



CORRELATION BETWEEN PHYSICOCHEMICAL PARAMETERS OF WATER AND ZOOPLANKTON OF TWO FRESHWATER PONDS OF PHULWARISHARIF, PATNA

Swati Kumari

Department of Zoology, VKS University, Arrah-802301

Amit Priyadarshi

Department of Zoology, VKS University, Arrah-802301

ABSTRACT This study examines the relationship between physicochemical parameters of water and zooplankton communities in Manikchand Pond and Phulwarisharif Pond, Patna. Zooplanktons are highly sensitive to changes in water quality and therefore serve as reliable indicators of ecosystem health. Water samples were collected monthly from selected sites in both ponds from 2023 to 2025. Key physicochemical parameters—temperature, pH, conductivity, turbidity, total alkalinity, hardness, DO, BOD, TDS, nitrates and chlorides—were analysed following standard procedures. Concurrently, zooplankton samples were collected using plankton nets and identified to the lowest possible taxonomic level. A total of 26 zooplankton species were recorded, representing five major groups: Protozoa (16-25%), Rotifera (41-46%), Copepoda (13-14%), Cladocera (21-22%) and Ostracoda (1-8%). The results revealed significant temporal and spatial variations in water quality, which were closely associated with changes in zooplankton composition and abundance. Sites with optimal DO and pH supported higher zooplankton diversity, whereas elevated levels of BOD and TDS corresponded with reduced zooplankton populations. Statistical analysis using Pearson's correlation further confirmed a strong relationship between water quality parameters and zooplankton distribution. Overall, the study highlights the importance of zooplankton as bioindicators of freshwater ecosystem health and underscores the importance of regular monitoring of pond ecosystems to detect and mitigate anthropogenic impacts.

KEYWORDS : Correlation, Physicochemical Parameters, Zooplankton, Freshwater Ponds.

INTRODUCTION

Animals and plants in freshwater ecosystems interact closely with their environment. Various zooplankton support the food chain in aquatic systems and undergo immediate changes if the water quality changes (Sharma and Sharma, 2019), such as temperature, pH, conductivity, turbidity, total alkalinity, hardness, DO, BOD, TDS, nitrates and chlorides (Chen, 2020). Analysing the above factors along with the zooplankton helps to understand how healthy freshwater ecosystems are. Several aspects of human life, such as an increase in population, manure from agriculture and discharges from factories, harm freshwater ponds. River-related activities alter water and chemical factors, which affect the abundance of zooplankton (Priyadarshi et al., 2024). The management and assessment of the ponds require understanding how both water quality and the number of zooplankton change (Jose and Furio, 2015).

There has been a focus on the importance of these assessments. The study evaluated the correlation between zooplankton and factors affecting the water in a pond in Jammu and revealed that over 2019, the water and zooplankton communities changed in different seasons (Paturej et al., 2016, Brraich et al. 2021). Chen (2020) investigated whether levels of nutrients in water influence the population of zooplankton in urban lakes.

Following earlier studies, research aims to identify how the main qualities of water affect zooplankton in Manikchand Pond and Phulwarisharif Pond at Patna. It also aims to identify changes in water quality year-round and the zooplankton found in various areas along these ponds and to encourage appropriate protection and management of these ponds.

MATERIALS AND METHODS

Patna (25°36'45.64" N; 85°09'31.95" E), the capital and largest city of Bihar, is situated on the southern bank of the River Ganga. It is administratively divided into six subdivisions, Patna Sadar, Patna City, Barh, Masaurhi, Danapur and Paliganj, comprising 23 blocks. Patna Sadar subdivision includes blocks such as Sampatchak and Phulwari Sharif. Phulwari Sharif (25°34'39" N; 85°04'46" E) is a town and block within Patna district and is part of urban Patna. Manikchand Pond and Phulwari Sharif Pond are two prominent freshwater bodies in the PhulwariSharif region, possessing considerable ecological, socio-economic and historical importance for the local community. However, increasing human settlement, discharge of untreated domestic wastewater, agricultural runoff, religious activities and encroachment have progressively altered their natural balance and adversely affected water quality.

The study involved the collection of water samples to evaluate the physico-chemical characteristics from 2023 to 2025. On-site measurements of dissolved oxygen were taken at the time of sampling,

while other parameters were analyzed in the laboratory using analytical procedures outlined in APHA (2012). Over the course of the study, seven key water quality parameters were analyzed including temperature, pH, conductivity, turbidity, total alkalinity, hardness, DO, BOD, TDS, nitrates and chlorides.

Zooplankton samples were collected from the surface water using a 60µ mesh Nylon plankton net with a conical shape. The identification of zooplankton was conducted using several zooplankton identification manuals, including (Kasturirangan 1963; Sharma 1998, Thorp and Covich 2009, Phan et al., 2015). Qualitative analysis of the zooplankton samples was carried out using a compound microscope and a light microscope, examining various zooplankton species (Goswami and Mankodi 2012). Hardy species were immediately preserved in formalin. The qualitative and quantitative examination of zooplankton was performed using Lackey's drop method. Some other groups, such as Rotifers, undergo significant morphological changes during preservation, making it necessary to observe them in their living conditions (Mishra 2014).

A Pearson's correlation coefficient was applied on Microsoft Excel 2008 to study how water quality factors affect the zooplankton.

RESULTS AND DISCUSSION

Data on physicochemical parameters and seasonal variations of zooplankton in Manikchand Pond, Phulwarisharif, Patna and Phulwarisharif Pond, Phulwarisharif, Patna, have been given in Tables 1 to 4. A total of 26 genera of zooplankton, representing 05 genera of Protozoa, 08 genera of Rotifera, 07 genera of Cladocera, 04 genera of Copepoda and only 01 genus of Ostracoda were identified in this work. Protozoan zooplankton was identified as Amoeba, Arcella, Balantidium, Paramaecium and Vorticella. As far as zooplankton of rotifers is concerned, they were Asplanchna, Brachionus, Conchilus, Filinia, Keratella, Lecane, Notholca and Testudinella. Cladoceran zooplankton in this study were identified as Alona, Alonella, Bosmina, Ceriodaphnia, Daphnia, Daphniosoma and Monia. Similarly, the zooplankton of Copepoda included Cyclops, Diaptomus, Heliidiaptomus, Nauplius and Thermocyclops and only one genus of zooplankton of Ostracoda was identified as Cypris.

Pai and Berde (2005) reported 48 and 50 species of zooplankton from Sadoba Pond of Kolhapur District and Santacruz Lake from Goa, respectively. Rajagopal et al. (2010) reported a total of 47 species of zooplankton from three Ponds, namely Chinnaperkovil Pond, Nallanchettipatti Pond and Kadabamkulam Pond of Tamil Nadu, comprising 24 species of rotifers, 09 species of copepods, 08 species of cladocerans, 04 species of ostracods and 02 species of protozoa. A total of 39 species of zooplankton have been reported by Koli and Muley (2012) in Tulshi reservoir of Kolhapur, containing 15 species of rotifers, 12 species of copepods, 10 species of cladocerans and 02 species of ostracods (Tables 1 and 3).

Relationship Between Physico-chemical Parameters and Zooplankton

Results of the two-way correlation coefficient matrix between the zooplankton and physico-chemical parameters of water of Manikchand Pond, Phulwarisarif, Patna Pond and Phulwarisarif Pond, Phulwarisarif, Patna, have been given in Tables 1 and 4. The correlation coefficient results indicate a relationship between the physicochemical parameters of water and zooplankton.

(a) Manikchand Pond, Phulwarisarif, Patna Pond

1. Water temperature showed moderately significant correlation with Copepoda ($r = -0.997, p < 0.01$); significant correlation with Cladocera ($r = 0.958, p < 0.05$); while insignificant correlation with Rotifera ($r = -0.736, p > 0.05$), Ostracoda ($r = 0.791, p > 0.05$) and Protozoa ($r = 0.624, p > 0.05$) (Table 2).
2. pH showed significant correlation with Copepoda ($r = 0.952, p < 0.05$), but insignificant correlation with Cladocera ($r = 0.867, p > 0.05$), Rotifera ($r = 0.561, p > 0.05$), Protozoa ($r = -0.787, p > 0.05$) and Ostracoda ($r = -0.630, p > 0.05$) (Table 2).
3. Conductivity showed a moderately significant correlation with Cladocera ($r = 0.994, p < 0.01$); significant correlation with Ostracoda ($r = 0.966, p < 0.05$); but insignificant correlation with Protozoa ($r = 0.273, p > 0.05$), Rotifera ($r = -0.941, p > 0.05$), ($r = -0.619, p > 0.05$) and Copepoda ($r = -0.949, p > 0.05$) (Table 2).
4. Dissolved oxygen showed highly significant correlation with Cladocera ($r = -0.999, p < 0.001$), significant correlation with Copepoda ($r = 0.980, p < 0.05$), but insignificant correlation with Protozoa ($r = -0.386, p > 0.05$), Rotifera ($r = 0.893, p > 0.05$) and Ostracoda ($r = 0.929, p > 0.05$) (Table 2).
5. Biochemical Oxygen Demand showed moderately significant correlation with Protozoa ($r = 0.997, p < 0.01$), but insignificant correlation with Cladocera ($r = 0.307, p > 0.05$), Rotifera ($r = 0.141, p > 0.05$), Ostracoda ($r = -0.055, p > 0.05$) and Copepoda ($r = -0.501, p > 0.05$) (Table 27).
6. Total alkalinity showed highly significant correlation with Cladocera ($r = 0.999, p < 0.001$); significant correlation with Copepoda ($r = -0.980, p < 0.05$); while insignificant correlation with Rotifera ($r = -0.892, p > 0.05$), Ostracoda ($r = 0.928, p > 0.05$) and Protozoa ($r = 0.380, p > 0.05$) (Table 2).
7. Hardness showed highly significant correlation with Ostracoda ($r = 0.999, p < 0.001$), moderately significant correlation with Rotifera ($r = 0.996, p < 0.01$), but insignificant correlation with Cladocera ($r = 0.935, p > 0.05$), Protozoa ($r = -0.022, p > 0.05$) and Copepoda ($r = -0.839, p > 0.05$) (Table 2).
8. Total dissolved solids showed moderately significant correlation with Ostracoda ($r = 0.998, p < 0.01$) and Rotifera ($r = -0.998, p < 0.01$), significant correlation with Copepoda ($r = -0.798, p > 0.05$), but insignificant correlation with Cladocera ($r = 0.907, p > 0.05$), Protozoa ($r = -0.049, p > 0.05$) (Table 2).
9. Chloride showed a moderately significant correlation with Cladocera ($r = 0.998, p < 0.01$), significant correlation with Ostracoda ($r = 0.954, p < 0.05$) Copepoda ($r = 0.962, p < 0.05$), but insignificant correlation with Rotifera ($r = -0.925, p > 0.05$), Protozoa ($r = 0.314, p > 0.05$) and (Table 2).
10. Nitrate showed highly significant correlation with Rotifera ($r = 0.999, p < 0.001$), moderately significant correlation with Ostracoda ($r = 0.994, p < 0.01$), but insignificant correlation with Cladocera ($r = 0.888, p > 0.05$), Protozoa ($r = -0.097, p > 0.05$) and Copepoda ($r = -0.771, p > 0.05$) (Table 2).
11. Turbidity showed significant correlation with Rotifera ($r = -0.978,$

$p < 0.05$) and Ostracoda ($r = 0.959, p < 0.05$), but insignificant correlation with Cladocera ($r = 0.793, p > 0.05$), Protozoa ($r = -0.268, p > 0.05$) and Copepoda ($r = -0.646, p > 0.05$) (Table 2).

(b) Phulwarisarif Pond, Phulwarisarif, Patna

1. Water temperature showed significant correlation with Cladocera ($r = 0.959, p < 0.05$), but insignificant correlation with Rotifera ($r = 0.150, p > 0.05$), Protozoa ($r = 0.112, p > 0.01$), Copepoda ($r = 0.798, p > 0.05$) and Ostracoda ($r = 0.849, p > 0.05$) (Table 4).
2. pH showed significant correlation with Cladocera ($r = 0.940, p < 0.05$) and Ostracoda ($r = 0.906, p < 0.05$); but insignificant correlation with Protozoa ($r = 0.005, p > 0.05$), Rotifera ($r = 0.268, p > 0.05$), and Copepoda ($r = 0.864, p > 0.05$) (Table 4).
3. Zooplankton of Protozoa, Rotifera, Cladocera, Ostracoda and Copepoda shared an insignificant ($p > 0.05$) relationship with Conductivity, Dissolved Oxygen, Biochemical Oxygen Demand, Total Alkalinity, Total hardness and Total Dissolved Solids (Table 4).
4. Chloride showed a moderately significant correlation with Cladocera ($r = 0.992, p < 0.01$), but insignificant correlation with Rotifera ($r = -0.513, p > 0.05$), Protozoa ($r = -0.240, p > 0.05$), Ostracoda ($r = -0.792, p > 0.05$) and Copepoda ($r = 0.786, p > 0.05$), (Table 4).
5. Nitrate showed a perfect positive significant correlation with Protozoa, Rotifera and Ostracoda and a negative perfect correlation with Cladocera and Copepoda (Table 4).
6. Turbidity showed significant correlation with Rotifera ($r = -0.985, p < 0.05$) and Ostracoda ($r = 0.967, p < 0.05$), but insignificant correlation with Cladocera ($r = 0.712, p > 0.05$), Protozoa ($r = -0.279, p > 0.05$) and Copepoda ($r = -0.649, p > 0.05$) (Table 4).

Bird and Day (2014) conducted a study focusing on the effects of habitat transformation on the physico-chemical characteristics of pH, DO, BOD, TDS, TSS and TS in temporary wetlands in the south-western Cape region of South Africa. Brraich et al. (2021) conducted a comprehensive study on the water quality parameters of Harike Wetland in Punjab, spanning from 2018 to 2019. To assess the relationships between different physico-chemical parameters, Pearson Correlation analysis was employed to determine the correlation coefficients. The study revealed the significant influence of pollution load from multiple sources on the seasonal variations and water quality parameters of the wetland, particularly pH, nitrates and phosphates specifically; pH exhibited a negative correlation with all other parameters except phosphates. Water temperature, alkalinity, total dissolved solids and nitrates generally displayed a significant positive correlation with other physicochemical parameters.

CONCLUSION

A significant correlation was observed between zooplankton abundance and both pH and BOD levels. These findings suggest a potential role for these parameters in shaping and supporting diverse zooplankton communities within the ecosystem. pH exerts a significant influence on overall water quality and can directly impact the survival and reproductive success of aquatic organisms, including zooplankton. Similarly, BOD levels serve as an indicator of organic pollution load and can indirectly affect zooplankton abundance by influencing dissolved oxygen availability. Therefore, the observed correlations highlight the potential importance of maintaining optimal pH and managing organic pollution inputs to promote and sustain diverse zooplankton assemblages within the ponds of Patna.

Table 1. Seasonal Variation of Zooplankton Density (Unit/Litre) from Manikchand Pond, Anisabad, Patna, During 2023-2025.

	Summer	Monsoon	Winter	Total	Mean
Protozoa	264 (32.23%)	163 (29.91%)	161 (15.54%)	588 (24.63%)	196 (24.63%)
Rotifera	341 (41.64%)	148 (27.16%)	484 (46.72%)	973 (40.74%)	324.33 (40.74%)
Cladocera	107 (13.06%)	112 (20.55%)	82 (7.92%)	301 (12.60%)	100.33 (12.60%)
Copepoda	101 (12.33%)	114 (20.92%)	305 (29.44%)	520 (21.77%)	173.33 (21.77%)
Ostracoda	6 (0.73%)	8 (1.47%)	4 (0.39%)	18 (7.53%)	6 (7.53%)
Total	819 (34.30%)	545 (22.82%)	1036 (43.38%)	2388	799.99

Table 2. Correlation-coefficient of Physicochemical Parameters of Water and Zooplankton of Manikchand Pond, Anisabad, Patna, During 2023-2025 (Tabulated r at df: 2 = 0.950 at 5%, 0.991 at 1% and 0.999 at 0.1% level).

	Water Temp. (OC)	pH	Cond. (umho/cm)	Dissolved Oxygen (mg/L)	Biochemical Oxygen demand	Total Alkalinity (mg/L)	Hardness (mg/L)	Total Dissolved Solid (mg/L)	Chloride (mg/L)	Nitrate (mg/L)	Turbidity (NTU)
Protozoa	0.624NS	-0.787NS	0.273 NS	-0.386NS	0.997**	0.380NS	-0.022NS	-0.049NS	0.314 NS	-0.097NS	-0.268NS
Rotifera	-0.736NS	0.561 NS	-0.941NS	0.893NS	0.141NS	-0.892NS	-0.996**	-0.998**	-0.925NS	0.999***	-0.978*
Cladocera	0.958*	0.867NS	0.994 **	-0.999***	0.307 NS	0.999***	0.935NS	0.907NS	0.998**	0.888NS	0.793NS
Copepoda	-0.997**	0.952*	-0.949 NS	0.980*	-0.501NS	-0.980*	-0.839NS	-0.798NS	-0.962*	-0.771NS	-0.646NS

Ostracoda	0.791NS	-0.630NS	0.966*	0.929NS	-0.0557NS	0.928 NS	0.999***	0.998**	0.954*	0.994**	0.959*
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(NS= Not Significant, *=Significant, **=Moderately Significant and ***=Highly Significant).

Table 3. Seasonal Variation of Zooplankton Density (Unit/Litre) from Phulwari Sharif Pond, Phulwari Sharif, Patna, During 2023-2025.

	Summer	Monsoon	Winter	Total	Mean
Protozoa	199 (19.72%)	133 (15.79%)	94 (24.63%)	426 (16.17%)	142 (16.17%)
Rotifera	556 (55.10%)	444 (52.73%)	254 (32.40%)	1254 (47.59%)	418 (47.59%)
Cladocera	123 (12.19%)	132 (15.68%)	114 (14.54%)	369 (14.00%)	123 (14.00%)
Copepoda	123 (12.19%)	125 (14.84%)	316 (40.31%)	564 (21.40%)	188 (21.40%)
Ostracoda	8 (0.79%)	8 (0.95%)	6 (0.76%)	22 (0.83%)	7.33 (0.83%)
Total	1009 (38.29%)	842 (31.95%)	784 (29.75%)	2635	878.33

Table 4. Correlation-coefficient of Physicochemical Parameters of Water and Zooplankton of Phulwari Sharif Pond, Phulwari Sharif, Patna, During 2023-2025 (Tabulated r at df: 2 = 0.950 at 5%, 0.991 at 1% and 0.999 at 0.1% level).

	Water Temp. (0C)	pH	Cond. (µmho/cm)	Dissolved Oxygen (mg/L)	Biochemical Oxygen demand	Total Alkalinity (mg/L)	Hardness (mg/L)	Total Dissolved Solid (mg/L)	Chloride (mg/L)	Nitrate (mg/L)	Turbidity (NTU)
Protozoa	0.112NS	0.005NS	0.494 NS	-0.548NS	-0.093NS	0.376NS	0.684NS	0.412NS	-0.240NS	1.00	-0.279NS
Rotifera	0.150NS	0.268NS	0.220NS	0.281NS	0.201NS	0.091NS	0.442NS	0.129NS	-0.513NS	1.00	-0.985*
Cladocera	0.959*	0.940*	-0.627NS	-0.576NS	0.891NS	-0.723NS	-0.427NS	-0.696NS	-0.992**	-1.00	0.712 NS
Copepoda	0.798NS	0.864NS	0.144NS	0.081NS	-0.538NS	0.273NS	-0.091NS	0.235NS	0.786NS	-1.00	-0.649NS
Ostracoda	0.849NS	0.906*	0.153NS	0.090NS	-0.5467NS	-0.281 NS	0.082NS	-0.243NS	-0.792NS	1.00	-0.967*

(NS= Not Significant, *=Significant, **=Moderately Significant and ***=Highly Significant).

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