ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 12| Issue: 3| March2026|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2026: 8.753 || ISI Value: 1.188

PHYSICOCHEMICAL PROFILE AND ZOOPLANKTON COMMUNITY STRUCTURE OF FRESHWATER SYSTEMS IN KALWAN REGION, NASHIK DISTRICT, MAHARASHTRA

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Article DOI: https://doi.org/10.36713/epra26600
DOI No: 10.36713/epra26600

ABSTRACT

Aquatic ecosystems exhibit dynamic ecological behaviour governed by physicochemical gradients that regulate productivity and biodiversity. The present investigation assessed water quality parameters and zooplankton assemblages across five freshwater habitats pond, well, river, lake, and reservoir in the Kalwan region of Nashik district, Maharashtra. Sampling was conducted monthly from January to June 2024 using standardized limnological protocols. Researchers evaluated temperature, pH, turbidity, conductivity, total dissolved solids, alkalinity, hardness, chloride, nitrate, phosphate, dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand. Zooplankton samples were obtained using a 50 µm mesh net, preserved in formalin, and quantified using a Sedgwick–Rafter chamber. Community composition was dominated by Rotifera, followed by Cladocera, Copepoda, and Ostracoda. Total density varied markedly, ranging from 90 Ind/L in the well to 378 Ind/L in the reservoir. Elevated diversity and density in lentic systems indicate favourable ecological conditions supporting plankton proliferation.

KEYWORDS: *Zooplankton Diversity, Limnological Parameters, Freshwater Ecosystems, Rotifera, Ecological Assessment, Kalwan*

INTRODUCTION

Freshwater ecosystems function as dynamic ecological systems where physicochemical conditions regulate biological productivity and community organization. These systems are essential for maintaining ecological balance while supporting human requirements such as drinking water, agriculture, and fisheries. The overall condition of freshwater habitats, including ponds, lakes, rivers, reservoirs, and wells, depends largely on key limnological parameters such as temperature, pH, dissolved oxygen, nutrient concentrations, and dissolved solids. These factors collectively influence species distribution, metabolic activity, and trophic interactions within aquatic environments (Dutta, 2021; Sharma & Sharma, 2019). Zooplankton represent a crucial component of freshwater food webs, occupying an intermediate trophic level between phytoplankton and higher consumers such as fish. Their ecological significance lies in their role in energy transfer and nutrient cycling. Due to their rapid life cycles and high sensitivity to environmental fluctuations, zooplankton communities are widely recognized as reliable indicators of water quality and ecosystem health (Pogare et al., 2023). Variations in their diversity, abundance, and composition are strongly influenced by environmental gradients such as temperature, dissolved oxygen, turbidity, and nutrient availability. Numerous limnological studies conducted across India have demonstrated that physicochemical variability significantly affects zooplankton assemblages and biodiversity patterns. Changes in nutrient levels, hydrological conditions, and anthropogenic inputs often result in shifts in community structure and ecosystem functioning (Salve & Hiware, 2020; Padhye et al., 2023). However, ecological information on freshwater systems of the Kalwan region in Nashik district remains limited. Therefore, the present investigation aims to evaluate physicochemical characteristics and analyse zooplankton diversity across selected freshwater habitats in this region, providing baseline data for ecological assessment and future conservation planning.

MATERIALS AND METHODS

Study Area and Sampling Design

Fieldwork was conducted in Kalwan (20.5° N, 74.0° E), Nashik district. Five contrasting freshwater systems were selected: pond, well, river, lake, and reservoir. Sampling occurred monthly between January and June 2024, during morning hours (08:00–11:00). The research team collected triplicate samples from each site to ensure statistical reliability.

Physicochemical Analysis

Investigators collected water samples in sterilized 2 L polyethylene containers and transported them under refrigerated conditions (4°C). Following APHA (2012) guidelines, they measured physicochemical variables. Field measurements included temperature and pH. Laboratory assessments involved turbidity, conductivity, and TDS using digital meters. Titrimetric procedures were applied for alkalinity, hardness, and chloride estimation. Nutrient

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concentrations (nitrate and phosphate) were determined colorimetrically. Dissolved oxygen was quantified using Winkler's method, while BOD and COD were evaluated through standard protocols.

Zooplankton Sampling and Enumeration
Researchers filtered 50 L of water through a 50 µm plankton net to obtain zooplankton samples. After concentration, samples were preserved in 4% formalin and adjusted to 50 mL. From each sample, a 1 mL aliquot was examined using a Sedgwick–Rafter counting chamber. Identification was performed using established taxonomic references (Battish, 1992; Edmondson, 1959). Copepod nauplii were included within Copepoda counts.

Density was Calculated as
Density (Ind/L) = (N × v) / (V × a)
Where:
N = organisms counted
v = concentrated volume (50 mL)
V = filtered volume (50 L)
a = subsample volume (1 mL)
Diversity indices (Shannon H′ and Pielou's J′) were computed.

Statistical Analysis
Data were processed using Microsoft Excel and analysed with SPSS (Version 26.0). Results are expressed as mean ± SD (n = 6). Pearson correlation analysis was performed using 30 observations (6 months × 5 sites), with significance levels set at $p < 0.05$ and $p < 0.01$.

RESULTS

Physicochemical Parameters
Substantial variation in limnological parameters was observed among the selected habitats. Temperature values ranged from 25.6°C in the river to 27.3°C in the pond, reflecting differences in hydrodynamics and solar exposure. pH values remained within a narrow neutral-to-alkaline range (7.1–7.9). Dissolved oxygen levels varied between 5.2 mg/L and 7.4 mg/L, indicating generally suitable conditions for aquatic organisms. Notably, nitrate and phosphate concentrations were elevated in the river and pond, suggesting higher allochthonous inputs, whereas the well exhibited relatively low nutrient levels.

Zooplankton Composition and Density
Marked differences in zooplankton distribution were recorded across habitats. Rotifera constituted the dominant group (46.2%), followed by Copepoda (25.9%), Cladocera (22.8%), and Ostracoda (14.9%). Density values were lowest in the well (90 Ind/L) and highest in the reservoir (378 Ind/L). Lentic habitats consistently supported richer assemblages compared to the flowing river system.

Zooplankton Diversity Indices
Diversity indices indicated moderate to high ecological stability across sites. Shannon index values ranged from 1.78 to 2.45, with highest diversity observed in the reservoir. Evenness values suggested relatively balanced species distribution in lentic habitats.

Correlation Analysis
Statistical analysis revealed significant relationships between environmental variables and zooplankton groups.

- DO showed strong positive correlation with Cladocera ($r = 0.72$)
- Temperature and phosphate correlated with Rotifera
- Nitrate influenced total density
- Turbidity negatively affected Cladocera

DISCUSSION

Observed physicochemical conditions align with typical tropical freshwater ecosystems in Maharashtra (Salve & Hiware, 2020). Neutral to slightly alkaline pH likely reflects underlying basaltic geology, creating favourable conditions for plankton growth. Higher dissolved oxygen in the lake suggests enhanced autochthonous production, while reduced DO in the well reflects limited atmospheric exchange. This pattern may be attributed to restricted mixing in groundwater systems. Rotifer dominance observed in this study corroborates earlier findings by Padhye et al. (2023). Their reproductive strategy and ecological flexibility allow them to thrive under varying environmental conditions. Interestingly, lentic habitats supported greater zooplankton density compared to lotic systems. One plausible explanation is that stable water columns enhance food availability and reduce physical disturbances. The strong DO–Cladocera relationship indicates oxygen dependency of filter feeders. Similarly, nutrient enrichment appears to promote rotifer proliferation. These results support the hypothesis that moderate nutrient levels enhance zooplankton productivity without causing ecological imbalance. The negative influence of turbidity on Cladocera suggests interference with feeding mechanisms. This finding aligns with the principle that suspended solids disrupt filter-feeding efficiency.

Overall, the data suggest that physicochemical stability plays a central role in maintaining ecological integrity and biodiversity in freshwater systems.

CONCLUSION

Freshwater ecosystems of the Kalwan region exhibit moderate ecological quality characterized by balanced physicochemical conditions and diverse zooplankton assemblages. Lentic habitats, particularly the reservoir and lake, support higher biodiversity compared to groundwater systems. Sustained monitoring and management interventions are essential to preserve these ecosystems and ensure long-term ecological stability.

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FIGURES AND TABLES

Table 1. Physicochemical Parameters of Freshwater Sites

Parameter	Pond	Well	River	Lake	Reservoir
Temperature (°C)	27.3±2.1	26.5±2.0	25.6±1.8	26.4±2.0	26.9±2.2
pH	7.4±0.2	7.8±0.2	7.1±0.2	7.9±0.2	7.5±0.3
Turbidity (NTU)	10.8±2.1	2.5±0.8	13.5±2.8	7.2±1.5	8.5±1.7
Conductivity (µS/cm)	315±24	265±18	325±28	270±19	295±22
TDS (mg/L)	295±28	245±20	315±30	225±18	260±24
DO (mg/L)	6.2±0.6	5.2±0.5	5.6±0.7	7.4±0.4	6.9±0.5
BOD (mg/L)	2.9±0.4	1.2±0.3	3.4±0.5	2.1±0.3	2.3±0.4
Alkalinity (mg/L)	162±15	125±10	178±18	135±11	152±14
Hardness (mg/L)	150±14	110±9	165±16	118±10	142±13
Chloride (mg/L)	49±5	28±4	54±6	39±4	45±5
Nitrate (mg/L)	0.73±0.09	0.35±0.05	0.82±0.10	0.55±0.06	0.68±0.08
Phosphate (mg/L)	0.43±0.06	0.18±0.03	0.48±0.07	0.29±0.04	0.39±0.05
COD (mg/L)	10.2±1.3	4.5±0.8	11.5±1.5	7.6±0.9	9.2±1.2

Table 2. Zooplankton Density (Ind/L) at Different Sites

Group	Pond	Well	River	Lake	Reservoir	Mean ± SD	%
Rotifera	145±28	42±10	89±18	138±26	158±30	114.4±48.9	46.2
Cladocera	70±15	18±5	44±10	74±16	76±17	56.4±25.7	22.8
Copepoda	72±14	20±5	52±11	85±17	92±19	64.2±28.8	25.9
Ostracoda	44±9	10±3	30±7	48±10	52±11	36.8±17.1	14.9
Total	287±52	90±18	215±42	345±60	378±68	263.0±113.5	100

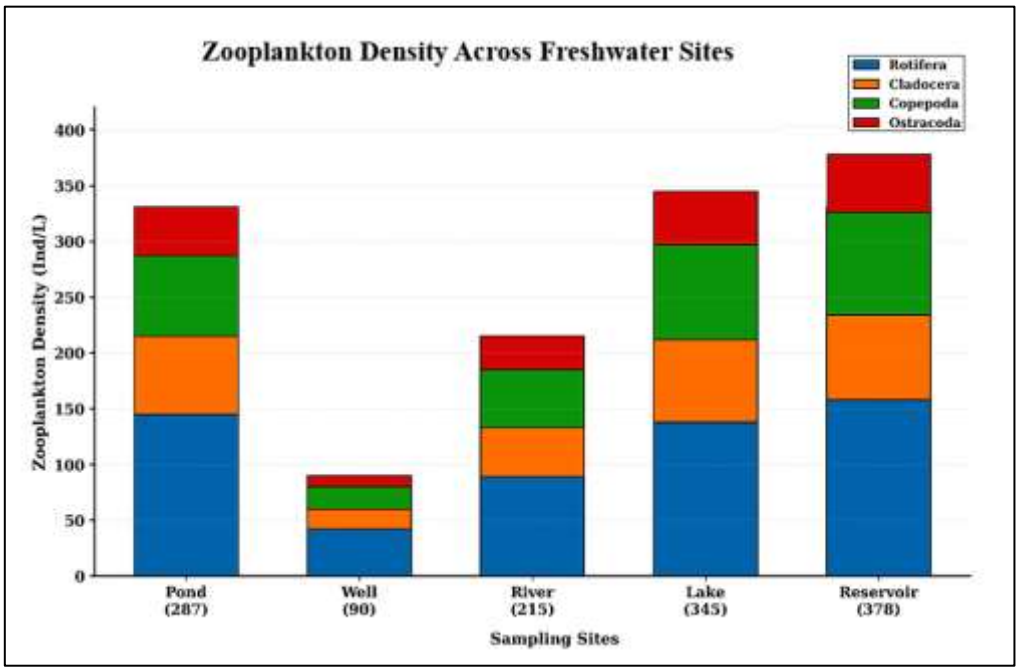


Figure 1. Zooplankton density (Ind/L) across freshwater sites showing group-wise composition of Rotifera, Cladocera, Copepoda, and Ostracoda.

Table 3. Diversity Indices of Zooplankton Communities

Site	Shannon (H′)	Evenness (J′)	Total Density (Ind/L)
Pond	2.34 ± 0.14	0.84 ± 0.04	287 ± 52
Well	1.78 ± 0.11	0.71 ± 0.05	90 ± 18
River	2.02 ± 0.12	0.74 ± 0.05	215 ± 42
Lake	2.39 ± 0.15	0.86 ± 0.04	345 ± 60
Reservoir	2.45 ± 0.16	0.88 ± 0.03	378 ± 68

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Table 4. Pearson Correlation (n=30, df=28)

Parameter	Zooplankton Group	r	p
Dissolved Oxygen	Cladocera	0.72	<0.001
Temperature	Rotifera	0.64	<0.001
Phosphate	Rotifera	0.62	<0.001
Nitrate	Total Zooplankton	0.58	<0.01
Turbidity	Cladocera	-0.55	<0.01

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