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Establishment of Significant Correlation between Seasonal Physicochemical parameters and Zooplankton Diversity in Saheb Bandh, at Purulia, West Bengal

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Abstract— In the aquatic ecosystem, zooplankton plays a crucial role. Its distribution and assortment, however, are driven by several physicochemical parameters in an association. The present study, on the zooplankton community, was carried out between March 2021 to February 2022 for one year at the Saheb Bandh, Purulia West Bengal, to unveil the critical association between zooplankton and physicochemical parameters. For this purpose, Water samples were also tested for zooplankton community composition and density. The parameters correlated positively with several zooplankton groups. A variety of physicochemical characteristics were measured for the water samples. Totally 4 taxonomic groups of zooplankton were identified from Saheb Bandh, Purulia (Rotifera, Cladocera, Copepoda, and Ostracoda). A total of 25 taxa were recorded (Rotifera 10, Cladocera7, Copepods 5 and Ostracoda 3). Among the Rotiferans, *Branchionus sp*, and *Keratella sp*, etc. species; among the Cladocerans, *Daphnia sp*, *Moina sp*, and *Bosmina sp*, etc. species; among Copepodans, *Cyclops sp* and *Mesocyclops sp*, etc. species and among the Ostracodans, *Candona sp*, *Heterocypris sp*, and *cypria sp*, etc. species were abundant. The zooplankton in this lake follows a sequence as Rotifera > Cladocera > Copepods > Ostracoda. A correlation was drawn between various physicochemical parameters and zooplankton density. Some changes in zooplankton community structure are related to seasonal changes in water temperature, ph, hardness, alkalinity, and nutrient content in the water. Increased levels of Dissolved Oxygen (DO) and nutrients such as nitrates, and phosphates indicate favorable conditions for the growth of zooplankton. This study showed that the presence of the aforementioned species is considered a biological indicator of eutrophication.

Keywords— Environmental factors, Seasonal Variation, Saheb Bandh Lake, Zooplankton, Rotifera, Global climate change

I. INTRODUCTION

Zooplankton species play an important role in the food webs of aquatic ecosystems. They are not only a vital member of the lentic community, but they also contribute greatly to the freshwater ecosystem's biological production. [1]. Several studies have been conducted on the ecological status of freshwater bodies in various regions of India [2]. The water needs for zooplankton and other aquatic species are a major problem nowadays since all water sources have reached critical levels as a result of uncontrolled expansion and industrialization. Water quality evaluation includes analyzing physicochemical and biological parameters which represent the abiotic and biotic condition of this aquatic ecosystem [3]. The physicochemical parameters are the fundamental aspects that influence the aquatic ecosystem [4]. Zooplankton is an essential part of the food chain and plays a crucial role in the organic matter cycling in an aquatic ecosystem. [5]. The water physicochemical parameters and the zooplankton community have also been studied [6]. Identification of zooplankton species in food webs is an important aspect of aquatic body management. The diversity of zooplankton indicates a chronic water pollution problem. Zooplankton is essential for the survival of commercially significant fish populations. The study of zooplankton diversity, abundance, and the impact of seasonal fluctuation on them are significant in fisheries planning and management. The most significant parameters influencing planktonic biomass production were physicochemical conditions and the nutrition statuses of water [7]. Zooplanktons are connecting links between producers and secondary consumers. Several studies on physicochemical parameters affecting the productive condition of confined water bodies have been carried out. [8]. The toxicity of different contaminants to freshwater organisms and the sensitivity of these organisms to toxicants are affected by changes in environmental and climatic conditions. During fish culture, the presence of zooplankton is critical to ensuring high fish output. [9]. Therefore the current study seeks to evaluate the variety of zooplankton species concerning water quality indicators.

II. RELATED WORK

This man-made lake is a good source of water in this drought-prone area. The diversity of Zooplankton is influenced by seasonal physicochemical parameters and some zooplankton species are a good biological indicator on this point several studies have been conducted on the zooplankton diversity and abundance at Saheb Bandh by many researchers [10].

III. MATERIALS AND METHODS

Study area

The Saheb Bandh (Figure 1), (23°20′01″N, 86°21’3″E) is situated ~1.5 km from the main town of Purulia. This is an artificial lake. This lake is maintained by the Purulia municipality. Hence, this study location was selected as a natural experimental area to comprehend and examine our aims.

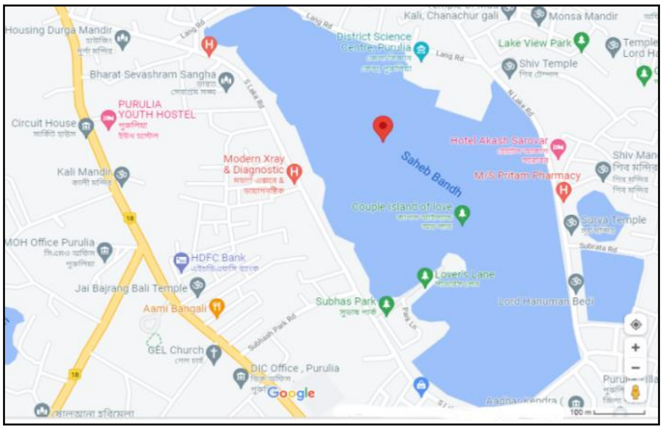

Figure 1. Location of the study site in the google map of Saheb Bandh, Purulia, West Bengal

Sampling duration

The sample was taken in the first week of each month, in the early morning hours (i.e., around 10.00 to 11.00 a.m.).

Collection of water sample

A bucket was used to collect subsurface water samples from the lake at four different seasons. During the sample collection process, every effort was made to avoid any type of water spilling or air bubbling.

Zooplankton samples collection

Bolting Silk no.25 plankton net was used to collect the zooplankton samples by filtering 50 liters of subsurface water. The collected samples were preserved by using a 5% formalin solution. The quantitative estimation of zooplankton was done by using a plankton counting cell. The conventional approach was used to identify zooplankton up to a generic level. [11].

Qualitative study of zooplankton

Preserved zooplankton specimens were identified up to the species level using a binocular light digital microscope at the requisite magnification (4X, 10X initially, followed by 40X). The zooplanktons were then identified following the standard literature of Battish, 1992; Edmondson 1992; [12], [13].

Quantitative study of zooplankton

A sedge-wick rafter cell measuring 50 mm long, 20 mm wide, and 1 mm deep was used to analyze zooplankton quantitatively. A measuring dropper was used to transfer the samples from a bottle to the counting cell. It was made sure that all of the zooplankton have settled down before counting. At least five times, each sample was counted for zooplankton, and an average was established for each month's samples throughout a year (i.e., from 2021- to 2022). The number of each species or genus was determined using the method below (Welch, 1948), and total forms were tallied on a monthly basis using the formula below.

$$N\ (\text{org L-1}) = \frac{a \times b}{V}$$

N= Zooplankton numbers per liter
a= Average number of zooplankton in all counts in a counting cell of 1 ml capacity.
b= Volume of original concentrate in ml (30 ml)
V= Volume of original water filtered (50 litres)

All of the microorganisms were statistically represented as organisms per liter. The formula below was used to examine the relationship between various physicochemical characteristics and zooplankton groups-

$$\text{Correlation coefficient (r)} = \frac{n\,(\Sigma nxy) - (\Sigma x)\,(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x^2)]\,[n\Sigma y^2 - (\Sigma y)^2]}}$$

n= Information of Quantity
Σx= Total of the First Variable Value
Σy= Total of the Second Variable Value
Σxy= Sum of the Product of & Second Value
Σx^2= Sum of the Squares of the First Value
Σy^2= Sum of the Squares of the Second Value

IV. RESULTS AND DISCUSSION

Species diversity and Seasonal fluctuation of Zooplankton

According to the current study, there were a total of 25 Zooplankton species found in this lake (Table 1). The annual periodicity shows that Rotifera dominancy constitutes 40%, Cladocera constitutes 28%, Copepoda constitutes 20% and Ostracoda constitutes 12% (Figure 2). The quantity of zooplankton in the research region, Rotifera was the most dominant among all other zooplankton groups throughout the study period, followed by Roti>Clado>Cope>Ostra. The zooplankton population density was highest in the summer and lowest in the winter. The percentage of seasonal variation of the Zooplankton recorded from Saheb Bandh was mentioned in (Figure 3).

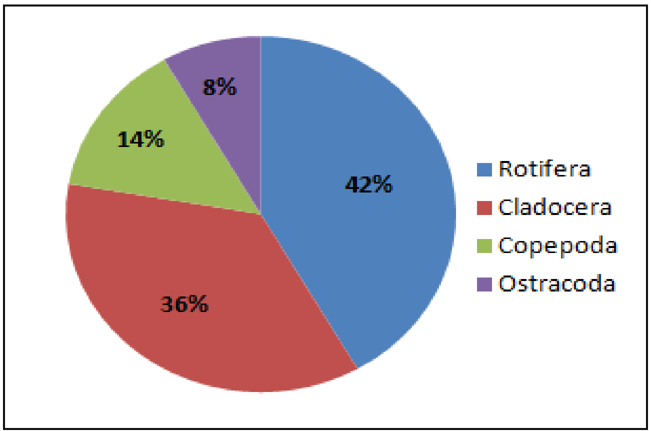

Figure 2. Groupwise Percent composition of Zooplankton at Saheb Bandh, Purulia

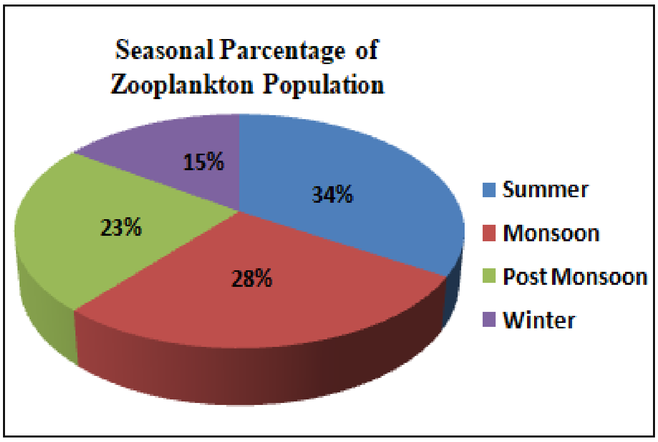

Figure 3. Percentage of Seasonal abundance of Zooplankton at Saheb Bandh

Table 1: Seasonal zooplankton diversity and abundance in Saheb Bandh, Purulia

Zooplankton	Observation			
	Summer	**Monsoon**	**Post monsoon**	**Winter**
		Rotifera		
Asplanchna sp.	5	6	4	2
Brachionus sp.	7	5	6	7
Filinia sp.	5	4	4	2
Keratellac sp.	10	7	8	4
Euchlanis sp.	5	4	6	2
Philodina sp.	4	6	5	0
Pompholyx sp.	7	5	0	5
Platyias sp.	3	1	2	0
Scaridium sp.	4	0	2	0
Lecane sp.	2	2	1	0
Total	**52**	**40**	**38**	**22**
		Cladocera		
Alona sp.	5	4	4	2
Alonella sp.	4	6	2	4
Bosmina sp.	7	9	8	6
Ceriodaphnia sp.	6	5	3	0
Daphnia sp.	9	8	6	5
Moina sp.	5	4	7	4
Sida sp.	3	4	1	0
Total	**39**	**40**	**31**	**21**
		Copepoda		
Cyclops sp.	7	6	7	4
Diaptomus sp.	2	1	0	0
Eucyclops sp.	3	0	2	0
Mesocyclops sp.	2	0	1	1
Thermocyclops sp	5	4	2	4
Total	**19**	**11**	**12**	**9**
		Ostracoda		
Candona sp.	5	5	1	2
Cypria sp.	4	3	0	1
Hetrocypris sp	4	1	3	1
Total	**13**	**9**	**4**	**4**

Seasonal physicochemical parameter of water at Study site

During the study period, different physicochemical parameters have been measured from the water body. The water temperature, Turbidity, pH, DO, TA, Hardness, Phosphate, Nitrate, Chloride, etc. were found in different parameters in the different seasonal conditions, which have a significant relationship with zooplankton (Table 2). For this purpose, we have taken the sample from different points of saheb bandh during different seasons to conduct the experiments. Data obtained from those experiments are as follows:-

Table 2: Seasonal physicochemical parameters of Saheb Bandh during the study period.

Physicochemical Parameter	**Summer**	**Monsoon**	**Post monsoon**	**Winter**
Temperature (^0C)	32.2±3.0	28.7±2.0	26.6±2.0	19±2.1
Turbidity (NTU)	8.11±2.0	5.19±1.0	9.93±1.2	6.87±3.0
pH	7.58±1.0	7.08±1.3	7.21±1.2	6.75±1.4
DO(mg/l)	7.68±2.0	5.34±1.0	7.60±1.5	6.16±1.7
Alkalinity (mg/l)	137±2.7	109.5±15	76.2±12	88.17±4.0
Hardness (mg/l)	102.3±2.0	123.2±12	93.75±7	111.21±9.0
Phosphate(mg/l)	3.57±1.0	2.31±1.0	1.175±1.0	1.172±2.0
Nitrate (mg/l)	0.75±0.7	0.36±0.41	0.532±0.61	0.587±29
Chloride (mg/l)	23.82±2.0	22.23±1.0	20.75±1.0	25.67±2.0
TDS (ppm)	190.7±1.0	175.5±1.2	187.6±1.2	191.1±1.0
Salinity (PSU)	0.187±0.5	0.172±0.3	0.184±0.2	0.186±0.4
Fluoride (ppm)	.25±0.2	.24±0.1	.28±0.1	.26±0.2
Conductivity (μS/Cm)	388.7±5.0	358.2±4.0	383.6±4.0	392.2±6.0
Free CO_2 (mg/l)	5.80±1.21	4.88±1.19	5.87±1.20	6.17±1.22

Correlation of Physicochemical parameters with zooplankton

A significant relation was established between zooplankton density and physicochemical parameters of the water samples at Saheb Bandh Lake were predicted in (Table 3). In the present investigation Zooplankton population showed a positive correlation with temperature, turbidity, pH, Dissolved Oxygen (DO), alkalinity, phosphate, and NO_3- whereas negative correlation with hardness, chloride, TDS, salinity, fluoride, conductivity, and free CO_2. The similar observations were made by [14], [15] and [16]. Among the zooplankton groups, Rotifers diversity was high during all the seasons with these physicochemical parameters. The other zooplankton groups throughout the study period were followed by Cladocera>Copepoda>Ostracoda. As a result, it is possible to deduce that the density of Zooplankton is directly or indirectly affected by several abiotic factors. Temperature is a significant and changeable abiotic factor in the freshwater of different regions but also in the same aquatic body during various times and seasons [17].

Total zooplankton density and variety are higher in summer than in other seasons, while they are lowest in winter. Finally, environmental conditions clearly impact on zooplankton density in freshwater and physicochemical variables influence population dynamics in this habitat. [18]. The availability of food and predation pressure are two additional essential factors influencing the zooplankton development and abundance. Crustaceans, which included Cladocerans, Copepods, and Ostracods, similarly exhibited a unimodal population curve despite being present at moderate temperatures. The crustacean group shows the highest numerical emergence during the warm season and the lowest during the cold season [19].

Zooplankton is abundant in the sampling sites and normally during the monsoon time, there is a reduced population due to the dilution factor and fluctuations in other physicochemical parameters. The population of some zooplankton species increases significantly during the winter season because of favorable climatic circumstances and a plentiful supply of food in the form of microorganisms and suspended debris, but, in summer, when inflow is lower than in other seasons, the water body becomes more stable, and food availability is increased due to organic material breakdown, and the zooplankton population may be high because of fewer predators. [20]. Water pollution from domestic sewage has also been noticed in this lake which is steadily lowering the aquatic ecosystem production status. Domestic sewage must be properly biologically and chemically treated before being discharged into the system to ensure the long-term sustainability of the resources [21].

Table 3: Correlation of physicochemical parameters with zooplankton.

SL. No.	Physicochemical Parameters with zooplankton	Correlation coefficient (‘r’Value)
1.	Zooplankton with Temperature	0.9866
2.	Zooplankton with Turbidity	0.0367
3.	Zooplankton with pH	0.9259
4.	Zooplankton with Dissolved Oxygen (DO)	0.3391
5.	Zooplankton with Alkalinity	0.8124
6.	Zooplankton with Hardness	-0.0682
7.	Zooplankton with Phosphate	0.9036
8.	Zooplankton with Nitrate	0.2586
9.	Zooplankton with Chloride	-0.3405
10.	Zooplankton with TDS	-0.2144
11.	Zooplankton with Salinity	-0.1401
12.	Zooplankton with Fluoride	-0.4309
13.	Zooplankton with Conductivity	-0.2825
14.	Zooplankton with Free CO2	-0.4512

The correlation between physicochemical parameters and zooplankton has been mentioned graphically in the below (Figure- 4,5,6,7,8,9,10,11,12,13,14,15,16,17).

Figure 4. Significant large positive relationship between Temperature and Zooplankton

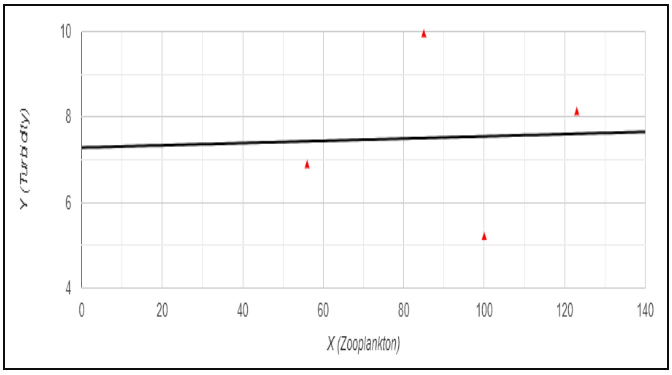

Figure 5. Non significant very small positive relationship between Turbidity and zooplankton

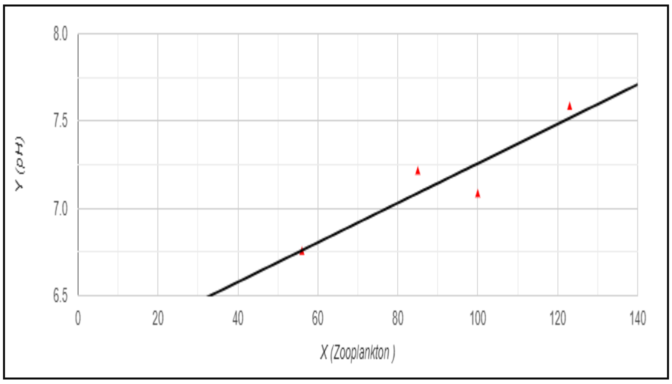

Figure 6. Non significant large positive relationship between pH and zooplankton

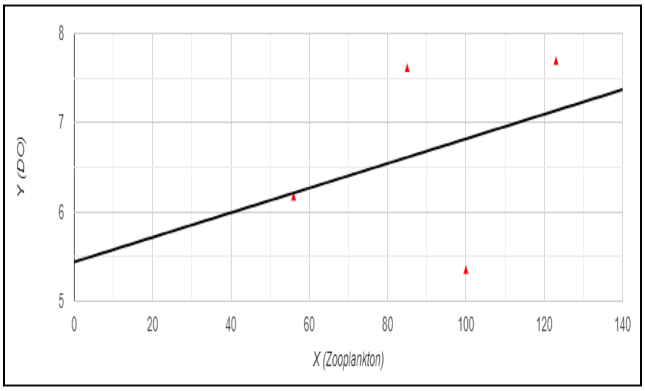

Figure 7. Non significant medium positive relationship between Dissolved Oxygen and zooplankton

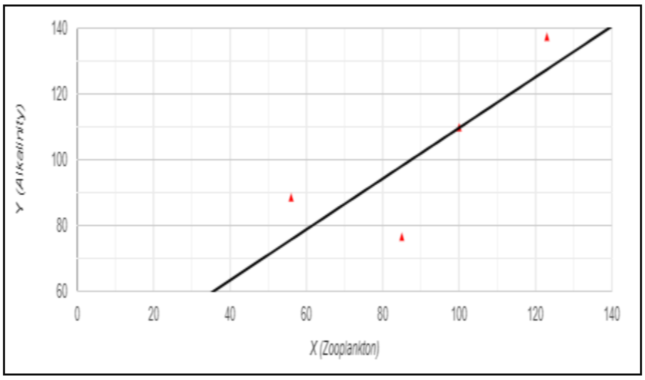

Figure 8. Non significant large positive relationship between alkainity and zooplankton

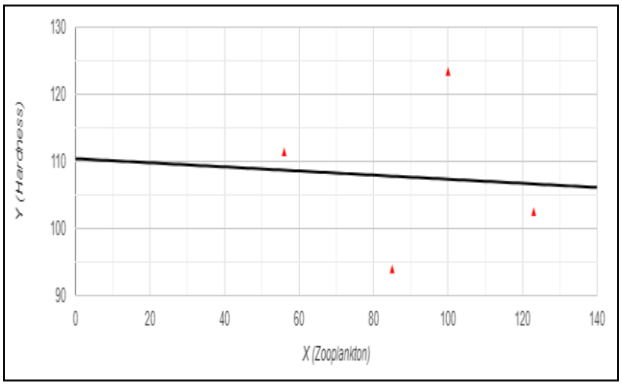

Figure 9. Non significant very small negative relationship between Hardness and zooplankton

Figure 10. Non significant large positive relationship between Phosphate and zooplankton

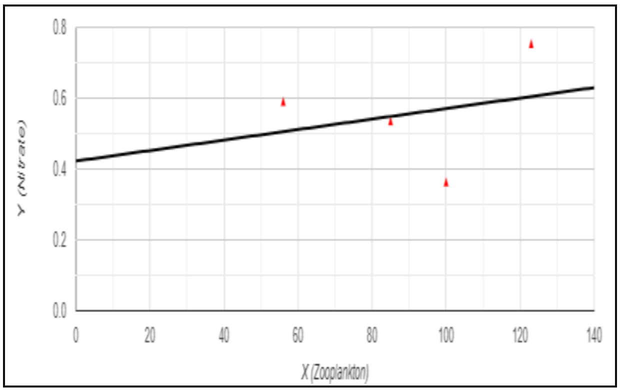

Figure 11. Non significant small positive relationship between Nitrate and zooplankton

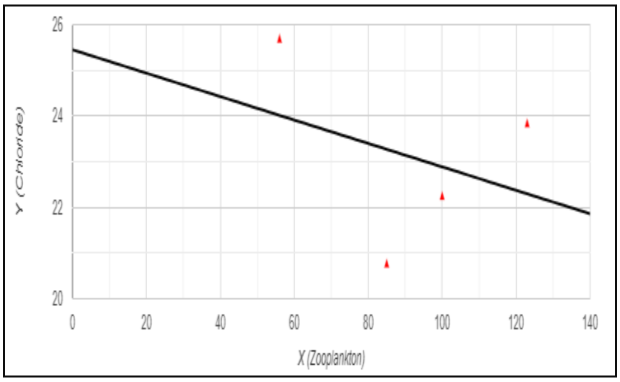

Figure 12. Non significant large positive relationship between Chloride and zooplankton

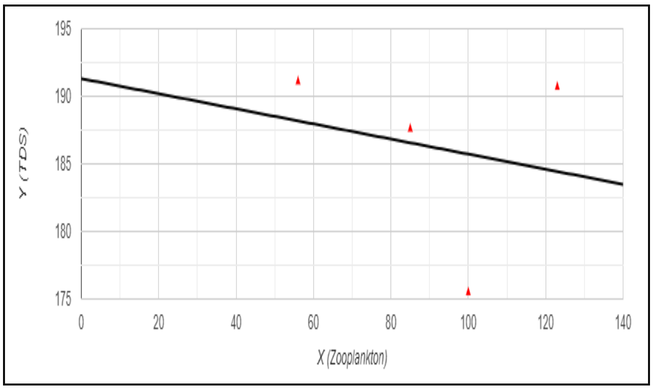

Figure 13. Non significant very small negative relationship between TDS and zooplankton

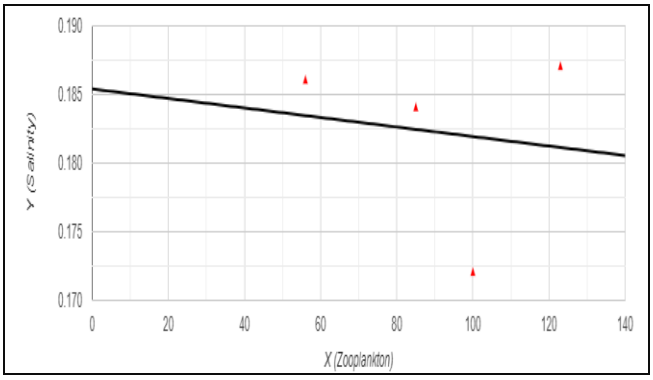

Figure 14. Non significant very small negative relationship between salinity and zooplankton

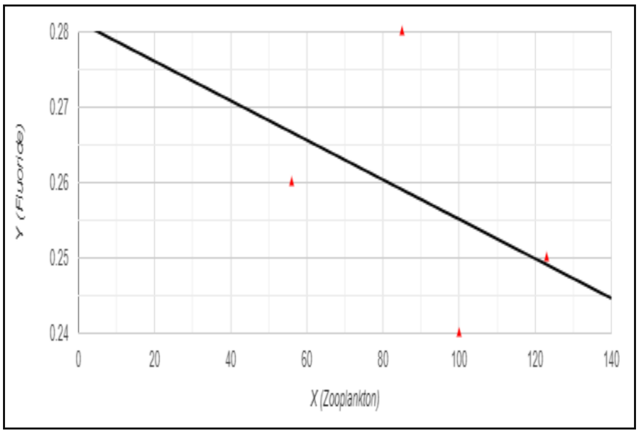

Figure 15. Non significant very small negative relationship between Fluoride and zooplankton

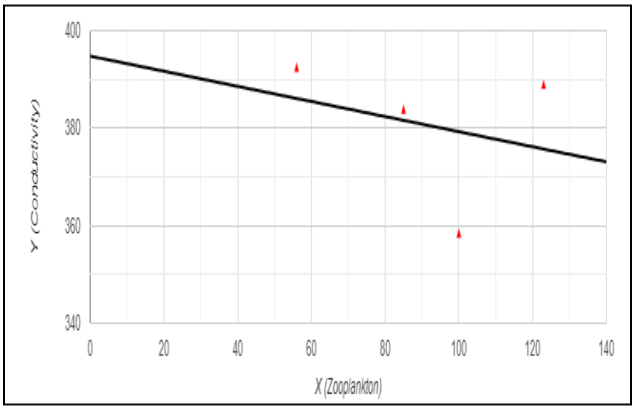

Figure 16. Non significant very small negative relationship between Conductivity and zooplankton

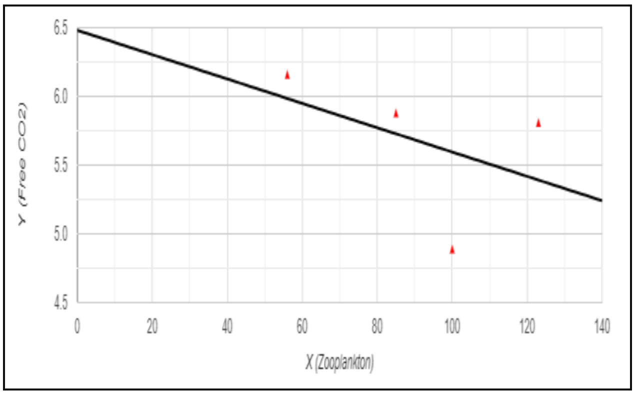

Figure 17. Non significant very small negative relationship between Free CO2 and zooplankton

V. Conclusion And Future Scope

Zooplanktons are an important group of plankton in the aquatic food chain. The abundance of zooplankton is regulated by a variety of physicochemical parameters, as well as the interplay of biological factors. During the study period in different seasons throughout the year, the physicochemical parameters of the water and the population of the zooplanktons species were found different in different seasons. This means the physicochemical parameters have an impact on zooplankton diversity. Some of the species of the zooplankton groups are a good biological indicator in some specific physicochemical parameters throughout the year. This study discovered that the presence of the aforementioned species may consider a biological indicator for eutrophication. Based on this study, which season will be suitable for aquaculture can be considered and necessary steps can be taken to keep this freshwater lake free from pollution.

VI. Acknowledgement

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VII. Conflict Of Interest

The authors declare no competing or financial interest.

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