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Diversity of Zooplankton Community of Chatla Floodplain Lake of Barak Valley, Assam, North East India in Relation to Physicochemical Characteristics of Water

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ABSTRACT:
A study was carried out to investigate zooplankton diversity over a period of one year (March, 2019-February, 2020) in Chatla floodplain lake (popularly known as *Chatla Haor*) in Cachar district of Assam, North East India. The study was carried out in three different areas of the wetland. Composition, density and diversity of zooplankton community were studied in relation to physicochemical characteristics of water. Zooplankton community was comprised of 33 taxa out of which 13 belong to Cladocera, 6 to Copepoda, 13 to Rotifera and 1 to Ostracoda. The mean density of total zooplankton in Chatla floodplain ranges from 1170.49 ut.L^{-1} (Site III) to 1378.50 ut.L^{-1} (Site I). Relative abundance of the zooplankton classes were studied. The community structure was analysed using Shannon-Wiener diversity index (H'), Menhinick's richness index, Evenness index (J') and Berger-Parker dominance index (D_{BP}). One-way analysis of variance (ANOVA) was also performed. Correlation and regression analysis was performed to estimate the effect of physicochemical properties of water on the diversity of zooplankton.

Key words: Chatla floodplain lake, Density, Diversity, Zooplankton, Relative abundance

1. Introduction

Floodplain wetlands are one of the most diverse and productive ecosystems on earth. They create an environment for the aquatic food web which is generally consumed by fish and other living entities (Mustafa, 2009). Wetlands are often referred to as 'Biological Supermarkets' as they support all forms of life through extensive food chain and biodiversity (Mitsch&Gosselink, 1993). Biological production in such an aquatic body is directly correlated with its physicochemical status (Sharma *et al.*, 2013). Physicochemical parameters are the most appropriate source to measure the water quality of any aquatic body. A slight change in the physicochemical properties affects the biodiversity of the ecosystem. Investigations have been made to correlate plankton distribution with physicochemical parameters. Correlation between physicochemical characteristics and planktons has been studied by many workers (Ayoade*et al.*, 2009, Harsha &Malammanver, 2004, Laskar& Gupta, 2009). The species composition of planktons, on the other hand are a great indicator of water quality because of their quick response to environmental changes.

Among planktons, zooplanktons are important link in the transformation of energy in an aquatic food web because of their drifting nature, large density, high species diversity and tolerance to the stress (Bhat *et al.*, 2014). It forms a major link in transfer of energy at secondary level between autotrophs and heterotrophs in an aquatic food web. They are the integral part of aquatic food web and contribute significantly to aquatic biological productivity in freshwater ecosystem (Nimbalkar *et al.*, 2013).

Several works on freshwater zooplankton composition and distribution have been carried out throughout the country in recent years, worth mentioning that of (Balakrishna *et al.*, 2013, Dede & Deshmukh, 2015, Pawar, 2015, Sharma *et al.*, 2015, Sharma & Sharma, 2008). A systematic survey of Indian fresh water zooplanktons is given in (Fathibi*et al*,. 2017). But the studies on zooplankton in north-east part of the country, especially in South Assam are hardly available except some worth mentioning works in recent years such as Das and Kar, 2013, 2016, Das *et al.*, 2018, Kar & Barbhuiya, 2004 and Kar & Kar, 2013.

The main focus of the present study is to depict the relevance of physicochemical characteristics in assessing the zooplankton diversity, composition and abundance in three different habitats. This study may be of help to the poor people of Chatla as abundance of zooplankton is of considerable assistance in evolving fish culture programmes (Bohra & Kumar, 2002).

2. Materials and Methods

This study was conducted in Chatla floodplain wetland (*Chatla Haor*) during March, 2019 to February, 2020. This wetland is one of the lakes in Cachar district in southern Assam in India. It is located at an elevation of 43.6 MSL, at a latitude of $24^0$42'40" N and at a longitude of $92^0$44'30" E. It is formed by meandering the river Ghagra, a south bank tributary of the river Barak of southern Assam, North-East India. It has a unique hydrology due to the presence of different types of habitats (inlets, floodplain fisheries, beels and outlets) which maintains a network among the floodplains, rivers and streams.

For the purpose of analyzing the zooplankton dynamics of Chatla floodplain wetland in relation to the physicochemical characteristics of water, water and zooplankton samples were collected from March, 2019 to February, 2020 in four different seasons, viz., pre-monsoon (March-May), monsoon (June-August), post-monsoon (September-November) and winter (Decmber-February) (Laskar& Gupta, 2009). Samples were collected from three selected areas, viz. Dargakuna (Site I), Baluchuri (Site II) and Mitapani (Site III) of the floodplain lake.

Surface water temperature, transparency and turbidity were measured on the spot by using a Mercury Thermometer, a Secchi Disc and a Turbidimeter (Systronics) respectively. Other chemical parameters such as pH, electrical conductivity (EC), dissolved oxygen (DO), total alkalinity (TA), total dissolved solids (TDS), free carbon-dioxide (FCO_2), chloride (Cl^-), total hardness (TH), calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), nitrate (NO_3), phosphate (PO_4) and biological oxygen demand (BOD) were analyzed by standard methods (APHA, 2005, Michael, 1984).

For zooplankton collection, twenty litres of water sample in three replicates from each site was filtered through a standard plankton net (mesh size 30 µm) and preserved in 3% formaldehyde solution. Qualitative and quantitative estimation of zooplankton from each site were carried out with the help of "Sedgwick Rafter" counting cell under a compound microscope according to required magnification (X10 initially, followed by X40) and identified using standard literature (Battish, 1992, Edmondson, 1959, Michael & Sharma, 1998, Needham & Needham, 1962, Sharma, 1999, Sharma & Sharma, 2002). The community structure was analysed using Shannon-Wiener diversity index (H'), Menhinick's richness index, Evenness index (J') and Berger-Parker dominance index (D_{BP}) (Magurran, 2004). One-way analysis of variance (ANOVA) was also performed. The Carl-Pearson correlation coefficient and regression analysis was used to examine the relationship among

various parameters (physicochemical parameters of water and zooplankton classes). All the statistical analysis done in this paper has been performed using MATLAB, v. 7.

3. Results and Discussion

3.1 Physicochemical Parameters of Water

The mean values (with respect to the four seasons mentioned earlier) of physicochemical parameters of water in all the three selected habitats of Chatla floodplain wetland are shown in Table 1. Water temperature shows a little variation, ranging between 24.55^{0}C (Site II) and 25.35^{0}C (Site III). Transparency and turbidity are found ranging from 1.64 cm (Site II) to 2.19 cm (Site I) and from 18.24 NTU (Site II) to 23.84 NTU (Site I), respectively. DO concentration ranges between 4.08 mgL^{-1} (Site III) and 4.92 mgL^{-1} (Site I). TA is found ranging from 36.80 mgL^{-1} (Site II) to 62.44 mgL^{-1} (Site I). The pH of different sites is found to be in the range of 6.44 (Site II) to 6.92 (Site I) (slightly acidic to normal). Higher EC values indicate the presence of a high concentration of salts in water. The range of TH varies from 48.52 mgL^{-1} (Site II) to 54.48 mgL^{-1} (Site I). The range of chloride (Cl^-) concentrations is well within the permissible limit. NO_3 concentration ranges from 3.47 mgL^{-1} (Site I/II) to 3.64 mgL^{-1} (Site III) which is much lower than the permissible value (45 mgL^{-1}). However, the range of PO_4 concentrations from 3.13 mgL^{-1} (Site I) to 4.16 mgL^{-1} (Site III) in different habitats are found to be slightly higher. The high range of BOD from 8.82 mgL^{-1} (Site I) to 10.51 mgL^{-1} (Site III) confirms that high organic load is present in water. The value of the TDS variable varies from 29.12 mgL^{-1} (Site II) to 39.69 mgL^{-1} (Site III). Therange of Free CO_2 falls in between 10.59 mgL^{-1} (Site III) and 12.25 mgL^{-1} (Site II). The range of Ca varies between 32.90 mgL^{-1} (Site I) and 46.50 mgL^{-1} (Site III), and the value of K variable varies from 1.34 mgL^{-1} (Site I) and 3.10 mgL^{-1} (Site III). Finally, the values of Mg and Na variables fall in between 14.47 mgL^{-1} (Site III) and 35.14 mgL^{-1} (Site I) and 6.87 mgL^{-1} (Site II) and 7.50 mgL^{-1} (Site I).

3.2 Zooplankton

A total of 33 zooplankton taxa were identified out of which 13 belong to Cladocera, 6 to Copepoda, 13 to Rotifera, and 1 to Ostracoda. Table 2 bears the details of the mean value (with respect to the four seasons mentioned earlier) of density ($ut.L^{-1}$) of all the species present in all the three sites. The abundance of total zooplankton in Chatla floodplain ranges from 1170.49 (Site III) to 1378.50 (Site I).The relative abundance of different classes of zooplankton revealed that Rotifera is the most abundant group of zooplankton in Site I with a contribution of 41.97% followed by Cladocera (36.92%) and Copepoda (20.73%). In this site, the dominant species of Rotifera are *Brachionus*sp., *Keratella*sp., *Polyarthra*sp. and *Pompholyx* sp. Ostracoda remains to be the least dominant group in all the three sites with contributions of 0.39% in Site I, 0.42% in Site II and 0.76% in Site III. In Site II, Cladocera is the most dominant group with a contribution of 40.11% followed by Rotifera (39.27%) and Copepoda (20.20%). In this site, the dominant species of Cladecora are *Diaphanosoma*sp.,*Macrothrix*sp. *and Sida*sp.Site III preserves a similar trend with that of Site II in respect of ranking in abundance of zooplankton classes with contributions of Cladocera 44.39%, Rotifera 32.42% and Copepoda 22.43%. Rotifera and Cladecora are highly competitive in Site II. Variation of zooplankton abundance in different sites is depicted in Figure 1.

Similar studies on zooplankton were reported in recent years throughout the country. Nimbalkar*et al*., 2013 reported 15 rotifers, 12 cladocerans and 6 copepods from AmbeGhosale lake, Thane city of Maharashtra. A total number of 54 genera of zooplankton were observed during the study of an anthropogenic pond in Madhya Pradesh (Verma *et al.*, 2013) where highest population percentage of rotifera over other groups of zooplankton were reported. Sharma *et al.*, 2017 reported 30 species of zooplankton in KeibulLamjao National Park (KLNP) Manipur, India. Das *et al*., 2018 reported 32 species of zooplankton in Chatlabeel (wetland of current study) and 29 and 24 species in two other wetlands of Cachar, Assam. 40 genera of zooplankton were reported by Kar & Kar, 2016

from Sat Beel, Cachar, Assam. Narzary et al., 2015 reported 6 genera of zooplankton in Ramnagar Anua, 15 in Tapang Haor and 8 in Srikona Beel. Laskar & Gupta, 2010 reported 21 genera of zooplankton in Chatla wetland of Barak valley, Assam in a study of two months duration in 2006. 30 different genera of zooplankton were reported by Das & Kar, 2016. Dutta *et al.*, 2017 reported 16

Table 1: Physicochemical Parameters of Water

(Mean of four seasons: Pre-monsoon, Monsoon, Post-monsoon and Winter)

Sl. No.	Parameters	Mean ± SE		
		Site I	Site II	Site III
1.	Temp. (^{0}C)	25.08 ± 3.85	24.55 ± 4.12	25.35 ± 4.18
2.	Tran. (cm)	2.19 ± 0.65	1.64 ± 0.40	1.99 ± 0.56
3.	Turb. (NTU)	23.84 ± 3.88	18.24 ± 2.24	21.45 ± 1.25
4.	DO (mgL^{-1})	4.92 ± 0.53	4.30 ± 0.60	4.08 ± 0.53
5.	TA (mgL^{-1})	62.44 ± 13.19	36.80 ± 9.30	41.24 ± 7.62
6.	pH	6.92 ± 0.22	6.44 ± 0.08	6.60 ± 0.13
7.	EC (µScm^{-1})	2921.00 ± 908.10	3834.30 ± 380.11	3453.40 ± 1152.80
8.	TDS (mgL^{-1})	34.49 ± 5.54	29.12 ± 5.31	39.69 ± 6.42
9.	FCO_2 (mgL^{-1})	11.72 ± 0.55	12.25 ± 0.54	10.59 ± 0.54
10.	Cl^- (mgL^{-1})	27.76 ± 7.03	41.53 ± 7.07	29.39 ± 5.82
11.	TH (mgL^{-1})	54.48 ± 10.44	48.52 ± 7.85	49.00 ± 6.23
12.	Ca (mgL^{-1})	32.90 ± 10.89	42.93 ± 4.51	46.50 ± 5.88
13.	K (mgL^{-1})	1.34 ± 0.28	2.31 ± 0.20	3.10 ± 0.96
14.	Mg (mgL^{-1})	35.14 ± 3.91	16.84 ± 3.72	14.47 ± 2.99
15.	Na (mgL^{-1})	7.50 ± 0.99	6.87 ± 1.20	7.20 ± 1.06
16.	NO_3 (mgL^{-1})	3.47 ± 0.22	3.47 ± 0.13	3.64 ± 0.34
17.	PO_4 (mgL^{-1})	3.13 ± 0.50	3.49 ± 0.64	4.16 ± 0.51
18.	BOD (mgL^{-1})	8.82 ± 1.59	8.94 ± 1.18	10.51 ± 1.04

Temp. = Temperature, Tran. = Transparency, Turb. = Turbidity, DO = Dissolved oxygen, TA = Total alkalinity, EC = Electrical conductivity, TDS = Total dissolved solids, FCO_2 = Free carbon di oxide, Cl^- = Chloride, TH = Total hardness, Ca = Calcium, K = Potassium, Mg = Magnesium, Na = Sodium, NO_3 = Nitrate, PO_4 = Phosphate, BOD = Biological oxygen demand

genera of zooplankton from a typical lake of Cachar district, Assam. Gupta & Devi, 2014 reported 12 species of zooplankton in Baskandi Anua, an oxbow lake of Barak Valley, Assam.

For community structure, Shannon-Wiener diversity index (H'), Menhinick's richness index, Evenness index (J') and Berger-Parker dominance index (D_{BP}) were computed for all the three sites and is given in Table 3. The lowest value of Shannon Wiener diversity index (H') is 3.37 (Site I/II) and the highest value is 3.38 (Site III). Richness index varies from 0.89 (Site 1) to 0.94 (Site III). Evenness index (J') varies from 0.96 (Site II) to 0.97 (Site I/III) and the Berger-Parker dominance index (D_{BP}) ranges from 0.06 (Site III) to 0.07 (Site I/II).

Table 4 shows one way analysis of variance (ANOVA) of site-wise variation of zooplankton classes and zooplankton species with respective p values where the F values are highly significant.

Table 5 shows the Carl-Pearson correlation matrix between various pairs of parameters (physicochemical parameters of water and zooplankton classes). Linear regression analysis has been performed for the significant correlations

(i) between Total Dissolved Solid and Cladocera ($r = 0.72,\ p < 0.01$),
(ii) between Calcium and Copepoda($r = -0.76, p < 0.01$),
(iii) between Magnesium and Rotifera ($r = 0.58, p < 0.05$),
(iv) between Potassium and Total Zooplankton ($r = -0.65,\ p < 0.05$)

which are shown in Figure 2.

Table 2: Density (ut.L$^{-1)}$ of Zooplankton Community
(Mean of four seasons: Pre-monsoon, Monsoon, Post-monsoon and Winter)

Sl. No.	Genus/Species	Mean ± S.E		
		Site I	Site II	Site III
	Class: Cladocera			
1.	*Alona* sp.	25.00 ± 6.19	46.43 ± 18.09	33.93 ± 11.80
2.	*Bosmina* sp.	42.86 ± 4.13	44.64 ± 10.66	39.29 ± 6.19
3.	*Bosminopsis*sp.	23.21 ± 7.92	10.71 ± 4.61	32.14 ± 10.71
4.	*Ceriodaphnia*sp.	14.29 ± 14.29	14.29 ± 4.13	32.14 ± 18.09
5.	*Chydorus*sp.	14.29 ± 8.25	14.29 ± 8.25	14.28 ± 7.71
6.	*Daphnia* sp.	48.21 ± 6.10	50.00 ± 12.71	42.86 ± 14.58
7.	*Diaphanosoma*sp.	62.50 ± 12.84	64.28 ± 7.71	44.64 ± 14.98
8.	*Macrothrix*sp.	64.28 ± 22.77	58.93 ± 7.36	50.00 ± 15.70
9.	*Moina*sp.	28.57 ± 6.52	32.14 ± 15.57	35.71 ± 7.71
10.	*Pleuroxus*sp.	57.14 ± 6.52	30.35 ± 5.36	53.57 ± 11.85
11.	*Scapholebris*sp.	37.50 ± 8.44	26.78 ± 13.79	42.86 ± 7.71
12.	*Sida*sp.	58.92 ± 17.10	76.78 ± 29.51	66.07 ± 19.86
13.	*Simocephalus*sp.	32.14 ± 6.84	41.07 ± 7.92	32.14 ± 6.19
	Cladocera Total	**508.91± 47.33**	**510.69± 50.72**	**519.63± 22.09**
	Class: Copepoda			
14.	*Cyclops* sp.	46.43 ± 9.45	39.29 ± 11.85	50.00 ± 9.22
15.	*Heliodiaptomus*sp.	5.35 ± 3.42	10.71 ± 8.50	14.28 ± 7.71
16.	*Mesocyclops*sp.	42.85 ± 11.29	50.00 ± 13.98	37.50 ± 8.93
17.	*Naupli larvae*	50.00 ± 33.76	25.00 ± 16.88	44.64 ± 35.76
18.	*Neodiaptomus*sp.	94.64 ± 12.50	89.28 ± 11.85	57.14 ± 25.59
19.	*Thermocyclops*sp.	46.43 ± 9.45	42.86 ± 15.15	58.93 ± 16.59
	Copepoda Total	**285.70± 23.87**	**257.14± 13.36**	**262.49± 28.78**
	Class: Rotifera			
20.	*Ascomorpha*sp.	28.57 ± 11.29	30.36 ± 9.39	32.14 ± 2.06
21.	*Asplanchna*sp.	41.07 ± 14.10	58.93 ± 16.07	44.64 ± 13.48
22.	*Brachionus*sp.	69.64 ± 17.34	58.93 ± 10.66	62.50 ± 10.67
23.	*Cephlodella*sp.	26.78 ± 6.10	39.28 ± 14.43	21.43 ± 9.22
24.	*Filina*sp.	23.21 ± 3.42	35.71 ± 16.24	23.21 ± 3.42
25.	*Keratella*sp.	71.43 ± 14.58	41.07 ± 7.36	30.36 ± 5.36
26.	*Lecane*sp.	32.14 ± 18.56	19.64 ± 15.26	-
27.	*Lepadella*sp.	37.50 ± 21.70	28.57 ± 22.02	28.57 ± 15.15
28.	*Plationus*sp.	48.21 ± 18.30	32.14 ± 6.19	30.35 ± 12.84
29.	*Polyarthra*sp.	64.28 ± 18.21	35.71 ± 10.10	48.21 ± 7.92
30.	*Pompholyx* sp.	60.71 ± 24.83	55.36 ± 21.89	7.14 ± 4.12
31.	*Testudinella s* sp.	32.14 ± 19.45	21.43 ± 17.00	23.22 ± 8.93
32.	*Trichocerca*sp.	42.86 ± 15.43	42.86 ± 21.03	27.68 ± 5.90
	Rotifera Total	**578.54±5.05**	**499.99± 28.12**	**379.45± 15.73**
	Class: Ostracoda			
33.	*Cypris* sp..	5.35 ± 1.78	5.35 ± 3.42	8.92 ± 3.42
	Ostracoda Total	**5.35± 1.78**	**5.35± 3.42**	**8.92± 3.42**
	Total Zooplankton	**1378.50± 35.36**	**1273.17± 24.98**	**1170.49± 45.75**
Total No. of Taxa		33	33	32
% Composition		36.07	33.31	30.62

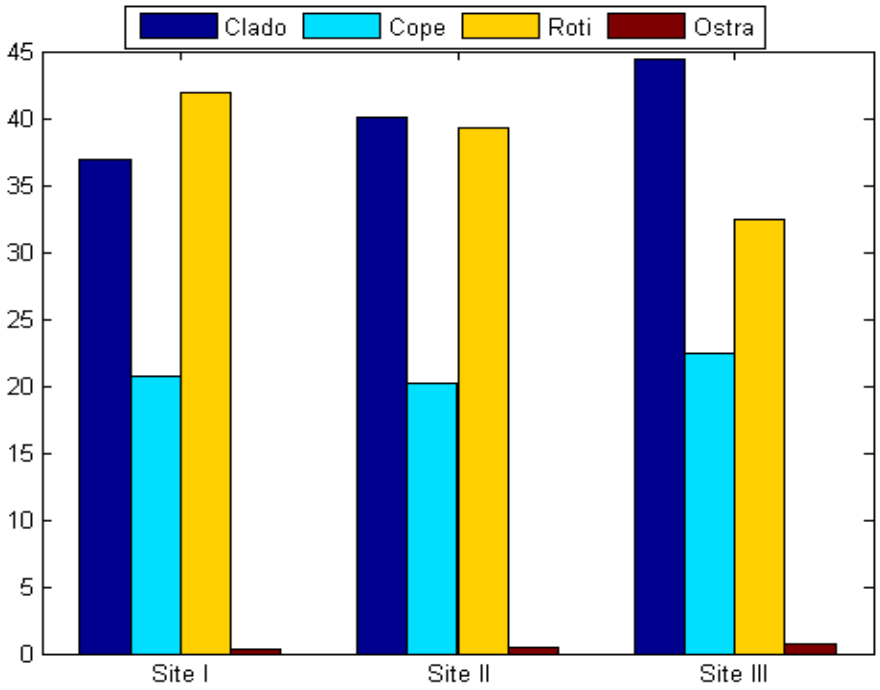

Figure 1:Relative Abundance of Zooplankton Classes

Table 3: Diversity Indices of Zooplankton Species

Index	Site I	Site II	Site III
Shannon Wiener diversity index (H')	3.37	3.37	3.38
Menhinick's richness index	0.89	0.92	0.94
Evenness index (J')	0.97	0.96	0.97
Berger-Parker dominance index (D_{BP})	0.07	0.07	0.06

Table 4: One Way ANOVA of Zooplankton Community

Parameters	F	p
Zooplankton Classes	64.22*	6.12×10^{-6}
Zooplankton Species	6.73*	3.76×10^{-11}

*Highly significant

4. Conclusion

In this paper, a study was carried out in Chatla floodplain lake in Cachar district of Assam, North East India to investigate zooplankton diversity over a period of one year (March, 2019-February, 2020). Composition, density and diversity of zooplankton community were studied in relation to physicochemical characteristics of water which is comprised of 33 taxa out of which 13 belong to Cladocera, 6 to Copepoda, 13 to Rotifera and 1 to Ostracoda. Relative abundance of the zooplankton classes were studied and diversity indices, namely, Shannon-Wiener diversity index (H'), Menhinick's richness index, Evenness index (J') and Berger-Parker dominance index (D_{BP}) were computed. One-way analysis of variance (ANOVA) was performed which shows that the value of F is highly significant for both zooplankton classes and zooplankton species. Correlation coefficients between physicochemical parameters of water and zooplankton classes were computed with sketches of regression lines for some of significant correlations. The present information on zooplankton composition and spatial variation from Chatla beel is helpful for further studies in zooplankton as well as for the conservation and maintenance of such aquatic ecosystem.

Table 5: Pearson Correlation Matrix between Physicochemical Parameters of Water and Zooplankton Classes

	Cladocera	Copepoda	Rotifera	Ostracoda	Total Zooplankton
W.Temp.	0.17	-0.69**	-0.04	0.27	-0.17
Tran.	0.15	-0.67**	0.01	0.23	-0.15
Turb.	0.00	0.53	0.25	-0.11	0.41
DO	-0.31	0.72*	0.32	-0.37	0.32
TA	-0.54	0.60**	0.43	-0.18	0.21
pH	0.01	0.68**	0.20	0.31	0.46
EC	0.05	-0.78*	-0.19	0.45	-0.41
TDS	0.72*	0.03	-0.45	0.57	0.16
FCO_2	-0.55	0.01	0.57	-0.28	0.09
Cl^-	-0.60**	-0.02	0.17	-0.55	-0.31
TH	0.12	0.28	0.08	0.18	0.27
Ca	0.44	-0.76*	-0.45	0.23	-0.36
K	-0.05	-0.65**	-0.45	0.23	-0.65**
Mg	0.05	0.07	0.58**	0.17	0.55
Na	0.54	-0.40	-0.14	0.57	0.13
NO_3	-0.38	-0.26	-0.08	0.12	-0.43
PO_4	0.33	-0.41	-0.46	0.16	-0.31
BOD	0.60**	-0.25	-0.47	0.43	-0.05

*Correlation significant at 1% level **Correlation significant at 5% level

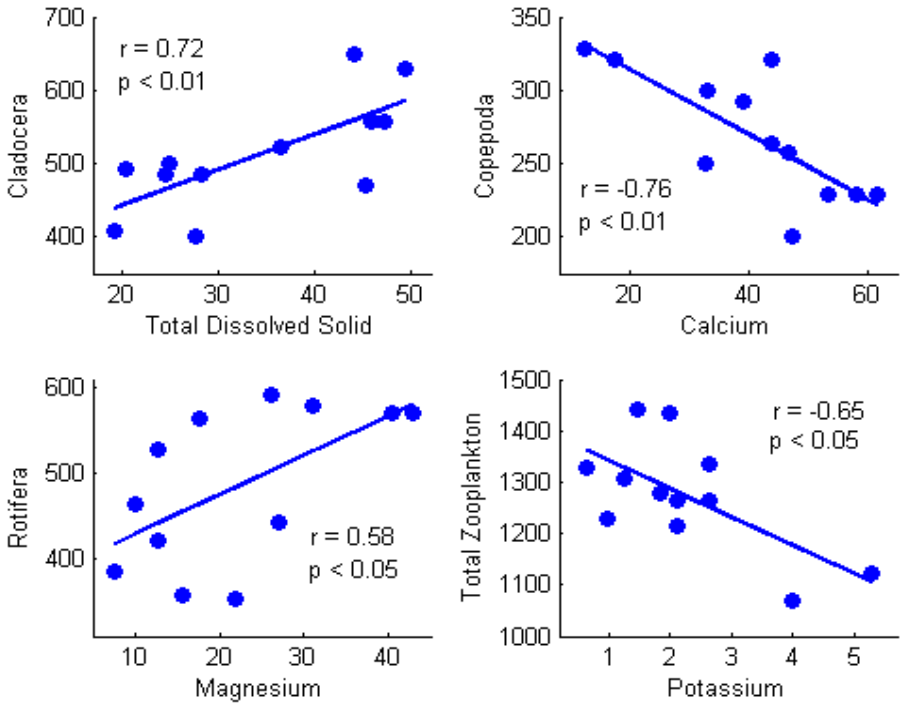

Figure 2: Simple Linear Regression Between Four Pairs of Selected Parameters

Conflict of Interest: No conflict of interest exists.

Authors' Contributions: This work was carried out in collaboration among all authors. Author BA designed the study and managed the analyses of the study. Author SBL managed the literature searches and wrote the protocol. Author PD wrote the first draft of the manuscript and Author AHC performed the statistical analysis. All authors read and approved the final manuscript and consented for its publication.

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