



A comparative study on zooplankton abundance in a polluted and a non-polluted pond in Suri-I development block, Birbhum, West Bengal

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Abstract

Biological or Biochemical oxygen demand (BOD) indicates water pollution status. BOD of a polluted municipal and a non-polluted village pond was measured for six months from January 2024 to June 2024 in Suri I Development block of Birbhum district. Higher BOD₅ indicates polluted water of municipality area pond and lower BOD₅ indicates village pond water is least polluted. Zooplankton density was found higher in non-polluted pond and considerably lowers in polluted pond in the study period. Rotifer, cladoceran and copepod zooplanktons were counted in the two study ponds. The t-value (0.05 significance level; df-10) of zooplankton sample of two ponds was 4.387 which is higher than critical t-value of 2.228 indicating inverse impact of water pollution on zooplankton abundance and density. There was found strong negative correlation between BOD and zooplankton density in both ponds. Zooplankton can serve as good bio indicator of water pollution.

Keywords: Birbhum, BOD, bio indicator, water pollution, zooplankton

Introduction

Zooplanktons constitute the major trophic level in aquatic food chain. Large variety of zooplankton is found in fresh water ponds in India. Kumar *et al.* (2010) [15] and Majumder *et al.* (2018) [16] performed limnological study and zooplankton diversity in several fresh water ponds. Zooplanktons are included under Rotifera, Crustacea and Protozoa (Battish, 1992 [9]; Altaff, 2004[4]). They serve as primary consumer feeding on phytoplankton which are autotrophs and fix energy in food through photosynthesis. Different aquatic animals consume zooplankton as their food and hence survival of such organisms largely depends upon abundance of zooplankton as there are no or very less alternatives of food items to be consumed (Shao *et al.* 2019) [25]. So richness of species or species diversity in aquatic system is determined by zooplankton population. Zooplanktons thrive well in favorable conditions of different physical and chemical parameters (Poongodi *et al.*, 2009 [19], Rajagopal *et al.*, 2010 [21]). In polluted water there is often source of composite effluents and these parameters are not expected to present in normal range (Mukhopadhyay *et al.*, 2007)[23]. Hence such contaminated water does not favour perfect plankton growth. Water in non-polluted pond is less turbid but higher in polluted pond that also affect growth of phytoplankton and zooplankton (Hart, 1990) [12]. Extent of water pollution is measured through biochemical oxygen demand or BOD. Dissolved oxygen (DO) content of water sample on sample collection time and on 5th day can be measured by different standard process (Choi *et al.*, 2012) [11]. From the difference value BOD₅ is obtained in mg/L unit. If there is more organic waste in pond water this is degraded and this process consumes oxygen and hence DO content lowers and BOD increases. Therefore BOD measurement is a standard procedure in determining pollution level of pond water that mostly caused by dead organic matter of plant and animal origin and also organic content rich effluents (Aziz and Tebbut 1980) [6]. Bath and Singh(1998) [8] observed that urban ponds are mostly polluted. Ahamad *et al.* (2011) [3] and Adhikari, Goswami, Mukhopadhyay (2017) [2] observed urban pond water

pollution through municipal sewage. Some plankton species can withstand higher BOD level (>30mg/L) and some species can not (Sousa *et al.* 2019) [26]. Therefore we can expect a higher zooplankton diversity in pond water with relatively low BOD₅ level (<10mg/L). A rich zooplankton density favours growth of animals of higher trophic level that ultimately make benefit in farming of some fish species that consume zooplanktons [25, 29]. Zooplankton density again depends upon growth of phytoplankton species. Their growth is accelerated in favorable physical and chemical parameters and oxygen is produced during their photosynthetic activity. More dissolved CO₂ causes more food and oxygen production and therefore more number of zooplanktons appear in the pond. If the rate of oxygen depletion surpasses rate of oxygen production then problem arises and the total phenomenon shifts to unfavourable to both phytoplankton and zooplankton growth [18]. DO is naturally used by all heterotroph biota living in the pond and this is balanced by production during photosynthesis of aquatic micro and macrophytes. But if there is organic waste mixed in pond from external source and also dead organisms of that pond consume much DO for decomposition and hence DO content depletes (Sarkar and Chowdhury, 1999) [24]. BOD is increased in this situation. Pond with eutrophication has less plankton diversity but may be with satisfactory zooplankton count as this higher nutritional level or trophic condition favours phytoplankton growth and some particular species of zooplankton thrive well and their density increases [1, 22, 27]. Makrushim (1976) [17] stated earlier that cladoceran density is an important indicator of water pollution. Rural ponds are less prone to be polluted but chemical organic fertilizer can be mixed from agricultural land run off and this may affect plankton abundance and diversity (Terziyski *et al.* 2007) [28].

Material and method

1. Selection of study site

A pond of Suri municipality at New Dangan Para or urban pond [23.9023N, 87.5241E] and a rural pond from Bhurkuna village [23.8265N, 87.5026E] of Suri-I

Development block of Birbhum district of West Bengal are selected for study (Figure 1). There is drainage system towards Pond 1 for domestic and municipal sewage mainly of households but no such contamination in Pond 2 that is located far from domestic habitat. Pond 1 has a size of about 1200 square meter with maximum water depth not more than two meters whereas Pond 2 has a size over 2000 square meter and maximum water depth more than two meters

during the study period that will certainly increase in monsoon months(August, September). Water is taken out for irrigation purpose in farming season from Pond 2 and there is chance of contamination by agricultural run-off containing insecticides and chemical fertilizers but not reported during study period. However this contamination may not have greater impact in polluting the water.

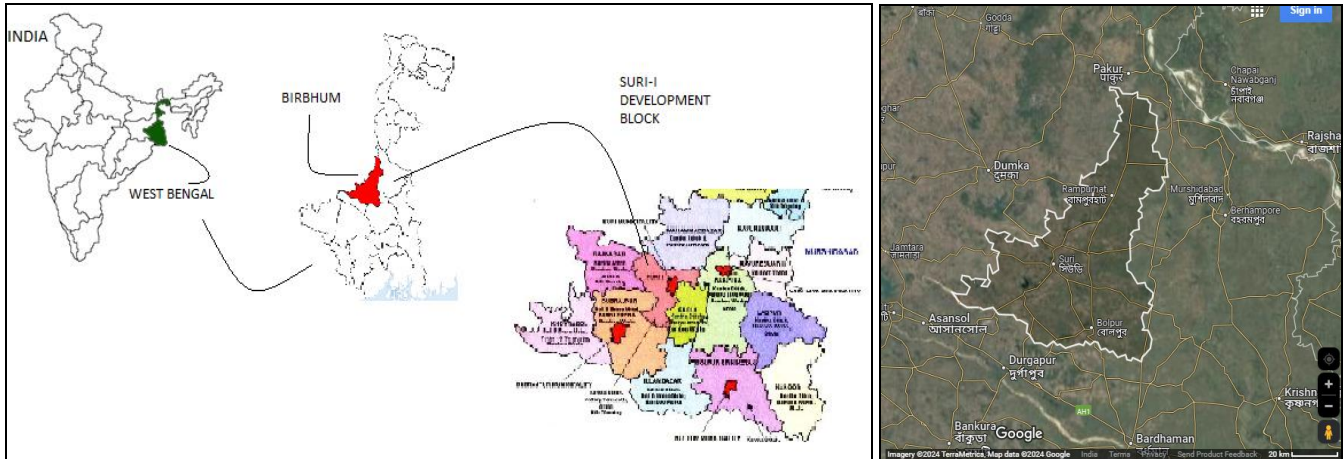


Fig 1: Location of Suri I block of Birbhum district, West Bengal (Courtesy Google Map)

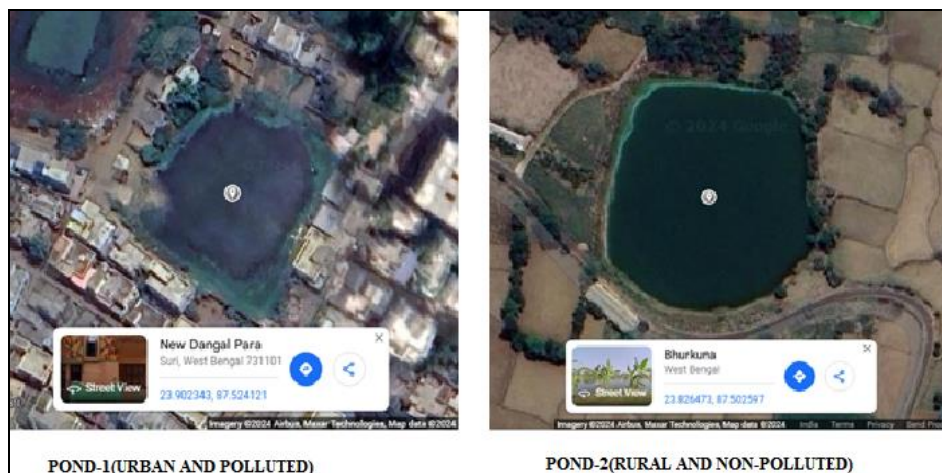


Fig 2: Study ponds from Suri municipality (Pond 1) and from Bhurkuna village (Pond 2) [Courtesy Google Earth]

2. Sample collection and counting

Water sample was collected same day from both ponds between 8 am to 9 am on fortnight basis in every month. This is possible as the two sites are located only of 7 km distance. Zooplankton was strained out from water collected in 10 liter size bucket randomly at five different sites of the pond by and then zooplanktons were strained out by plankton net with mesh size of 50 micron. They were kept in several bottles, preserved in 0.3% Formalin solution and taken to laboratory for microscopic observation and counting by Sedgwick-Rafter counting slide and presented in count/L unit.

3. BOD estimation

Dissolved oxygen (DO) in water sample is measured on the study site in Oxygen meter (Lutron DO-5510). Then the sample water is put in BOD bottle of 300mL size. This is left in laboratory for five days allowing decomposition of organic content present in water. On the 5th day DO is again measured in Oxygen meter. Some amount of oxygen will be

used for decomposition of organic contamination of collected sample. From difference of DO content on first and fifth day BOD₅ is obtained.

4. Data analysis

Data analysis was performed by statistical method. Correlation between zooplankton density and BOD was measured through Student's t-test at 95% (0.95) probability level or 5% (0.05) significance level. As there are two sets of sample one for urban ($n_1=6$) and another for rural pond ($n_2=6$) degree of freedom (df) is 10 [$df=(n_1+n_2)-2$]. Table value of two tailed t-test is 2.228 at 5% significance level and $df = 10$. If calculated t value exceeds this critical table value therefore it is said that a significant difference is present between mean of two set of data sample that is caused by different parameters affecting the sample.

Result and discussion

Abundance and diversity of zooplankton differ in polluted and non-polluted pond as found in the study with respect to

BOD presented in Table 1 and Table 2. It is found that abundance of zooplankton is higher in non-polluted pond than polluted pond throughout the study period. This means most kind of zooplankton species can thrive well in lesser or non-polluted water. In the present study three groups of zooplankton were studied from urban and rural pond marked for study. In Figure 3, relative number of zooplankton counted per liter of water sample using Sedgwick-Rafter counting slide from polluted and non-polluted ponds are presented that shows positive skewness of zooplankton abundance towards organic contamination free pond water i.e lower BOD. To measure correlation between BOD and abundance of zooplankton Students t-test is performed using zooplankton count in polluted and non-polluted pond as sample size is less than 30(here $n_1+n_2=12$). In Table 3 calculation of t-test has been shown for study of

significance of mean difference of zooplankton sample sets of two ponds. Calculated t-value at 5% significance level of the two sets of samples collected from two kinds of ponds is 4.387. This value is higher than Table value of t (2.228) that indicates significant difference between means of two sample sets. This difference is due to pollution level of the two study ponds. There are other physical and chemical parameters (Kar, 2018) [13] also but I have concentrate my view on whether pollution level of water has an impact on abundance and density of zooplankton. Correlation value (r) between BOD and abundance of zooplankton in both ponds are strongly negative. Correlation value in case of polluted pond is (-0.99) and in non-polluted pond is (-0.93). Therefore abundance of total zooplankton is inversely related to extent of pollution that is presented through BOD measurement.

Table 1: Month-wise BOD and Zooplankton density in Polluted pond

Month of Study	Sample Volume(ml)	Dilution water and Sample(ml)	Dilution Factor(DF)	DO on Day 1 in mg/L(D ₁)	DO on Day 5 In mg/L(D ₅)	(D ₁ -D ₅)	BOD=(D ₁ -D ₅)x DF (mg/L)	Total number of Zooplanktons per liter of water sample	Correlation value(R) between BOD and Zooplankton density
January 2024	15	300	300/15=20	12.85	9.12	3.73	74.6	253	-0.99 (Strong negative correlation)
February 2024	15	300	300/15=20	12.27	8.31	3.96	79.2	238	
March 2024	15	300	300/15=20	10.94	6.86	4.08	81.6	217	
April 2024	15	300	300/15=20	10.38	6.08	4.30	86.0	184	
May 2024	15	300	300/15=20	9.81	4.93	4.88	97.6	143	
June 2024	15	300	300/15=20	9.16	4.22	4.94	98.8	132	
Mean				10.85	6.4		86	194.5	
SD				1.297	1.741		9.237	45.624	

Table 2: Month-wise BOD and Zooplankton density in Non-polluted pond

Month of Study	Sample Volume(ml)	Dilution water+ Sample Vol(ml)	Dilution Factor(DF)	DO on Day 1 in mg/L(D ₁)	DO on Day 5 In mg/L(D ₅)	(D ₁ -D ₅)	BOD=(D ₁ -D ₅)x DF (mg/L)	Total number of Zooplanktons per liter of water sample	Correlation value(R) between BOD and Zooplankton density
January 2024	15	300	300/15=20	14.16	14.09	0.07	1.4	347	-0.93 (Strong negative correlation)
February 2024	15	300	300/15=20	13.94	13.86	0.08	1.6	336	
March 2024	15	300	300/15=20	13.51	13.38	0.13	2.6	324	
April 2024	15	300	300/15=20	10.90	10.74	0.16	3.2	297	
May 2024	15	300	300/15=20	10.11	9.94	0.17	3.4	265	
June 2024	15	300	300/15=20	9.12	8.95	0.17	3.4	262	
Mean				11.96	11.83		2.6	305.16	
SD				1.91	2.03		0.82	33.16	

Table 3: Study of significance of mean difference of Zooplankton sample of Polluted and Non- polluted ponds

Month of Study	Zooplankton density of Polluted pond (Count/L)	Zooplankton density of Polluted pond (Count/L)	Independent 2-tailed t-value ($\alpha=0.05;df=10$)	Table value	Comment
January 2024	253	347	4.387	2.228	Significant difference* between the two means of the samples
February 2024	238	336			
March 2024	217	324			
April 2024	184	297			
May 2024	143	265			
June 2024	132	262			
MEAN	194.5	305.16			

[* The difference is due to water quality of the two ponds]

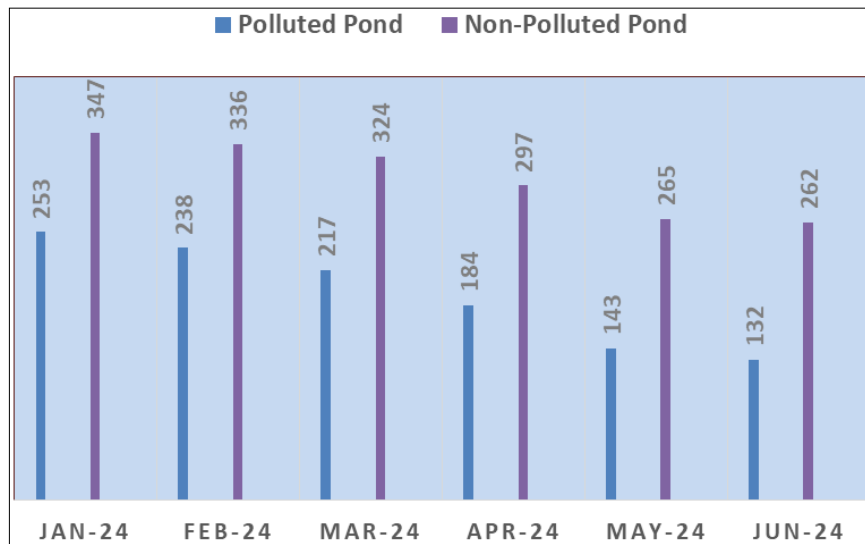


Fig 3: Month-wise comparison of Zooplankton count in polluted and non-polluted pond

Conclusion

From this study it is found that zooplankton abundance decreases toward increase of BOD. BOD has been taken as important index of water pollution level estimation. Most pollutant contents are dead organic matter in lentic water bodies including ponds. Hence oxygen is deliberately consumed for degradation of organic content of water. Phytoplankton species have sufficient CO₂ to make food and also water is nutrient rich favoring their growth but number of zooplankton decreases and hence phytoplankton are not consumed by zooplankton. So death of excess phytoplankton deteriorates the water quality more and even algal bloom occurs. More study however is required whether some species can tolerate the higher BOD level and thrive well in polluted pond water.

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