

RESEARCH ARTICLE



Seasonal variations of zooplankton diversity in fresh water reservoir of West Bengal, India

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Abstract

Background/Objective: Present study was carried out to identify zooplankton density at Baburpukur pond along with physicochemical properties. In India. Planktonic richness reflects the biodiversity stock. The present study assumes greater importance for biodiversity conservation/ pollution indicator and aquaculture of fish and prawns. **Methods/Statistical analysis:** Statistical analysis in this experiment was performed by Student's t-test. In this test, 0.05 probability, degree of freedom, critical t-value, and calculated t-values were recorded. Here zooplankton number along with physico-chemical parameters was recorded. From these t-values, significant seasonal variations were found in the respective water body. The zooplankton density and physicochemical parameters were recorded during the period of Jun 2018 to February 2020. Diversity of zooplankton has been counted using Sedgwick-Rafter counting chamber. **Findings:** Four different species of zooplankton were studied such as *Daphnia*, *Cyclops*, *Cypris* and *Brachionus*. Zooplankton community structure generally changes with temperature, pH of water, free CO₂ level, dissolved O₂. This study also reveals that zooplanktons have their own peak periods of density which is influenced by the above environmental conditions. **Application:** At present, this water reservoir is suitable for fish culturing. So several management practices are necessary to conserve this zooplankton density for proper healthy situation of water body. This study is also helpful in understanding the zooplankton diversity of Baburpukur Pond with proper maintaining of aquaculture.

Keywords: Zooplankton; biodiversity conservation; pollution indicator; aquaculture

1 Introduction

Presence of zooplankton in water body helps to increase economically important fish populations and they play a major role in energy transfer between phytoplankton and fish⁽¹⁾. The study of freshwater zooplankton fauna is wide

and complicated process because physical, geographical, environmental and some chemical indicators influence their existence⁽²⁾. Because they live in freshwater, these freshwater habitats are among the most threatened ecosystem of Earth⁽³⁾, and majority of these losses comes from anthropogenic activities. Zooplankton diversity is also influenced by the presence of phytoplankton for outcome of nutrients for better survival in aquatic life. Zooplanktons feed on phytoplanktons and facilitate the conversion of plant substance into animal tissue and in turn constitute the basic food for higher animals including fishes, particularly their larvae. Many bigger forms of zooplankton feed on their own smaller community and thus forms secondary consumers, some of them are organic substance feeder lying on the bottom sediment⁽⁴⁾ and many others demonstrated that zooplankton study of any water body establishes the present health status of that region. Fluctuations in zooplankton community composition and species diversity can indicate their distribution in any environment; it also acts as an indicator of ecological state of water body related to changes in nutrient concentration and climatic conditions^(5,6). If the habitat of zooplankton community changes with the relative environmental conditions, there is a corresponding change in their population number, so they are used as monitoring tool in any aquatic ecosystem and acts as an important ecological indicator^(7,8). Due to their central position in the food web of aquatic ecosystem, several researchers around the world are attracted to study their role in the ecosystem⁽⁹⁾. So understanding their various roles and predicting future changes in the ecosystem are becoming increasingly important area⁽¹⁰⁾. Throughout India a number of studies have been carried out about the ecological conditions of freshwater bodies⁽¹¹⁻¹³⁾. The present investigation is an attempt to identify zooplankton density with physico-chemical parameters of the Baburpukur pond.

2 Methodology

2.1 Study area

The Baburpukur (23° 15'35.9172"N and 87° 52'34.7520"E) pond is located in Burdwan town, West Bengal, India, near Sishuniketan School. The temperature of water was also recorded. The total area of the pond is about 0.20 hectare and average depth is 7 m. The pond is surrounded by some trees and walking path. During monsoon, it is filled up with rain water. A part of pond is regularly used for dumping domestic wastes and it is regularly used for bathing.

2.1.2 Sampling time

Zooplankton samples were collected for a period of July 2018 to February 2020 from the pond between 5.30 a.m. to 8.30 a.m. For quantitative analysis of zooplankton, 100 L of pond water were filtered through zooplankton net (mesh size 60-75 μ m) and then plankton biomasses were transferred to the specimen bottles (preserved with 5% freshly prepared formalin). Other fixatives occasionally used are picric acid, ethanol, acetic acid etc. These were then taken to the laboratory and separated group wise using a dissecting microscope and then the specimens were mounted on microscopic slides on a drop of 20% glycerin after staining with eosin.

2.1.3 Identification of zooplankton sample

For proper identification of zooplankton, 1 ml of zooplankton sample was taken and poured into Sedgwick-Rafter counting chamber, allowed to settle sometime and observed under light microscope with proper magnification (such as X10, X40). Zooplankton were identified by referring the standard manuals and textbooks⁽¹⁴⁻¹⁸⁾.

2.1.4 Analysis of parameter

1. Temperature of reservoir – Measured by thermometer
2. PH of the water – Measured by digital pH meter
3. Free CO₂ level of water– Estimated by APHA method
4. Dissolved O₂ - Estimated by Winkler's method

2.1.5 Statistical Analysis

Statistical analysis was performed by 'Student's t-test'. In this test, 0.05 probability, degree of freedom, critical t-value, and calculated t-values were recorded. Here zooplankton densities along with physico-chemical parameters were observed. From these t-values, significant seasonal variations were found in the respective water body. In this experiment, at 0.05 probabilities with degree of freedom 3, critical t-value is 3.84, calculated t-values between the two month of each season are: July'18-Aug'18: calculated t-value is 0.67, null hypothesis is accepted; Apr'19-May'19: calculated t-value is 1.116, null hypothesis is accepted; Dec'19-Jan'20: calculated t-value is 0.81, null hypothesis is accepted. Here calculated t-values in every season are less than critical t-value, so null hypothesis is accepted. Thus there is no significant change of zooplankton diversity found in a particular season. But when data was compared between two seasons at 0.05 probabilities, degree of freedom 3.84, then calculated t-values between two seasons are as follows: in monsoon-winter season: Calculated t-value is 8.527, so it rejects null hypothesis; in Post-monsoon - winter season: Calculated t-value is 7.35, so it also rejects null hypothesis. Thus when data were compared according to season wise, it is found that calculated t-value is higher than the critical t-value. So it rejects the Null hypothesis and accepts the alternative hypothesis. From the analysis of t-test, it is concluded that the number of zooplankton significantly varies from season to season along with the change of parameters like temperature, pH, dissolved O₂ and free CO₂ level of the pond.

3 Results and Discussions

In the present investigation at Baburpukur, generally four different numbers of species of zooplankton such as *Daphnia*, *Cyclops*, *Cypris* and *Brachionus* were recorded. Quantitative analysis of zooplankton with physicochemical properties (temperature of reservoir, pH of water, free CO₂ level of water and dissolved O₂ of the water body) indicates that the abundance of zooplankton number and it greatly changes accordingly with the particular season. The physicochemical parameters were represented in Table 1 and the diversity of zooplankton species were represented in Table 2. In the present study, it is found that zooplankton population density greatly varies with the physiochemical parameters of the water body. It is also found that seasonal variations have an important role in the fluctuations of physicochemical parameters of Baburpukur. The physicochemical parameters and nutrient pattern play an important role in the species composition and distribution of plankton^(19,20). From the present study it is estimated that zooplankton composition greatly depends on the physicochemical parameters.

Table 1. Monthly variation of physicochemical parameters of Baburpukur

Parameters	Jul-18	Aug-18	Sept-18	Mar-19	Apr-19	May-19	Dec-19	Jan-20	Feb-20
Temperature of water(0 ⁰ C)	30	28°C	21°C	25°C	29°C	35°C	12°C	10°C	13°C
pH of water	7.0	7.0	7.1	6.9	6.8	6.7	7.0	7.2	7.1
Dissolved O ₂ (mg/l)	6.58	6.24	6.15	6.60	6.62	6.64	5.24	5.07	5.97
Free CO ₂ (mg/l)	25.43	25.80	24.7	25.87	25.9	26.7	23.9	23.14	24.12

Table 2. Monthly and seasonal abundance of zooplankton at Baburpukur

Zooplankton Species	Jul-18	Aug-18	Sept-18	Mar-19	Apr-19	May-19	Dec-19	Jan-20	Feb-20
<i>Daphnia</i>	24	19	19	21	23	29	17	15	18
<i>Cyclops</i>	20	21	17	18	19	25	15	14	16
<i>Cypris</i>	18	17	15	22	25	21	14	13	15
<i>Brachionus</i>	15	16	12	07	09	12	09	09	10
Total No	77	73	63	68	76	86	55	51	59

The correlation between number of zooplankton species and temperature is presented here. Physiological, metabolic activities and distribution of aquatic organisms generally depends on water temperature^(21–23). The number of zooplankton increases significantly with the increasing temperature. In winter season, when the temperature of water

body is 10°C, the total number of zooplankton is 51/100ml of water. But in summer season, when the water temperature raised up to the level of 35°C, the total number of zooplankton also increases to 86/100ml of water. It suggests that higher temperature helps to increase the number of zooplankton species of this water body.

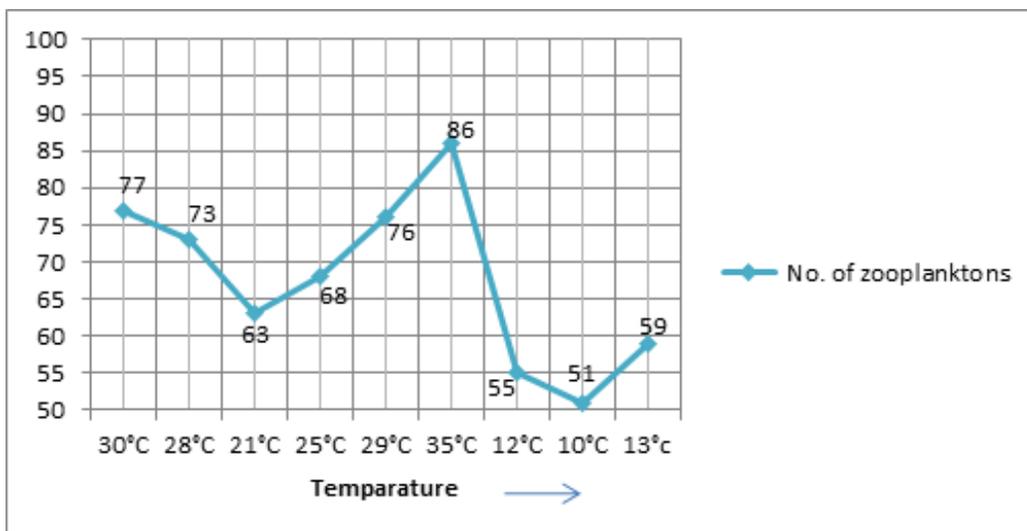


Fig 1. Effect of temperature on zooplankton density

In case of pH, zooplankton number is highest when the pH is low; in May'2019 when the pH of water is 6.7 the total zooplankton is 86/100ml of water but in January'2020 when the pH of water is 7.2, then the number of total zooplankton is 51/100ml of water. So the change of pH in the water body is significantly affecting the density of zooplankton population. Maximum pH in any condition increases photosynthesis due to high temperature resulting in higher consumption of carbon dioxide in the pond ecosystem⁽²⁴⁾. In this experiment we also found high pH decreases the zooplankton density.

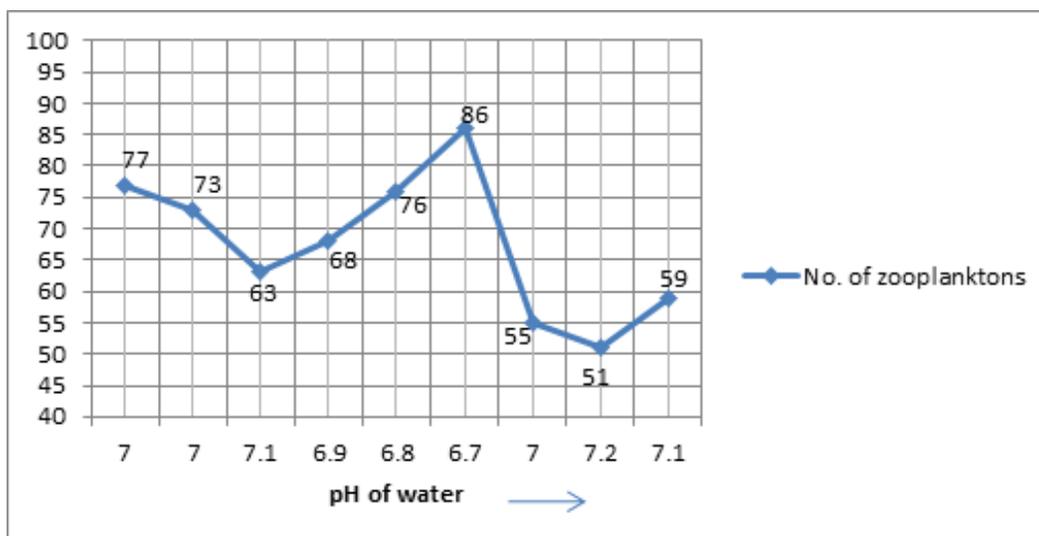


Fig 2. Effect of pH on zooplankton density

The value of free CO₂ in this experiment ranged between 23.9mg/l to 26.7mg/l. The maximum free CO₂ was recorded generally in summer and minimum was recorded in winter⁽²⁵⁾. It suggested that maximum CO₂ concen-

tration is in the month of March. It was also noticed that free CO₂ level of water plays an important role in zooplankton density. With the higher level of free CO₂, as in the month of May, 2019, the number of zooplankton is high, i.e. 86/100ml of sample; but in January, 2020, at 23.14mg/l of free CO₂ concentration, the number of zooplankton is 51/100ml of sample. So from this data it was found that high CO₂ concentration in the water body helps to increase the zooplankton density.

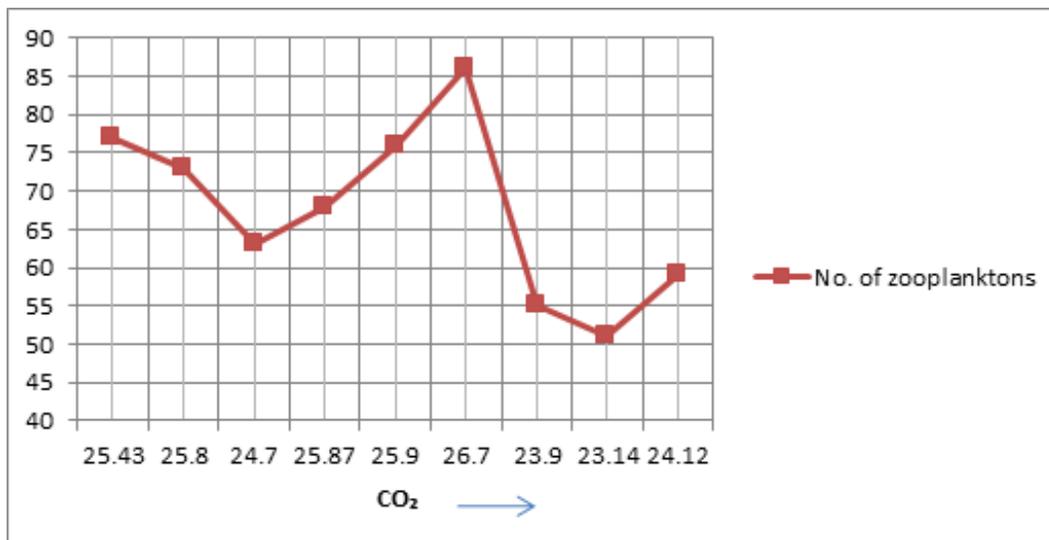


Fig 3. Effect of carbon dioxide on zooplankton density

In case of dissolved O₂ level which indicates water quality and diversity of living organisms, it was found that in summer May'2019 the total zooplankton number is 86/100ml of sample where dissolved O₂ is the highest, 6.64mg/100ml but in Jan' 2020, O₂ level is 5.07mg/100ml and the total number of zooplankton species is 51/100ml of sample. So, it is found that zooplankton number is proportional to the dissolved O₂ level. The minimum value of dissolved oxygen was found in the month of January and maximum in the month of May⁽²⁶⁾.

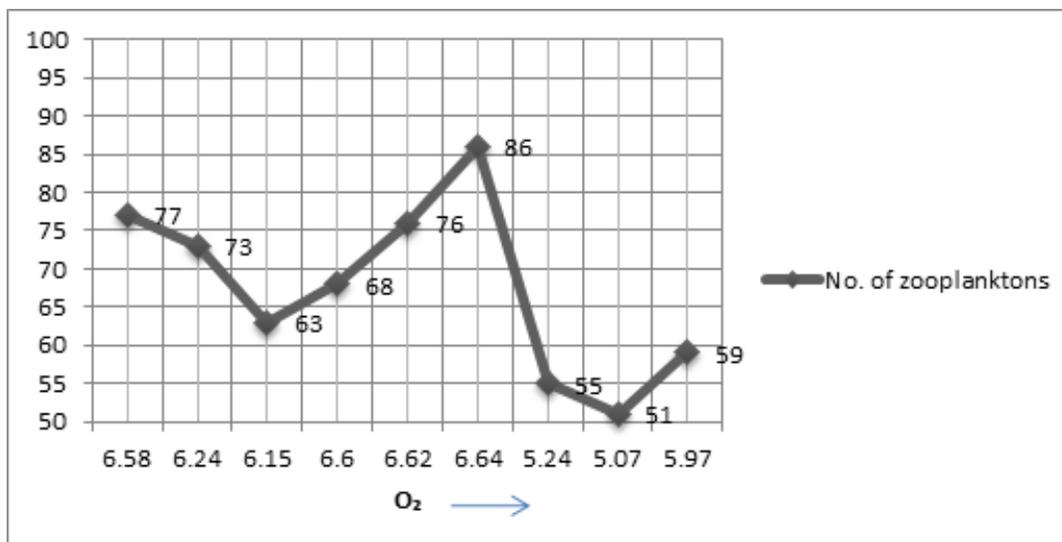


Fig 4. Effect of dissolve O₂ on zooplankton density

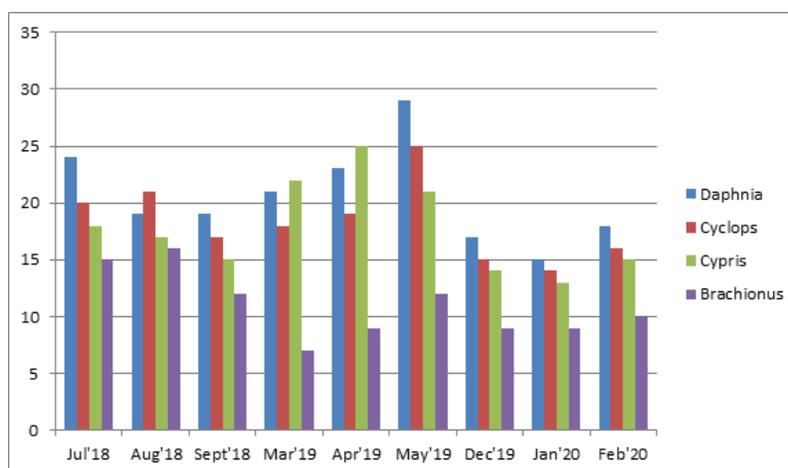


Fig 5. Seasonal variation of zooplankton species at Baburpukur, West Bengal

From the present study it was found that in the summer months, zooplankton density was generally high because of the favorable environmental conditions and also availability of nutrients in the pond ecosystem. High nutrient enrichment helps to increase the number of phytoplankton which ultimately increases zooplankton density⁽²⁷⁾. From the present study it was found that increased temperature also increased the rate of evaporation, photosynthesis and ultimately more nutrient concentration in the water body which accelerates zooplankton density but when temperature falls, zooplankton density also decreases. At present this water reservoir is suitable for fish culturing. If zooplankton number falls, then food chain of total pond ecosystem will diminish. So several management practices are necessary to conserve this zooplankton density for proper healthy situation of water body. Recently several DNA-based methods have been invented for proper identification of zooplankton species and their density in freshwater ecosystem⁽²⁸⁾. Zooplankton diversity is also considered to be strategic component of freshwater aquatic ecosystem and it maintains aquatic food webs⁽²⁹⁾. This study is helpful in understanding the zooplankton diversity of Baburpukur Pond with proper maintenance of aquaculture. Limitations of the present study: Zooplankton may exist in a wide range of environmental conditions but temperature, pH, dissolved O₂ and free Carbon dioxide level of water are the limiting factors. The number of zooplankton in freshwaters is continuously changing in space and time. This changing pattern ultimately makes it difficult to estimate their abundance in the collected samples.

4 Conclusion

Zooplankton density was observed to peak during summers but it was least during monsoons. But during rainy season, the sudden fall of temperature and mineral dilution decreases their numbers^(30–32). In aquatic ecosystems, zooplankton plays an important role not only converting plant material to animal food but also acts as a food source for higher organisms. The zooplankton density of this habitat was found to be dominated by *Daphnia* followed by *Cyclops*, *Cypris* and *Brachionus*. The highest zooplankton number in the month of summer may be due to phytoplankton increase, decaying vegetation and also increased level of organic matter in the water body. In the future study, complete biotic enumeration would help in understanding the interplay of zooplankton, phytoplankton and abiotic factor for preserving aquatic biodiversity. Therefore, the present investigation on quantitative analyses of zooplankton in this aquatic ecosystem is the first step towards this direction.

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