Journal of Life Sciences and Informatics
ISSN Online: 3106-6542 , ISSN Print: 3106-6534

Research Paper

Assessment of Physicochemical Parameters and Plankton Diversity in River Ravi, Pakistan

Asim Bilal *[1], Tanveer ul Amin [2]

[1] Quality Control lab, Fisheries Research and Training Institute, Manawa, Lahore.
[2] Department of Molecular Biotechnology, University of Campania, Italy.

Correspondence: asimbilal363@gmail.com

Abstract:

Significant freshwater systems like rivers are useful in supporting agriculture, biodiversity, and the livelihood of human beings. The growing anthropogenic pressures, however, disrupt their ecological integrity. The current research studied planktonic biodiversity and water quality of the river Ravi in June-August 2024 at three sampling points, namely, Siphon, Shahdara, and Motorway Bridge (Babu Sabu Interchange). Analysis of the pH, conductivity, turbidity, total hardness, and total alkalinity of the water samples was done through the standardized protocol of APHA and AOAC. The population of the zooplankton and phytoplankton was determined using the compound microscope and Sedgwick-Rafter counting chambers. At the Shahdara, the highest turbidity (28 ± 3 NTU) and the lowest alkalinity (115 ± 5 mg/L CaCO3) were detected, which indicates the untreated domestic and industrial effluents. *Brachionus* sp. (*Rotifera*) that was prevailing in the samples is a member of the zooplankton and a bioindicator of organic pollution. Eutrophic situations are revealed by the Phytoplankton diversity, which includes Euglena, *Holopedium*, *Cosmarium*, and Pediastrum species. The results of the current research suggest that the degree of contamination of the River Ravi is moderate, and it is necessary to conduct frequent monitoring and efficient wastewater management actions to preserve and maintain aquatic biodiversity.

Keywords: Plankton diversity, phytoplankton, river Ravi, water quality, zooplanktons, pollution.

Citation: Bilal A., Amin T U. (2026) Assessment of Physicochemical Parameters and Plankton Diversity in River Ravi, Pakistan. J Life Sci Inform, 2(1), 1–9.

Conflict of Interest: Author(s) declared no conflict of interest

Introduction:

Freshwater is a significant natural resource that regulates the hydrological flows, biodiversity, agriculture, and domestic and commercial water supply (Wetzel, 2001; Kumari et al., 2020). These systems depend on rivers as significant ecological and socioeconomic lifelines. However, in third-world countries like Pakistan, industrialization, urbanization, and agricultural activity have been very fast, thus rendering riverine ecosystems extremely difficult, which has resulted in substandard water quality and biodiversity loss (Aslam et al., 2021). The River Ravi is among the most contaminated rivers in South Asia, which used to be one of the major branches of the Indus Basin (Iqbal et al., 2019). A massive amount of untreated municipal waste, sewage, industrial effluents, and agricultural runoffs is released into it, especially in and near Lahore. This means that the river serves as an effective source of pollution, and therefore a menace to human health, aquatic life, and environmental sustainability. Considerable physicochemical parameters that define the quality of water and determine the existence, progress, and reproduction of aquatic organisms are pH, electrical conductivity, turbidity, hardness, and alkalinity (Hassan et al., 2023; Khan et al., 2025). There is also an understanding that the Plankton diversity is a sensitive bioindicator of the health of aquatic ecosystems (Reynolds, 2006; Hemraj et al., 2017). Zooplankton *Brachionus* species of rotifers are notorious in their association with nutrient-rich and organically polluted habitats (Hamre, 2016). On the same note, the composition and phytoplankton diversity can be used to supply significant data on the trophic conditions and levels of eutrophication (Reynolds, 2006; Wang et al., 2023). Previous research has been carried out in Pakistan, which indicates that there is a declining aspect of biodiversity and rising pollution in the major river systems. Ahmad et al. (2020) detected a high level of contamination on the Indus River, and Khan et al. (2018) noted the presence of extreme turbidity and toxic discharges on the Ravi below Lahore. Zooplankton assessments in the impaired water bodies have always indicated the domination of pollution-resistant ones like *Brachionus* (Iqbal et al., 2019). Irrespective of such outcomes, the number of comprehensive research studies that combine physicochemical research with the evaluation of the planktonic biodiversity of the River Ravi is low. Thus, the current investigation was carried out to (i) measure the significant water quality indicators in three chosen locations of the River Ravi, (ii) to document the diversity and composition of planktonic communities, and (iii) to determine ecological tendencies that are characteristic of pollution and eutrophication. It is hoped that the results of this study will form the groundwork of the necessary baseline data needed in the long-term monitoring, as well as the formulation of a useful management framework of one of the most environmentally stressed river systems in Pakistan.

Material and Methods

Material Required:

Compound microscope, Sedwick Rafter counting chamber, micropipette, colony counter, Digital pH meter (AOAC 973.41), Glass beakers, Conductivity meter (APHA 2130B), Turbidity meter (APHA 2130B), Eriochrome Black T (EBT) indicator, 0.01M EDTA titrant,

Ammonia buffer solution, burette, pipette, flask, 0.02N Sulfuric acid, Methyl orange indicator.

Study Sites and Sampling

Three sample points along River Ravi were chosen, namely, Siphon (upstream, less polluted), Shahdara (sewage and industrial discharges), and Motorway Bridge at Babu Sabu Interchange (downstream, moderately polluted). Water samples were collected monthly from June to August 2024, in the early months of the monsoons. To decrease the possibility of mistakes, triplicate samples were collected at each site to ensure consistency. Water samples were collected in clean bottles, properly labelled, transported to the laboratory in insulated containers, and analyzed according to standard procedures.

Physicochemical Parameters

pH meter:
A beaker of 25ml of water was taken. The digital pH meter was rinsed with distilled water and lowered into the sample. The pH was observed after stabilization. All the samples were done in triplicate (Food et al., 2020).

Conductivity Measurement:
The beaker was filled with 25 mL of a water sample. The conductivity meter was applied to the sample in the form of a digital meter, and the reading was taken when the meter stabilized. Triplicate analysis was conducted in each sample (Rahmanian et al., 2015).

Turbidity Measurement:
A 10 mL sample was placed in a vial, degassed to remove air bubbles, and inserted into the turbidity meter. The turbidity value was directly recorded. Each sample was analysed in triplicate (Rahmanian et al., 2015).

Total Hardness Measurement
The water sample of 25ml was titrated against EDTA using EBT as an indicator. The endpoint was indicated by a change in colour from red to blue (Rahmanian et al., 2015).
Hardness (mg/L as $CaCO_3$) = (ml EDTA) x 1.01 x 1000 / ml sample.

Total Alkalinity Measurement
A 25 mL water sample was titrated against H_2SO_4 using methyl orange as an indicator. The endpoint was marked by a color change from green to pink (Rahmanian et al., 2015).
Total Alkalinity (mg/L as $CaCO_3$) = (ml H_2SO_4) x 0.02 x 50,000/ ml sample

Plankton Identification

In the case of planktons, the water was filtered using a 150 µm plankton net (30 L of water). The concentrate was stored with 4% formaldehyde and analyzed in the laboratory using a Sedgwick Rafter counting chamber under a microscope (10x magnification). Zooplankton had been counted in three random rows, and phytoplankton had been

counted in grids. ID was identified in accordance with Edmondson (1959) and APHA (2017).

Statistical Analysis:

Statistical analyses were performed by using Microsoft Excel 2019 and SPSS version 20.0. A significance level of $p < 0.05$ was considered statistically significant.

Results and Discussion

Physicochemical Parameters

The elevated conductivity and turbidity values observed at Shahdara are likely associated with the discharge of untreated municipal wastewater, industrial effluents, and urban runoff entering the River Ravi in the Lahore region. Increased conductivity reflects a higher concentration of dissolved ions and salts, whereas elevated turbidity indicates greater loads of suspended particles and organic matter. Similar patterns have been reported in previous investigations of the River Ravi, where downstream sections exposed to anthropogenic activities exhibited poorer water quality than upstream locations. Such changes can adversely affect aquatic organisms by reducing light penetration, altering habitat conditions, and influencing physiological processes in fish and invertebrates.

The quality of water was different across sites (Table 1). Turbidity was the highest at Shahdara (28 ± 3 NTU), and the lowest alkalinity (115 ± 5 mg/L CaCO3) was also the lowest, which indicates the entry of untreated effluents. However, Siphon was of higher quality, whereas Motorway demonstrated intermediate scores.

Table 1: Physicochemical parameters of River Ravi water samples (mean ± SD)

Site	pH	Conductivity (µS/cm)	Turbidity (NTU)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	TDS (mg/L)
Siphon	7.5 ± 0.1	650 ± 15	12 ± 2	180 ± 5	140 ± 4	223 ± 3.06
Shahdara	7.2 ± 0.2	820 ± 20	28 ± 3	220 ± 6	115 ± 5	260 ± 3.51
Motorway	7.4 ± 0.1	750 ± 18	19 ± 2	210 ± 7	125 ± 6	327 ± 6.11
Anova (p-value)	0.270	0.004**	0.001**	0.009**	0.0017**	0.002 **

These results align with earlier studies indicating that water quality deteriorates downstream of Lahore (Iqbal et al., 2019). Elevated conductivity and hardness at

Shahdara and Motorway suggest the presence of dissolved salts and ions from industrial waste. Such parameters directly affect fish physiology and overall aquatic productivity.

Zooplankton Diversity

The dominance of *Brachionus* sp. across the investigated sites is ecologically significant because rotifers of this genus are widely recognized as indicators of nutrient enrichment and organic pollution. Their ability to tolerate fluctuating environmental conditions and elevated organic loads allows them to thrive in disturbed aquatic systems where more sensitive zooplankton groups may decline. Similar dominance of rotifer communities has been reported from eutrophic freshwater bodies and polluted river systems in South Asia, suggesting that the observed plankton composition may reflect environmental stress associated with anthropogenic inputs.

Brachionus sp. (Rotifera) had an overwhelming dominance over the Zooplankton community in every site and month (Table 2). The domination of rotifers is a classical indication of organic enrichment (Gilbert, 2022). Lack of delicate taxa like cladocerans and copepods denotes poor water quality and a lack of ecological equilibrium. This is in line with other eutrophic Punjabi rivers, which harbour rotifers through nutrient-enriched and organic-polluted environments (Ahmad et al., 2020).

Table 2: Identified dominant zooplankton species from the River Ravi at different sampling sites

Site	Month	Dominant Zooplankton
Siphon	June	*Brachionus* sp.
Shahdara	July	*Brachionus* sp.
Motorway	August	*Brachionus* sp.

Figure 1: Identified *Brachionus* sp. (viewed at 10x magnification)

Phytoplankton Diversity

The occurrence of *Euglena* sp., *Pediastrum* sp., and *Cosmarium* sp. may provide useful insights into environmental conditions within the studied river reaches. Species of *Euglena* are frequently associated with organically enriched waters, whereas *Pediastrum* and *Cosmarium* are commonly reported in nutrient-rich freshwater environments. Although nutrient concentrations were not measured in the present study, the presence of these taxa together with elevated turbidity and conductivity values may indicate increased nutrient availability resulting from anthropogenic activities. Comparable phytoplankton assemblages have been reported in freshwater ecosystems experiencing moderate environmental disturbance and nutrient enrichment.

There were site-specific differences in the phytoplankton composition (Table 3). The abundance of the *holopedium* and the *euglena* (Figure 2) at the Siphon and Shahdara location, and *Pediastrum* and *Cosmarium* at the Motorway location, was more prevalent. Green algae are considered positive indicators of eutrophication and nutrient enrichment (*Pediastrum, Cosmarium*) (Reynolds, 2006; Wurtsbaugh et al., 2019). The decline of the diatom dominance, as earlier reported by Ravi in his previous surveys, and its replacement by the green algae are indicators of ecological changes that could have been attributed to nutrient enrichment and organic loading. These alterations have an impact on the DO values, water transparency, and the general fish productivity.

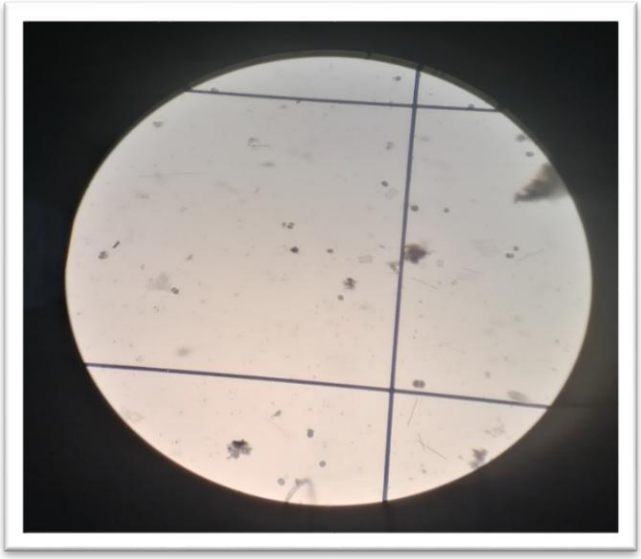

Figure 2: Identified phytoplankton species (viewed at 10x magnification)

Table 3: Identified dominant phytoplankton species from the River Ravi at different sampling sites

Site	Month	Dominant Phytoplankton
Siphon	June	*Holopedium* sp., *Euglena* sp.
Shahdara	July	*Holopedium* sp.
Motorway	August	*Cosmarium* sp., *Pediastrum* sp.

The identification of major plankton taxa and their ecological significance were the main objectives of this study. Due to the lack of comprehensive abundance data for all taxa, quantitative biodiversity indexes as species evenness, Simpson diversity, and Shannon-Wiener diversity were not computed. Therefore, the presence of pollution-tolerant taxa and observed physicochemical traits were used to interpret ecological conditions and eutrophication. For a more thorough evaluation of the ecological health of the River Ravi, future research should include quantitative data on plankton abundance and biodiversity indexes.At Siphon, the level of DO was greater, and the turbidity was less in June, primarily because of dilution by upstream flows, which is an indication of seasonal variation. By comparison, the samples of Shahdara and Motorway in July and August exhibited greater turbidity, increased abundance of rotifers, and organic decomposition with high temperatures and monsoonal runoffs. These differences are oriented to the seasonal fluctuation of the ecosystem in the river in terms of climate and human activity (Liang et al., 2020). In general, it is possible to indicate that the water quality of the Ravi is worsening, but it is happening in most of the downstream locations at a very fast pace. The loss of delicate taxa and resistant species of Chlorella and Brachionus is an ecological indicator of stress and extinction of biodiversity. These constructions are very threatening to the fisheries and ecology of the river. The management should react to this step by undertaking urgent actions to make sure that the industrial and domestic wastewater are treated before discharge; they must also develop routine monitoring programs, which would involve bioindicators such as the planktons, and restrictive policies governing pollution control. Without them, the Ravi River will be negatively affected further, and this will be a threat to the biodiversity and the availability of the freshwater supply.

A limitation of the present study is its relatively restricted spatial and temporal coverage. Sampling was conducted at three locations along the River Ravi during the monsoon period (June–August 2024), which may not fully capture the spatial heterogeneity and seasonal fluctuations of physicochemical conditions and plankton communities within the river system. Consequently, the findings should be interpreted as a baseline assessment of the selected river reaches. Future investigations should include additional sampling stations and year-round monitoring to better evaluate temporal trends, ecological variability, and the long-term impacts of anthropogenic activities on river health.

Conclusion:

The present study provides baseline information on selected physicochemical characteristics and plankton composition at three locations along the River Ravi. Higher turbidity, conductivity, and hardness values observed at Shahdara and Motorway sites, together with the occurrence of pollution-tolerant plankton taxa such as Brachionus sp., suggest environmental stress associated with anthropogenic activities. However, because the study was limited in spatial and temporal scope and did not include nutrient or advanced water-quality analyses, the findings should be regarded as preliminary indicators rather than definitive evidence of eutrophication or biodiversity decline. Future studies incorporating broader seasonal sampling, quantitative biodiversity analyses, nutrient assessments, and additional biological indicators would provide a more comprehensive evaluation of river health.

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