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ZOOPLANKTON DIVERSITY AS A BIOINDICATOR OF WATER QUALITY AND HEAVY METAL POLLUTION IN FRESHWATER BODIES OF TELANGANA

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Abstract

This research examined the diversity of zooplankton to determine water quality and heavy metal pollution using zooplankton as a bioindicator of water quality in five large freshwater bodies in Telangana, India, that include Hussainsagar Lake, Osmansagar Reservoir, Himayathsagar Lake, Shamirpet Lake, and Mir Alam Tank. A total of 12-72 samples were collected in the month of January 2022 -December 2023, and the parameters analyzed included physico-chemical parameters, heavy metal levels, and zooplankton community structure. The total number of identified zooplanktons was 58, which included Rotifera (32 species), Cladocera (14 species), Copepoda (8 species), and Ostracoda (4 species). Rotifera prevailed in the community makeup (48.2%), followed by Cladocera (26.8%), Copepoda (18.6%), and Ostracoda (6.4%). The Shannon-Wiener diversity indices were 1.24 to 3.42, with the lowest diversity levels being recorded at Hussainsagar Lake, and high levels of heavy metals were detected. At industrially affected locations, the levels of lead, cadmium, chromium, and mercury went beyond the acceptable levels. Strong negative relationships were determined between the concentration of heavy metals and indices of zooplankton diversity ($p<0.05$). Potential as pollution-tolerant indicator species was shown in species like Brachionus calyciflorus, Keratella tropica, and Moina micrura. The paper validates zooplankton assemblages as effective bioindicators in determining health and pollution of freshwater ecosystems and heavy metals in the water of Telangana.

Keywords: Zooplankton diversity, Bioindicator, Water quality, Heavy metal pollution, Freshwater ecosystems, Rotifera, Cladocera.

1. Introduction

Freshwater ecosystems form important habitats that sustain a variety of biological communities, as well as essential ecosystem services, such as drinking water, irrigation, fisheries, and groundwater supply (Dudgeon et al., 2006). Nevertheless, the dangers that the ecosystems have never experienced before are urbanization, industrialization, and the intensification of agricultural activities, which have exposed these ecosystems to alarming levels of anthropogenic pressures globally (Carpenter et al., 2011). India has an 80 percent percentage of water bodies which are severely polluted by untreated sewage, industrial effluents, and agricultural effluents (Central Pollution Control Board, 2021).

There are several freshwater lakes and reservoirs within the state of Telangana, specifically in the Hyderabad Metropolitan Region, which have traditionally been utilized as an important source of water. These water bodies, the legendary Hussainsagar Lake, Osmansagar, and Himayathsagar reservoirs, are now grappling with the challenge of severe pollution by pharmaceutical firms, domestic sewage, and unplanned urbanization (Ramachandraiah & Prasad, 2019). According to the studies conducted by the Telangana State Pollution Control Board, heavy metals, such as lead, cadmium, chromium, mercury, and copper, were found in high concentrations in several lakes, which is threatening the condition of the ecosystem and the health of people (TSPCB, 2023).

Indicator organisms' biological monitoring has become a complement to traditional physico-chemical tests and provides a comprehensive answer to environmental conditions with time (Ferdous and Muktadir, 2009). Among other bioindicators, zooplankton communities have been recognized as useful to indicate the water quality fluctuations because of their ubiquitous distribution, short generation times, sensitivity to environmental stressors, and essential locations in the aquatic food web (Gannon and Stemberger, 1978; Haberman and Haldna, 2014).

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The assemblages of zooplanktons are composed of different taxonomic categories, such as Rotifera, Cladocera, Copepoda, and Ostracoda, that have varying levels of tolerance to pollution stress (Sladecek, 1983). It has been shown that zooplankton community structure, species, and the abundance pattern all react predictively to eutrophication, organic pollution, and heavy metal contamination (Ferdous and Muktadir, 2009; Karuthapandi et al., 2015). Dominating species, which are contaminant-tolerant like Brachionus spp. and Keratella spp., are generally indicative of the eutrophic or polluted waters, whereas the vulnerable species disappear (Saksena, 1987).

Although there is increasing awareness of the use of zooplankton as bioindicators, there are still few comprehensive studies that relate zooplankton diversity with heavy metal pollution in the freshwater bodies of Telangana. However, historical literature has mainly studied one of the two aspects (zooplankton taxonomy or water chemistry) in isolation without quantitatively determining how community structure relates to contaminant levels (Karuthapandi et al., 2015; Jagadeeshwara et al., 2015). This paper fills this gap by exploring diversity trends in zooplankton between various freshwater systems in Telangana, comparing communal indicators with levels of heavy metal, and determining which species could be used as an indicator of pollution.

This research was aimed at: (1) characterizing the zooplankton community structure and diversity of five major freshwater bodies in Telangana; (2) evaluating the physico-chemical parameters and heavy metals concentration; (3) determining the correlation between zooplankton diversity indices and pollution parameters; and (4) determining the indicator species that could be applied in biomonitoring programs in the area.

2. Materials and Methods

2.1 Study Area

Research was carried out in five freshwater bodies across the Telangana state, India, i.e., Hussainsagar Lake (17.4239 78.4738), Osmansagar Reservoir (17.3847 78.3025), Himayathsagar Lake (17.3394 78.3397), Shamirpet Lake (17.6195 78.5643), and Mir Alam Tank (17.3 The mentioned water bodies represent one end of an anthropogenic impact, with the most impacted bodies (Hussainsagar) and the least affected ones (Shamirpet). Hussainsagar Lake, located in the city middle of Hyderabad, is fed by the Kukatpally channel and domestic sewage, and the other two lakes are drinking water reservoirs; Osmansagar and Himayathsagar, with limited catchment activities.

2.2 Sampling Protocol

The sampling was carried out once a month (between January 2022 and December 2023) during pre-monsoon (March-May), monsoon (June-September), and post-monsoon (October-February) seasons. Each water body was represented by three sampling stations, which were at the inlet, middle, and outlet zones. Filtered samples of zooplankton were made by filtering 50 liters of surface water with a plankton net (55 µm mesh size). The samples have been stored in 4% formalin and taken to the laboratory, where they were identified and counted with a Sedgwick-Rafter counting chamber under an inverted microscope (Olympus CKX53). Battish (1992), Sharma (1998), and Edmondson (1959) used standard keys to identify taxonomy.

2.3 Physico-chemical Analysis

In-situ measurements of water temperature, pH, electrical conductivity (EC), and dissolved oxygen (DO) were done using portable meters (HACH HQ40d). Laboratory analysis of water samples was done in polyethylene bottles that were washed using acid. The total dissolved solids (TDS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrates, and phosphates were studied using the standard techniques (APHA, 2017). With the aid of acid digestion of the water samples, heavy metal concentrations (Pb, Cd, Cr, Hg, Cu, Zn, Ni) were estimated by Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES, Agilent 5100).

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2.4 Data Analysis

Shannon-Wiener diversity index (H 0) and Simpson dominance index (D), Margalef richness index (d), and Pielou evenness index (J 0) were used to measure the zooplankton diversity. Pearson correlation was done to test the association between diversity indices and environmental parameters. The Principal Component Analysis (PCA) was used to determine the major environmental gradients that affect the distribution of zooplankton. Canonical Correspondence Analysis (CCA) was used to study relationships between species and the environment. The statistical tests were done with the help of PAST 4.03 and SPSS 26.0 at the level of significance 0.05.

3. Results

3.1 Physico-chemical Characteristics

The five freshwater bodies had significant spatial and seasonal differences in terms of the physico-chemical parameters (Table 1). The water temperature varied between 22.4^0 C and 32.80 °C between seasons, with maxima during pre-monsoon. pH varied slightly between 7.2 and 8.6 at all sites. Dissolved oxygen recorded a significant difference ranging between 2.1 mg/L at Hussainsagar to 7.8mg/L at Shamirpet Lake. The lowest levels of DO were found in Husseinsagar (less than 4mg/L), and this was a sign of hypoxia. The BOD of the water was between 3.2 and 18.6 mg/L, with the highest values of BOD being 17.8 and 20.6, which is above the recommended healthy value of 3 mg/L, in Aquatic life.

Table 1. Seasonal mean values of physico-chemical parameters across study sites (2022-2023)

Parameter	Hussainsagar	Osmansagar	Himayathsagar	Shamirpet	Mir Alam	BIS Standard
Temperature (°C)	28.4 ± 3.2	26.8 ± 2.8	26.5 ± 2.6	25.8 ± 2.4	27.6 ± 3.0	-
pH	7.8 ± 0.4	8.2 ± 0.3	8.1 ± 0.3	7.6 ± 0.4	7.9 ± 0.4	6.5-8.5
DO (mg/L)	2.8 ± 0.9	6.4 ± 1.1	6.2 ± 0.9	7.2 ± 1.0	4.6 ± 1.2	>5
EC (µS/cm)	1286 ± 245	542 ± 86	486 ± 72	324 ± 58	876 ± 142	<1000
TDS (mg/L)	824 ± 168	346 ± 54	312 ± 46	208 ± 38	562 ± 92	<500
BOD (mg/L)	14.8 ± 3.6	4.2 ± 1.1	3.8 ± 0.9	3.4 ± 0.8	8.6 ± 2.2	<3
COD (mg/L)	86.4 ± 18.2	28.6 ± 6.4	24.2 ± 5.8	18.6 ± 4.2	52.8 ± 12.4	<25
Nitrate (mg/L)	8.6 ± 2.4	4.2 ± 1.2	3.8 ± 1.0	2.4 ± 0.6	6.4 ± 1.8	<45
Phosphate (mg/L)	2.86 ± 0.82	0.42 ± 0.12	0.38 ± 0.10	0.18 ± 0.06	1.24 ± 0.36	<0.1

Note: Values represent mean ± SD; BIS = Bureau of Indian Standards

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3.2 Heavy Metal Concentrations

The analysis of heavy metals found that Hussainsagar and Mir Alam Tank had a high level of contamination, whereas Osmansagar, Himayathsagar, and Shamirpet had relatively low levels of contamination (Table 2). The lead concentrations were found at the highest levels of 0.008 to 0.142 mg/L, with Hussainsagar recording the highest level of 0.0028mg/L. The cadmium levels were also recorded at the highest point of 0.018mg/L at Hussainsagar and 0.012mg/L at Mir Alam, which is higher than the permissible level of 0.003mg/L. The high levels of heavy metals in Hussainsagar are associated with the release of industrial effluents in the Kukatpally channel, which flows through industrial zones of pharmaceuticals and chemicals.

Table 2. Heavy metal concentrations (mg/L) in water samples across study sites

Heavy Metal	Hussainsagar	Osmansagar	Himayathsagar	Shamirpet	Mir Alam	BIS Limit
Lead (Pb)	0.142 ± 0.032*	0.012 ± 0.004	0.010 ± 0.003	0.008 ± 0.002	0.068 ± 0.018*	0.01
Cadmium (Cd)	0.018 ± 0.006*	0.002 ± 0.001	0.001 ± 0.000	0.001 ± 0.000	0.012 ± 0.004*	0.003
Chromium (Cr)	0.086 ± 0.024*	0.018 ± 0.006	0.014 ± 0.004	0.012 ± 0.004	0.042 ± 0.012	0.05
Mercury (Hg)	0.0028 ± 0.0008*	0.0004 ± 0.0001	0.0003 ± 0.0001	0.0002 ± 0.0001	0.0014 ± 0.0004*	0.001
Copper (Cu)	0.286 ± 0.064	0.042 ± 0.012	0.036 ± 0.010	0.024 ± 0.008	0.124 ± 0.034	0.05
Zinc (Zn)	0.864 ± 0.182	0.124 ± 0.036	0.098 ± 0.028	0.068 ± 0.018	0.426 ± 0.098	5.0
Nickel (Ni)	0.124 ± 0.032*	0.018 ± 0.006	0.014 ± 0.004	0.010 ± 0.003	0.056 ± 0.016*	0.02

*Note: *Values exceeding BIS permissible limits; Values represent mean ± SD*

3.3 Zooplankton Community Composition

Approximately 58 species of zooplankton were found in all of the sampling sites, and they belonged to four taxonomic groups, i.e., Rotifera (32 species), Cladocera (14 species), Copepoda (8 species), and Ostracoda (4 species) (Table 3). The most abundant faction was rotifera, which contributed 48.2 to the total zooplankton abundance, followed by Cladocera (26.8), Copepoda (18.6), and then Ostracoda (6.4). The abundance of rotifers is typical of eutrophic freshwater environments of tropical origin and reflects enrichment by organic means (Sladecek, 1983).

The richness of the species differed greatly across sites, with Shamirpet Lake having the highest (48 species) and Hussainsagar the lowest (26 species). Brachionus calyciflorus, B. angularis, B. diversicornis, Keratella tropica, K. cochlearis, Filinia longiseta, and Lecane luna were the most common rotifer species. Moina micrura, Ceriodaphnia cornuta, Diaphanosoma excisum, and Bosmina longirostris were common amongst the cladocerans. Mesocyclops leuckarti, Thermocyclops hyalinus, and Heliodiaptomus viduus were the copepods. The tolerance of the pollution by

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pollinaceous species like Brachionus calyciflorus, B. angularis, and Moina micrura was greater in Hussainsagar and Mir Alam, whereas the sensitive species like Diaphanosoma excisum and Heliodiaptomus viduus were more abundant in Shamirpet and Himayathsagar.

Table 3. Zooplankton species composition and abundance (Ind./L) across study sites

Taxonomic Group	Hussainsagar	Osmansagar	Himayathsagar	Shamirpet	Mir Alam
Rotifera					
Brachionus calyciflorus	186 ± 42	68 ± 18	54 ± 14	32 ± 10	124 ± 32
Brachionus angularis	142 ± 36	56 ± 14	48 ± 12	28 ± 8	98 ± 26
Keratella tropica	124 ± 32	86 ± 22	72 ± 18	68 ± 16	96 ± 24
Other Rotifera (28 spp.)	164 ± 38	248 ± 56	286 ± 62	342 ± 74	198 ± 46
Cladocera					
Moina micrura	86 ± 22	42 ± 12	36 ± 10	24 ± 8	64 ± 18
Ceriodaphnia cornuta	48 ± 14	62 ± 16	58 ± 14	72 ± 18	52 ± 14
Other Cladocera (12 spp.)	62 ± 16	124 ± 32	148 ± 36	186 ± 42	86 ± 22
Copepoda (8 spp.)	142 ± 36	186 ± 44	198 ± 46	224 ± 52	162 ± 38
Ostracoda (4 spp.)	32 ± 10	56 ± 14	62 ± 16	74 ± 18	42 ± 12
Total Abundance	986 ± 186	928 ± 174	962 ± 182	1050 ± 196	922 ± 178
Species Richness	26	42	44	48	32

Note: Values represent mean ± SD of annual samples (Ind./L)

3.4 Diversity Indices and Correlation Analysis

Shannon-Wiener diversity index (H) varied between 1.24 and 3.42 across Hussainsagar and Shamirpet Lake, respectively (Table 4). The dominance index of Simpson demonstrated the opposite trend, and the maximum dominance (D = 0.42) was observed at Hussainsagar, which implies a lack of diversity and domination by a limited number of tolerant species. Richness index of Margalef was between 3.62 and 6.84, whereas evenness of Pielou was between 0.48

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and 0.86. These reduced diversity indices of Hussainsagar and Mir Alam are associated with high levels of heavy metal and organic pollution.

Table 4. Zooplankton diversity indices across study sites

Study Site	H′	D	d	J′
Hussainsagar Lake	1.24 ± 0.18	0.42 ± 0.08	3.62 ± 0.52	0.48 ± 0.10
Osmansagar Reservoir	2.86 ± 0.32	0.18 ± 0.04	5.84 ± 0.72	0.74 ± 0.12
Himayatsagar Lake	3.12 ± 0.36	0.14 ± 0.03	6.24 ± 0.78	0.78 ± 0.14
Shamirpet Lake	3.42 ± 0.42	0.12 ± 0.03	6.84 ± 0.86	0.86 ± 0.16
Mir Alam Tank	1.86 ± 0.24	0.32 ± 0.06	4.42 ± 0.58	0.58 ± 0.12

Note: H' = Shannon-Wiener index; D = Simpson's dominance; d = Margalef's richness; J' = Pielou's evenness

The Pearson correlation analysis indicated that there were significant negative correlations between heavy metal concentration and zooplankton diversity indices (Table 5). Shannon-Wieners index had a strong negative relationship with the lead ($r = -0.86$, $p<0.01$), cadmium ($r = -0.82$, $p<0.01$), and mercury ($r = -0.78$, $p<0.05$). Richness of the species showed a significant negative relationship with all the measured heavy metals. Diversity index and dissolved oxygen showed a positive correlation, whereas BOD, COD, and nutrient concentration showed a negative correlation with diversity index.

Table 5. Pearson correlation coefficients between diversity indices and environmental parameters

Parameter	H′	D	d	J′	Abundance
DO	0.84**	-0.76**	0.82**	0.78**	0.62*
BOD	-0.78**	0.72**	-0.74**	-0.68*	-0.42
Lead (Pb)	-0.86**	0.82**	-0.84**	-0.76**	-0.48
Cadmium (Cd)	-0.82**	0.78**	-0.80**	-0.72**	-0.44
Chromium (Cr)	-0.74**	0.68*	-0.72**	-0.66*	-0.38
Mercury (Hg)	-0.78*	0.74**	-0.76**	-0.68*	-0.42
Nickel (Ni)	-0.72**	0.66*	-0.70**	-0.64*	-0.36

*Note: *p<0.05; **p<0.01*

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4. Discussion

This paper shows that zooplankton community structure is a good indicator of water quality gradients as well as heavy metal pollution in the freshwater bodies of Telangana. The patterns of diversity, species make up, and abundance observed are consistent with the known concepts of the zooplankton ecology and its reaction to environmental stress (Gannon and Stemberger, 1978; Ferdous and Muktadir, 2009).

The prevalence of Rotifera in all the study sites is in accordance with other tropical freshwater systems found in India (Karuthapandi et al., 2015; Jagadeeshwara et al., 2015). The reproductive rates, generation time, and environmental tolerance of rotifers are high, thus making them dominate in the nutrient-rich and disturbed environments (Sladecek, 1983). The high level of pollution-tolerant species like Brachionus calyciflorus and B. angularis at Hussainsagar is a sign of organic enrichment and eutrophication; earlier researchers identified these species as an indicator of a polluted environment (Saksena, 1987; Sharma, 1998).

The high and negative correlations between diversity indices and the concentrations of heavy metals prove the hypothesis according to which zooplankton communities can be considered as sensitive bioindicators of metal pollution. Examples of toxic mechanisms caused by heavy metals are enzyme inhibition, membrane damage, and oxidative stress, which have different toxicity effects on the zooplankton taxa depending on their physiological tolerances to these heavy metals (Rainbow, 2002; Wang and Fisher, 1999). The relative depletion in species richness and evenness at the contaminated locations is an indication of elimination and growth of sensitive species and an increase in the tolerant taxa, which is well established in the metal-polluted aquatic systems (Yan and Miller, 1984).

The high level of heavy metal at Hussainsagar Lake is related to the discharges by industries via the Kukatpally channel that cuts across pharmaceutical and chemical manufacturing areas (Ramachandraiah & Prasad, 2019). The reported surpassing of the acceptable concentrations of lead, cadmium, mercury, and nickel is concerning for the ecosystem health and possible bioaccumulation via the food web. The same contamination trends have been reported in the sediments and groundwater in Hussainsagar in earlier research (TSPCB, 2023), which shows that the problem of heavy metal pollution in Hussainsagar is long-term.

The increase of diversity in Shamirpet and Himayathsagar Lakes is relatively higher; this is attributed to the fact that the lakes are safeguarded drinking water sources that do not have many catchment activities. The findings highlight the significance of watershed management and pollution control as measures to maintain aquatic life. Shannon Wisconsin diversity values exceeding 3.0 in these locations signify that they have healthy, stable communities with high evenness of the species (Magurran, 2004).

The discovery of possible indicator species helps to design region-specific biomonitoring guidelines for the freshwater ecosystems in Telangana. The Brachionus calyciflorus and Moina micrura proved to be consistently associated with degraded waters, whereas Diaphanosoma excisum and Heliodiaptomus viduus were found to prefer cleaner waters. These non-parametric forms of distribution are useful in making quick evaluations of the water quality as opposed to the traditional chemical monitoring.

The paper has some limitations, such as the emphasis on surface water zooplankton without considering the sediment communities, which might exist in distinct assemblages. The bioaccumulation of heavy metals in zooplankton tissues was

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also not measured, and this could have given information regarding the transfer of metals through the trophic levels. These are areas where future studies should focus, as well as monitor other water bodies in Telangana.

5. Conclusion

In this study, zooplankton community structure has been determined to be a good system of bioindicators in measuring water quality and heavy metal pollution in the freshwater bodies of Telangana. The 58 species found in the five water bodies had different distributions of the pollution gradients. Strong negative associations among the diversity indices and the heavy metal levels confirm the applicability of zooplankton in biomonitoring.

Hussainsagar Lake had the minimum diversity and maximum contamination by heavy metals, which is a symptom of chronic pressure on its environment by industries and urbanization. Conversely, the watershed protection proved beneficial as the diversity in such safeguarded water bodies as Shamirpet and Himayathsagar was greater. These findings of pollution-tolerant (Brachionus calyciflorus, Moina micrura) and pollution-sensitive (Diaphanosoma excisum, Heliodiaptomus viduus) species offer working tools of quick ecological evaluation.

The conclusions point to the necessity of improving the pollution control measures, especially in Hussainsagar Lake, in which the industrial effluent treatment should be reinforced. The combination of biological monitoring with the use of zooplankton and traditional physico-chemical measurements is suggested to be used to fully assess the health of freshwater ecosystems. This research provides baseline information to be used in subsequent surveillance and evidence-based conservation of the valuable freshwater resources in Telangana.

References

1. APHA. (2017). *Standard methods for the examination of water and wastewater* (23rd ed.). American Public Health Association.
2. Battish, S. K. (1992). *Freshwater zooplankton of India*. Oxford & IBH Publishing.
3. Carpenter, S. R., Stanley, E. H., & Vander Zanden, M. J. (2011). State of the world's freshwater ecosystems: Physical, chemical, and biological changes. *Annual Review of Environment and Resources, 36*, 75-99.
4. Central Pollution Control Board. (2021). *Status of water quality in India 2020*. Ministry of Environment, Forest and Climate Change, Government of India.
5. Dudgeon, D., Arthington, A. H., Gessner, M. O., Kawabata, Z. I., Knowler, D. J., Lévêque, C., ... & Sullivan, C. A. (2006). Freshwater biodiversity: Importance, threats, status, and conservation challenges. *Biological Reviews, 81*(2), 163-182.
6. Edmondson, W. T. (1959). *Freshwater biology* (2nd ed.). John Wiley & Sons.
7. Ferdous, Z., & Muktadir, A. K. M. (2009). A review: Potentiality of zooplankton as bioindicator. *American Journal of Applied Sciences, 6*(10), 1815-1819.
8. Gannon, J. E., & Stemberger, R. S. (1978). Zooplankton (especially crustaceans and rotifers) are indicators of water quality. *Transactions of the American Microscopical Society, 97*(1), 16-35.
9. Haberman, J., & Haldna, M. (2014). Indices of zooplankton community as valuable tools in assessing the trophic state and water quality of eutrophic lakes. *Ecological Indicators, 45*, 113-125.
10. Jagadeeshwara, C. T., Mahender, J., Sunil Kumar, & Rajashekhar, A. V. (2015). Zooplankton diversity, abundance, and seasonal variation of Nagulakunta Water Tank, Vinjapally, Karimnagar District, Telangana State, India. *International Journal of Science and Research, 4*(7), 1651-1654.

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11. Karuthapandi, M., Rao, D. V., & Innocent Xavier. (2015). Zooplankton composition, diversity, and physicochemical features of Bandam Kommu Pond, Medak District, Telangana, India. *Proceedings of the Zoological Society, 69*(2), 189-204.
12. Magurran, A. E. (2004). *Measuring biological diversity*. Blackwell Publishing.
13. Rainbow, P. S. (2002). Trace metal concentrations in aquatic invertebrates: Why and so what? *Environmental Pollution, 120*(3), 497-507.
14. Ramachandraiah, C., & Prasad, S. (2019). *Urban water governance in Hyderabad: Issues and challenges*. Centre for Economic and Social Studies, Hyderabad.
15. Saksena, D. N. (1987). Rotifers as indicators of water quality. *Acta Hydrochimica et Hydrobiologica, 15*(5), 481-485.
16. Sharma, B. K. (1998). Freshwater rotifers (Rotifera: Eurotatoria). *Fauna of West Bengal, State Fauna Series, 3*(11), 341-461.
17. Sladecek, V. (1983). Rotifers as indicators of water quality. *Hydrobiologia, 100*(1), 169-201.
18. Telangana State Pollution Control Board. (2023). *Annual report on water quality monitoring of freshwater bodies in Telangana*. Government of Telangana.
19. Wang, W. X., & Fisher, N. S. (1999). Assimilation efficiencies of chemical contaminants in aquatic invertebrates: A synthesis. *Environmental Toxicology and Chemistry, 18*(9), 2034-2045.
20. Yan, N. D., & Miller, G. E. (1984). Effects of deposition of acids and metals on chemistry and biology of lakes near Sudbury, Ontario. *Environmental Impacts of Smelters*, 243-282.