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# Study on Zooplankton Community Structure and Diversity Indices of River Godavari at Kopargaon (MH), India

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## Abstract:

The present study evaluated the ecology and diversity of zooplankton in the Godavari River at Kopargaon (MH), India. As the longest river of the state, it supports a wide range of diverse aquatic habitats. However, water quality has deteriorated due to unsustainable anthropogenic activities. Therefore, the primary objective of this study was to assess the impact of water pollution on the zooplankton community. The investigation was conducted over one year, from May 2022 to April 2023. A total of 21 zooplankton species were recorded, with Rotifera contributing 52.39%, followed by Cladocera (23.8%), Copepoda (19.05%), and Ostracoda (4.76%). The occurrence of pollution-tolerant species suggests eutrophic conditions in the river. The Simpson's diversity index (1−D) ranged from 0.68 to 0.70, whereas the Shannon–Wiener diversity index (H′) varied from 1.25 during the monsoon to 1.28 in the post-monsoon season, indicating slight to moderate diversity within the zooplankton community. Effective management of industrial effluent discharge and proper functioning of sewage treatment plants are essential for the conservation and sustainability of aquatic biodiversity. The study provides inadequate baseline data for further research and policymakers.

**Keywords:** Zooplankton diversity, Diversity Indices, Anthropogenic impact, Godavari River, Kopargaon

## Introduction:

Zooplankton are key components of aquatic ecosystems, serving an essential role in linking primary producers to higher trophic levels in the food web (Zhang et al., 2019; Nimbalkar et al., 2013). Due to their short lifespan and rapid response to environmental changes, particularly water pollution, they are widely recognized as reliable indicators of water quality (Martins et al., 2024; Gazonato Neto et al., 2014). Furthermore, zooplankton diversity is an important parameter for assessing aquatic ecosystem health (Datta Munshi, 1995). These organisms also contribute to the breakdown of organic pollutants in water (Trivedi and Goel, 1986). The diversity and distribution of zooplankton are influenced by both biotic and abiotic factors within a given ecosystem; consequently, even similar aquatic environments may exhibit variations in their zooplankton community structure (Sehgal et al., 2013).

The Godavari River is an ecologically significant riverine system at both state and national levels and is often referred to as the "Dakshin Ganga." It originates at Trimbakeshwar in Nashik, Maharashtra, and flows eastward, ultimately draining into the Bay of Bengal by traversing several states, including Telangana, Chhattisgarh, Odisha, and Andhra Pradesh. It is the second-longest river in India, extending approximately 1,465 km from its source (Central Water Commission, 2015). The extensive river basin supports rich floral and faunal biodiversity across diverse habitats, such as reservoirs, floodplains, and wetlands. However, in recent years, water quality has deteriorated due to increasing anthropogenic pressures, including urbanisation, industrial discharges, and agricultural runoff. These factors significantly influence nutrient dynamics and, consequently, the structure and composition of biological communities, particularly that of zooplankton. (Akindele & Adeniyi, 2013) Despite its ecological importance, there is a handful of information available on zooplankton diversity in this river system from the study area.

Therefore, this study aimed to provide insights into the diversity and distribution of the zooplankton community in the Godavari River at Kopargaon.

The review of literature indicates that Kolhe B. G. (2013) reported that contamination from urban sewage and industrial effluents adversely affects zooplankton communities. Bhadane R. S. (2016) investigated zooplankton diversity at Ramkund in the Godavari River, Nashik (MH), and documented 32 species, with Rotifera as the dominant group in terms of abundance. B. K. Sharma and S. Sharma (2018) recorded 140 species of Rotifera from Jammu and Kashmir, including one species new to India and 25 new to the northwestern region. Nalawade P. M. and Bagul A. B. (2020) examined physicochemical parameters and plankton diversity in the Godavari River within Nashik city. They reported that water quality was adversely affected by industrial, agricultural, and other anthropogenic activities. D. N. Pandit, P. Kumari, and S. K. Sharma (2020) studied zooplankton diversity and its correlation with physicochemical parameters in the Ganga River in Bihar. V. B. Yannawar et al. (2022) analyzed the biodiversity and community structure of zooplankton in the Godavari River at Nanded and reported Rotifera as the dominant group, along with a positive correlation between zooplankton abundance and environmental factors such as temperature and pH. D. R. Kasab (2024) documented zooplankton biodiversity in the Nathsagar Dam, located on the Godavari River at Paithan, Chhatrapati Sambhajinagar, and reported 17 species belonging to four major groups: Rotifera, Cladocera, Copepoda, and Ostracoda. Furthermore, Md. Mofizur Rahman et al. (2025) examined the composition, diversity, and assemblage of zooplankton in relation to environmental factors in the Dakatia River, Bangladesh, across wet and dry seasons, and reported moderate zooplankton diversity influenced by varying environmental conditions.

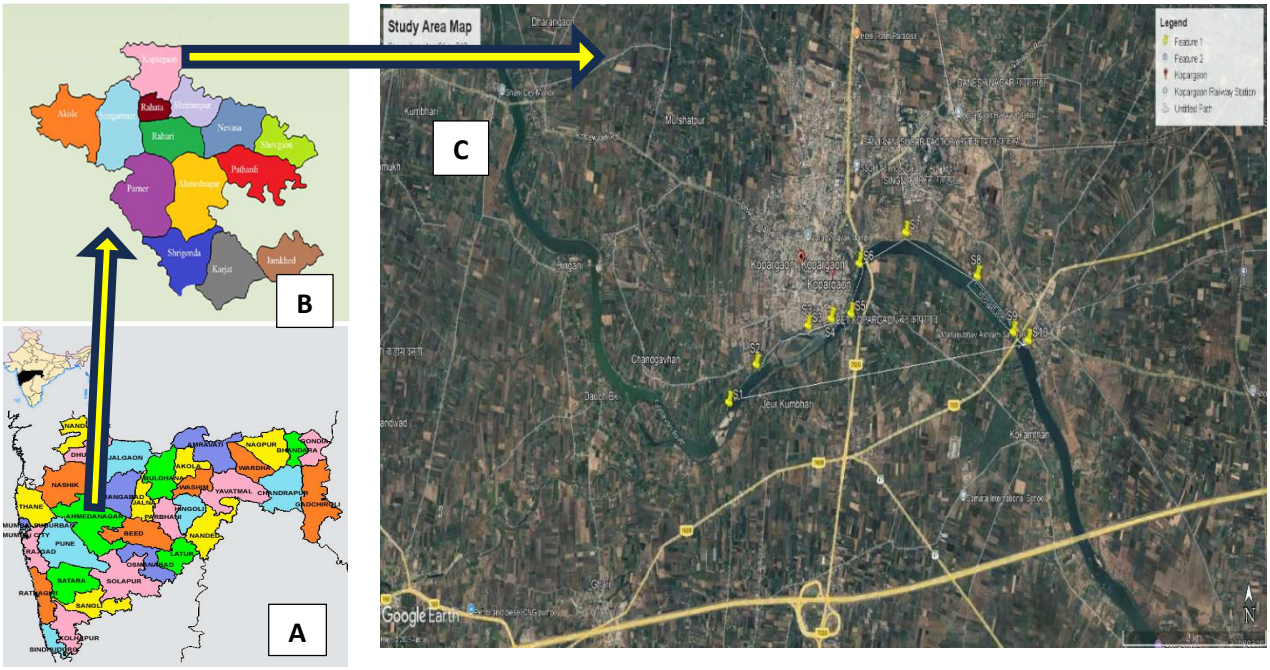
**Materials and Methods:**

Kopargaon city is situated along the banks of the Godavari River (latitude: 19.882389, longitude: 74.476051). Ten sampling sites were strategically selected from both upstream and downstream stretches of the city, considering varying degrees of ecological disturbance, including agricultural runoff, discharge of untreated sewage, and industrial effluents. The study was conducted over a one-year period, from May 2022 to April 2023, to capture seasonal variations in the zooplankton community.

Zooplankton sampling was conducted monthly during the morning hours to ensure consistency in collection and minimise diurnal variation. For quantitative analysis, 50 litres of surface water were filtered through a zooplankton net with a mesh size of 45 µm. Qualitative samples were obtained by horizontally towing a plankton net across the water surface. The collected samples were carefully transferred into 100 ml containers and preserved immediately at the sampling site using 4% formalin solution to prevent decomposition. All samples were subsequently transported to the laboratory for detailed examinations.

Quantitative estimation of zooplankton was performed using a Sedgwick-Rafter counting cell, while qualitative analysis was conducted using temporary slides under an Olympus light microscope. Zooplankton taxa were identified using standard taxonomic keys and relevant literature (Prescott, 2008; Tonpi, 1980; Pennak, 1989; APHA, 1998; Dhanpati, 2000; Segers, 2007). For the final analysis, multiple counts were performed for each sample, and the average values were considered to ensure accuracy and reproducibility.




**Map A- Map showing India, Maharashtra, with Districts.**
**Map B- Ahilyanagar District with its tehsil**
**Map C: Study site of the Godavari River.**
*Photos from Google and Google Earth*

| Sr.no | Phylum | Species | Summer | Monsoon | Post-monsoon |
|---|---|---|---|---|---|
| 1 | Rotifera | a. *Brachionus falcatus,* | + | + | + |
| | | b. *Brachionus* | + | + | + |
| | | c. *Diversicornis* | - | + | + |
| | | d. *Brachionus durgae* | + | + | + |
| | | e. *Brachionus caudatus* | + | + | + |
| | | f. *Brachionus angulari* | + | - | + |
| | | g. *Filinia terminalis* | + | + | + |
| | | h. *Filinia longiseta* | + | + | + |
| | | i. *Keratella tropica* | + | + | + |
| | | j. *Keratella quadrata* | + | + | + |
| | | k. *Testudinella insinuate* | + | - | + |
| 2 | Copepoda | a. *Diaptomus* | + | + | + |
| | | b. *Mesocycl opsedox* | + | + | + |
| | | c. *Napulli* | + | + | + |
| | | d. *Paracyclop affinis* | + | + | + |
| 3 | Cladocera | a. *Daphnia rosea* | + | + | + |
| | | b. *Cerodaphnia quadrangular* | + | + | + |
| | | c. *Moina brachiate* | + | - | + |
| | | d. *Alona affinis* | - | + | + |
| | | e. *Cerodaphnia reticulate* | + | + | + |
| 4 | Ostracoda | a. *Cypris* | + | _ | + |

**Table 1: List of Zooplankton Found in the Study Area (+ = Present, - = Absent)**

| Zooplankton Group | Summer | Monsoon | Post-monsoon |
|---|---|---|---|
| Rotifera | 455 ± 40 | 265 ± 25 | 470 ± 36 |
| Cladocera | 290 ± 30 | 156 ± 22 | 320 ± 24 |
| Copepoda | 196 ± 24 | 120 ± 15 | 254 ± 21 |
| Ostracoda | 87 ± 15 | 56 ± 11 | 115 ± 18 |
| **Total** | **1028 ± 57** | **597 ±38** | **1159 ± 51** |

**Table 2: Seasonal Variation in Zooplankton Community**

| Season | Shannon–Wiener Index (H′) | Simpson's Dominance Index (D | Interpretation |
|---|---|---|---|
| **Summer** | **1.27** | **0.69** | **Moderate diversity** |
| **Monsoon** | **1.25** | **0.68** | **Slightly lower** |
| **Post-monsoon** | **1.28** | **0.70** | **Slightly higher** |

**Table 3: Variation in Diversity Indices**

| Zooplankton Group | Number of Species | Percentage Contribution (%) |
|---|---|---|
| Rotifera | **11** | **52.39** |
| Copepoda | **4** | **19.05** |
| Cladocera | **5** | **23.8** |
| Ostracoda | **1** | **4.76** |
| Total | **21** | **100.0** |

**Table 4: Percentage contribution of zooplankton groups.**

**Result and Discussion**:

In the present study, four major groups of the zooplankton community (Rotifera, Copepoda, Cladocera, and Ostracoda) were examined with respect to their diversity and seasonal abundance in the water column. A total of 21 zooplankton species were identified during this study. Rotifera exhibited the highest relative abundance (52.39%), followed by Cladocera (23.8%), Copepoda (19.05%), and Ostracoda (4.76%), as detailed in **Table 4.**

Rotifers are dominant and thrive in eutrophic conditions and organic enrichment, likely due to anthropogenic activities, untreated sewage, and industrial effluents released into the river. (Pawar & Pulle, 2005; Jadhav et al., 2014). Ostracods were present in relatively low abundance because they are more sensitive to pollution and habitat disturbances than other groups of zooplankton. indicates the stress condition of a particular ecosystem. (Mezquita et al., 2001)

Seasonal variations in zooplankton abundance are shown in **Table 2.** The lowest density was observed during the monsoon (597 ± 38 Ind. $L^{-1}$) and the highest in the post-monsoon season (1159 ± 51 Ind. $L^{-1}$), whereas summer showed an intermediate value (1028 ± 57 Ind. $L^{-1}$). Environmental factors, such as temperature, rainfall, and high turbidity, reduce primary productivity and ultimately the growth of zooplankton (Patil & Patil, 2016). However, in the post-monsoon season, due to stagnation in water flow, the settling of particles in the water, and a remarkable increase in primary productivity, conditions are favourable for zooplankton. (Abd Razak & Sharip, 2019, Simões et al., 2012)

The diversity indices (**Table 3**) showed moderate zooplankton diversity over the study period. The Simpson's diversity index (1−D) fluctuated between 0.68 and 0.70, whereas the Shannon–Wiener diversity index (H′) ranged from 1.25 during the monsoon to 1.28 during the post-monsoon. The dominance of a few tolerant species under disturbed conditions, which results in decreased evenness, may be the cause of the minor decrease in diversity during the monsoon. (Odum, 1971; Magurran, 2004).

The observed dominance of Rotifera and moderate diversity index values are consistent with the influence of organic pollution and nutrient enrichment; conditions often associated with untreated sewage and anthropogenic inputs into river systems. Similar findings have been reported in other studies on the Godavari River and freshwater ecosystems in Maharashtra and other states of India, where rotifer dominance and moderate diversity indices were associated with eutrophic conditions and environmental stress (Shinde et al., 2012; Shaikh & Ghadage, 2018).

Overall, the zooplankton community structure in the present study reflected a transitional ecological condition, characterised by moderate diversity, seasonal fluctuations, and dominance of pollution-tolerant taxa. These findings highlight the usefulness of zooplankton as bioindicators for assessing the ecological health and water quality of riverine ecosystems.

**Conclusion:**

The present study observed that the study site selected in the Godavari River was markedly diverse in the zooplankton community. Reporting of 21 zooplankton species belonging to four major taxonomic groups. The dominance of the Rotifera group and the low diversity of the ostracods show the eutrophic and stressed conditions of this freshwater ecosystem.

Seasonal variation significantly affects the zooplankton community in terms of composition, abundance and community structure. The post-monsoon season shows considerable diversity, owing to optimum temperature and stagnant water conditions, which support increased primary productivity in the ecosystem. On the other hand, monsoon season shows lower diversity due to river swelling and increased turbidity, which reduce ecosystem productivity. In summer, low water levels and the influx of untreated sewage and industrial effluents result in algal blooms, which affect the diversity of the zooplankton community. Thus, seasonal shifts affect the zooplankton community, indicating the role of zooplankton as potential bioindicators. The diversity indices showed variations in the zooplankton community throughout the study period, indicating stress conditions in this freshwater ecosystem. The presence and absence of pollution-tolerant and non-tolerant species further indicated that the Godavari River at Kopargaon is experiencing environmental stress and disturbance.

Overall, this study provides important baseline ecological data for the study area. This study is important for tracking further changes in this freshwater ecosystem and for informing strategies for the conservation of the flora and fauna of the Godavari River. To ensure conservation and ecological sustainability, prolonged monitoring of the zooplankton community along with physicochemical parameters is recommended for this important freshwater ecosystem in the future.

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**1. Shannon-Wiener Diversity Index (H′)**

- One of the most widely used indices
- Takes into account both richness and evenness

$$H' = -\sum(p_i \ln p_i)$$

Where:

- $p_i$= proportion of individuals of species $i$

👉 **Interpretation:**

- Higher value → more diversity
- Lower value → less diversity

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**2. Simpson's Diversity Index (D)**

- Measures the probability that two individuals randomly selected belong to the same species

$$D = \sum p_i^2$$

  

👉 Often expressed as:

- **1 − D** (more intuitive)
- Higher value → higher diversity

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