocera and Cyanophyceae; with dissolved oxygen, total alkalinity, total hardness and pH. These water quality parameters showed a significant positive correlation with abundance of Cladocera and cyanophyceanplankters.

DISCUSSION

Overall water quality parameters (Temperature, DO, CO_2, TH, TA, Nitrite, Nitrate, Phosphate and pH) were found in the limits suggested for aquaculture practices except few station like STN 1, 4, and 5 shown poor water quality, this may be due to domestic sewage and organic matter load released from local communities. According to Saini *et al.* (2015) the DO level at the five sampling stations along the Narmada River near Bargi reservoir fluctuated between 3.1-6.5 mg/l and lower value recorded in summer months. Similarly, Ubarhande (2018) reported that dissolved oxygen concentration was varied from 3.5-8.95 mg/l in Vishnupuri reservoir, Nanded, Maharashtra (India). The concentration of free carbon dioxide in Hasanpur Barahi chaur was varied from 3.1-5.4 mg/l. Similar findings reported by other researchers where the values ranged between 1.75- 5.81mg/l (Bora and Biswas, 2015), 3.33- 9.66 mg/l (Bera *et al*., 2014). It was noticed that at station 1 and at station 4, the values were comparatively higher than other stations which showed visual signs of pollution with high organic load and weed infestation. Observed pH value in Hasanpur Barahi chaur fluctuated between 6.4-8.3 during different sampling periods. This may be due to inherent characteristics of the soil and geology of Hasanpur Barahi chaur.

In the present study, total 50 genera of phytoplankton were identified. It included 24 genera of Chlorophyceae, 12 genera of Bacillariophyceae, 11 genera of Cyanophyceae, 2 genera of Euglenophyceae and 1 genera of

Dinophyceae. Similar finding was reported by Ratheesh *et al.* (2012) that is total 34 genera of phytoplankters belonging to Chlorophyceae (16 genera), Bacillariophyceae (7 genera), Dinophyceae (1 genus), Euglenophyceae (2 genera) and Cyanophyceae (8 genera) were observed in Powai Lake. According to Rasal *et al.* (2019) a total of 54 genera were identified from Bargi Dam (Narmada River). Which included 16 genera of Bacillariophyceae, 21 genera of Chlorophyceae and 10 genera of Cyanophyceae, 2 genera by each of Chrysophyceae and Euglenophyceae, whereas 3 genera of Dinophyceae group. Sharma *et al.* (2011) also reported that a total of 14 genera belonging to Bacillariophyceae (5 genera), Cyanophyceae (8 genera) and Euglenophyceae (1 genera) at Dograwadaghat in river Narmada.

The phytoplankton abundance shows sharp increase from January to April (pre-monsoon) with Chlorophyceae as the most dominant group and Euglenophyceae as the least dominant. This variation in phytoplankton number (high in summer and low in winter) may be due to high temperature. A positive correlation was noticed between temperature and phytoplankton in Hasanpur Barahi chaur.

According to Khare (2005) there was a significant correlation between plankton density and temperature, DO, phosphate and nitrate, respectively. Several researchers have suggested that water temperature plays a pivotal role in algal growth (Ramkrishnaiah and Sarkar, 1982; Verma and Datta Munshi, 1987; Kaushik *et al.,* 1991; Bohra and Kumar, 1999).

In present the study, total 13 genera of zooplankton were identified. It included 6 genera of Rotifers, 4 genera of Cladocerans and 3 genera of Copepods. Similar findings were reported by several researchers Rotifers > Cladocerans > Copepods > Ostracods by Dhanasekaran *et al.* (2017). According to Devi *et al.* (2013) total 17 species of zooplankton identified from temple pond in Virudhunagar Tamil Nadu belonging to four major groups (10 species of Rotifera, 3 species each of Cladocera and Copepoda and 1 species of Ostracoda).

All group of zooplankton showed very low abundance during monsoon, however, there was an increase in abundance during pre-monsoon, thehighest level of zooplankton abundance was evident during post-monsoon months. Similar findings reported by Majagi and Vijaykumar (2009), validated that composition of Rotifera population showed higher number during north-east monsoon and summer period, while, it was lower during the month of August. They concluded that this may be due to high organic load, especially dead or decaying vegetation and higher bacterial population. The lowest population noticed in south west monsoon period, concluded this may be due to influence of profuse quantity of rainwater and leads to turbidity, which gets drained into the reservoir.

The data of the present study shows that the water quality of Hasanpur Barahi chaur is good for aquaculture practices except few stations. But its water quality deteriorating due to high human interferences, pushing this ecosystem towards the process of eutrophication. The findings provide an evidence for the intensified efforts for controlling the discharge of sewage, domestic wastewater and pollutants from various point and non-point sources especially from the thickly populated areas nearby this reservoir. The data and information presented in this paper will serve as a baseline data for further investigations, comparing the future changes in this reservoir and to conserve this ecosystem.

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