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Impact of water quality on zooplankton biodiversity in Murna River, Shahdol district Madhya Pradesh, India

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Abstract
The present study deal with the role of biotic parameter especially zooplankton community and its trophic level to assess water quality of Murna river, Shahdol district (M.P.), India. The zooplankton of the river Murna was studied from July 2022 to June 2023 at different sampling stations. Four sampling station were selected for the study, station -A (Kalyanpur), station- B (MPEB Colony), station – C (Sohagpur) and station – D (Kshirsagar). Physico-chemical parameters like Temperature, pH, Dissolve oxygen, Biological oxygen demand and Chemical oxygen demand were also measured and the correlation coefficient value of temperature with zooplankton showed significant relation (0.075), and inverse relation with pH, Dissolve oxygen, Biological oxygen demand and Chemical oxygen demand (-0.022, -0.685, -0.477 & -0.569), it was found that they influence zooplankton abundance in river Murna. During the study period various species of Rotifers, Copepods, Cladocerans were recorded, in all samples total 18 species of zooplankton identified, 10 species of Rotifers, 05 species of Cladocerans and 03 species of Copepods. The zooplankton community was dominated by Rotifers, in all samples. The highest zooplankton densities were recorded in the month of May and June.

Keywords: Zooplankton, Murna River, Shahdol, physico-chemical parameters

Introduction
A water body's condition as determined by physio-chemical and biological parameters is referred to as its quality. A location's water's physicochemical properties are the outcome of a complicated interaction between natural and artificial factors (Singh *et al.* 2020 and Matta, *et al.* 2020) [1-2]. Every single person's life is significantly impacted by rivers. Surface water contamination is a problem that affects the environment globally. To determine the current state of the quality and make sure that it is maintained at a level that is consistent with the desired requirements, it is imperative to routinely monitor the quality of surface water. For instance, rivers are vital resources for irrigation and drinking water. They are also utilized for energy generation and fishing. The quality of surface water has become a highly contentious issue in recent times. Despite being essential to life, water is entirely polluted due to its ability to dissolve and carry a variety of pollutants through it. Aquatic ecology is severely strained by the rapid industrialization and urbanization of society, which lowers water quality and biodiversity. (Nnorom, *et al.* 2019 and Ustaoğlu &Tepe, 2019) [3-4]. Agriculture is a non-point source of contamination because it produces chemicals such as insecticides and fertilizers during irrigation, and rainfall runoff carries this pollution burden to a surface water system that is accessible. The transportation of pollutants in the atmosphere, which originate from a variety of sources, is also attributed to rainfall (Kumar *et al.* 2014, Barakat *et al.* 2016 and Alam, *et al.* 2021) [5-7].
The Greek word planktons, which means wandering, is where the word "plankton" originates. It refers to the tiny, typically immobile, freely floating creatures that inhabit watery environments (Powell *et al.* 1975) [8]. Plankton drives energy cycling in aquatic ecosystems as they are the productive base of food webs, converting basic forms of energy into forms usable by higher trophic levels (Vilar *et al.* 2003) [9]. Due to their fundamental role in aquatic ecosystems, and their consumption of carbon dioxide, plankton determine the survival of all other aquatic organisms, and along with terrestrial primary producers, are drivers of global carbon cycles (Daly & Smith Jr 1993 [10]; Vilar *et al.* 2003 [9]). The features of their surroundings, such as the availability of light and nutrients, temperature, salinity, pH,

currents, turbulence, and degree of predation, all affect the growth and dynamics of plankton. There are four major groups of zooplankton: Copepoda, Cladocera, Ostracoda, and Rotifera.

The microscopic fauna known as Rotatoria, or Rotifers, are primarily found in freshwater environments and are distinguished by the presence of a rotating structure in the form of an anterior wheel called a corona. Some people believe that rotifers are the most significant soft-bodied invertebrates (Hutchinson, 1967) [11]. As a group, the rotifers display an amazing range of morphological variations and adaptations. Yet the great majority has several fundamental features in common. Cladocerans popularly called as 'water flea' prefers to live in deep water and constitute a major item of food for fish. Thus they hold key position in food chain and energy transformation (Uttangi, 2001) [12]. The majority of cladocera order members range in length from 0.2 to 3.0 mm. One of the main zooplankton populations found in all kinds of water bodies are copepods. They are an important component of ecological pyramids and provide food for a variety of fish. The majority of species are 2.0 mm long and have dull grayish or brownish colors, however certain species, particularly those found along the coast, have spectacular orange, purple, or red colors in the spring and at high elevations. Water body pollution and trophic status can be evaluated by the use of bio-indicators, indices, and systems that have been developed through qualitative and quantitative analysis of various groups of species.

Materials and methods

Study area (sampling sites)

The river basin lies between the latitudes of 23°15' N to 24° N latitude and 81°E to 81°45' longitude. District Shahdol is located roughly 110 miles (177 km) northwest of Bilaspur along the Murna River, a tributary of the Son River. The Murna River runs northeastward from the south. The Murna River also supplies a few Shahdol city settlements with the water they need. It was discovered during the survey that there is essentially no forest cover along the Murna River's bank. Along the riverbank, there were also both big and little slum encroachments. The river Munra (which is now a drainage) has drastically dried up as a result of the bank of the river being encroached upon (Khan, 2017) [13].

Samples were taken at the following points during alternate month

This study was carried out on Murna River and water samples were collected in the July 2022 to June 2023 from four selected places namely.

- **Station A (Kalyanpur):** This station is located Shahdol (latitude 23.291216°/longitude 81.349732°; city entrance).
- **Station B (MPEB Colony):** This station is located near MPEB colpony Shahdol (latitude 23.296317°/longitude 81.348981°; city centre),
- **Staton C (Sohagpur):** Shahdol (latitude 23.2949° longitude 81.342176°; through the city).
- **Station D (Kshirsagar):** Where the river Murna meets Sone.

Sampling Methods

Four samples were collected from each sampling site, and samples were collected twice. Standard procedures (APHA 2012) [14] were followed throughout the process of collecting the water samples, preserving them, transporting them to the lab and conducting the analysis. In total five different parameters, including temperature, pH, dissolved oxygen (DO), the biochemical oxygen demand (BOD) and the chemical oxygen demand (COD) were measured in the samples analysed.

Samples of zooplankton were obtained from the surface water of the river at (fixed site names 1 to 8) by passing 50 liters of water through a mesh size of 60–65 µm plankton net. The samples were then stored in a solution containing 4% formalin.

Laboratory methods: Zooplankton samples were concentrated in a lab setting to a 100 mL volume. Subsamples of 0.5 mL were utilized to evaluate the contents. One hundred people in all were measured every other month. A 50 mm long, 20 mm wide, and 1 mm deep Sedgwick-Rafter (S-R) counting cell was used to help with the quantitative enumeration of the zooplankton. To ensure that there were no air bubbles in the cell covers, the cover glasses were put diagonally across the SR cell before samples were transferred using a large bore pipette. The S-R cell's plankton (Zooplankton) count was calculated using the formula below (Ghosh & Biswas, 2015) [15].

$$No./ml. = \frac{C \times 1000mm^3}{L \times D \times W \times S}$$

Where, C = Number of Organisms Counted; L = length of each strip (S-R cell length) in mm; D = depth of a strip (whipped grid image width) in mm; S = number of strips counted. The number of cells per mm was multiplied by a correction factor to adjust the number of organisms per liter (APHA 2012) [14]. Zooplankton was identified with the help of standard books and monographs, Nedhaam and Nedhaam (1962) [16] and Dhanpati (2000) [17].

The correlation between abiotic (physico-chemical) parameters was done by using coefficient of correlation Karl Pearson`s formula:

$$r = \frac{\sum d_x d_y}{L \times D \times W \times S}$$

Results

Various Physico-chemical parameters recorded in different ranges, temperature was recorded 24.82 at station-A, 26.45 at station-B, 23.94 at station-C and 25.42°C at station-D respectively. pH was recorded 7.45 at station-A, 7.08 at station-B, 7.64 at station-C, 7.36 at station-D. Dissolve oxygen recorded 7.58 at station-A, 6.84 at station-B, 6.32 at station-C, and 7.04 mg/l at station-D. Biological oxygen demand was found 18.42 at station-A, 17.36 at station-B, 16.58 at station-C, 18.06 mg/l at station-D. Chemical oxygen demand was found 36.05 at station-A, 32.08 at station-B, 30.12 at station-C, 34.22 mg/l at station-D respectively (Table 1).

Total 18 species of zooplankton identified, 10 species of Rotifers, 05 species of Cladocerans and 03 species of Copepods. During the study period total 18 species of zooplankton identified 10 species of Rotifers, 05 species of Cladocerans and 03 species of Copepods. The zooplankton community was dominated by Rotifers 10 species, in all samples. In all zooplanktonic group 10 species and 08 genera of Rotifers, namely *Branchionus calyolflorus*, *B.falcatus, B.quadridentatus, Philodina, Keratella, Asplanchna, Polyarthra, Monostyla, Trichotria, Filinia.* 05 species and 05 genera of Cladocerans zooplankton namely *Daphnia, Ceriodaphnia, Moina, Simocephalus, Bosmina.* 03 species and 03 genera of Copepods zooplankton namely *Cyclops virdis, Diaptomus, Nauplius larvae.*

In the present study the peak period of zooplankton occurrence during May and June, and in all samples of zooplankton Rotifers species were dominated than other Cladocerans and Copepods groups. The species composition of Cladocera was 34% at station-A, 13% at station-B, 15% at station-C and 38% at station-D respectively. Rotifer species composition was 22% at station-A, 24% at station-B, 25% at station-C and 29% at station-D. Copepoda species composition at station-A was 33%, 18% at station-B, 19% at station-C and 30% at station-D (Table 2). The correlation coefficient value of temperature with zooplankton showed significant relation (0.075), and inverse relation with pH, Dissolve oxygen, Biological oxygen demand and Chemical oxygen demand (-0.022, -0.685, -0.477 & -0.569) (Table 3).

Table 1: Water quality parameter at different stations

Parameters	Station A	Station B	Station C	Station D
Temperature	24.82	26.45	23.94	25.42
pH	7.45	7.08	7.64	7.36
DO	7.58	6.84	6.32	7.04
BOD	18.42	17.36	16.58	18.06
COD	36.05	32.08	30.12	34.22

Table 2: Total number of Zooplanktons (organism/l) at different stations from July 2022 to June 2023

Zooplanktons	Station A	Station B	Station C	Station D
ROTIFERA	**601**	**580**	**549**	**686**
Branchionus calyolflorus	46	42	60	70
B. falcatus	57	38	40	47
B. quadridentatus	47	105	95	48
Philodina	22	30	26	36
Keratella	111	111	78	120
Asplanchna	90	45	55	79
Polyarthra	88	36	31	69
Monostyla	98	34	41	133
Trichotria	12	21	27	27
Filinia	30	118	96	57
CLADOCERA	268	248	311	342
Daphnia	69	61	38	59
Ceriodaphnia	29	30	42	35
Moina	97	64	27	98
Simocephalus	41	36	49	93
Bosmina	32	57	155	57
COPEPODA	516	880	937	882
Cyclops virdis	137	173	189	148
Diaptomus	50	87	115	204
Nauplius larvae	329	620	633	530

Table 3: Correlation of coefficient of water quality parameter with zooplankton

Parameters	Zooplankton	Co-eff. correlation	Comment
Temperature	Zooplankton	0.075	Significant relation
pH	Zooplankton	-0.022	Inverse relation
DO	Zooplankton	-0.685	Inverse relation
BOD	Zooplankton	-0.477	Inverse relation
COD	Zooplankton	-0.569	Inverse relation

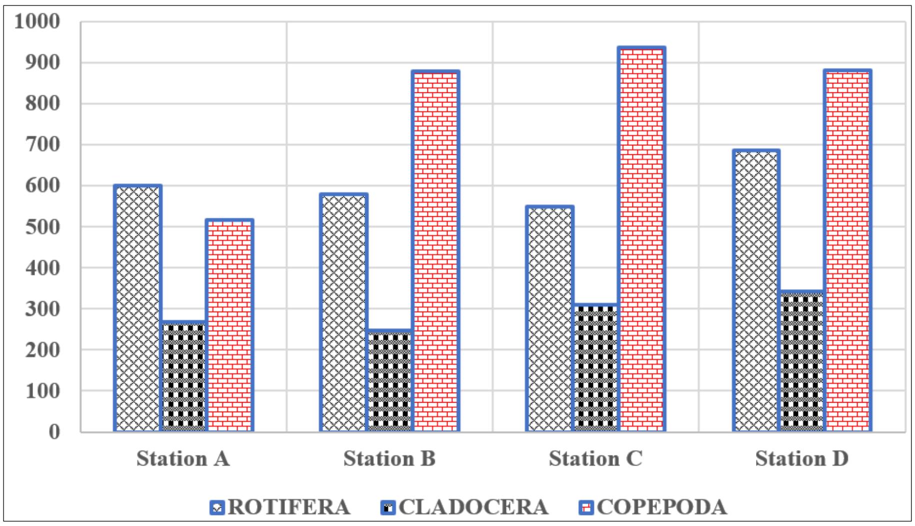

Fig 1: Graph analysis of Zooplanktons (organism/l) at different stations from July 2022 to June 2023

Discussion

All living things are impacted by temperature. It has an impact on a variety of water's chemical and physical properties, including density, viscosity, and the solubility of gases and salts. Plankton can grow because the water's surface receives direct sun radiation. Every sample station recorded the seasonal variations in river water temperature. At every station, the seasonal fluctuation revealed a similar tendency. The mixing of sewage effluents caused a modest increase in temperature at station B. The shallow Murna River at MPEB colony has caused the water temperature to have a tendency to closely follow the air temperature during the research period of examination. The findings were common with the observations of Das *et el.* (2003) [18] and Chouhan, Satyendra Singh and Kumar, Kaushlendra (2024) [19].

The logarithm of the reciprocal of the hydrogen activity in moles per liter at a specific temperature is used to express the pH of a solution, which is related to its hydrogen ion activity (APHA, 1992) [20]. The pH expresses the intensity of acidity or alkalinity of an aquatic environment. The present finding reveal that in river Murna pH fluctuate in station A Kalyanpur and station C Sohagpur, while in other stations pH was uniform ranged recorded (Table 1). Effect of low pH on zooplankton was studied by Zhaung *et al.* (1995) [21] the observed that the species of zooplankton were found to decline gradually with a reduction of pH value. The pH levels of stations A and C have changed. The pH was found to have dropped. The released effluents may have contributed to the river Murna's pH drop.

Oxygen contents of water are one of the important factors and it is necessary for all living organism (WHO, 2004) [22]. The amounts of dissolved oxygen (DO) in waste and natural water are influenced by the physical, chemical, and biological processes that are present in the water body. There is a comparatively high proportion of dissolved oxygen in running water. The increased solubility of oxygen at colder temperatures, which favours oxygen retention, was the cause of the high level throughout the winter. Summertime sees a decline in both water volume and flow rate, although sewage and waste water disposal at stations B MPEB colony and C Sohagpur stay essentially unchanged and exhibit the lowest levels of dissolved oxygen. The same results were reported by Khan (2017) [1] and Jain and Tiwari (2024) [23]. Minimum dissolved oxygen due to effluents discharge, Emongor *et al.* (2005) [24].

One significant metric that is frequently used to assess the pollutant load of waste water is biological oxygen demand, or BOD. In aerobic conditions, the amount of oxygen needed by microorganisms to stabilize carbonaceous, biologically decomposable organic matter in water is known as biological oxygen demand. Station C in Sohagpur recorded the lowest BOD value in the current study, whereas station A in Kalyanpur recorded the highest BOD value. Higher values of BOD were noted in late summer (May–June), according to seasonal variations in the hydro biological variables. These were due to higher rate of decomposition of organic matter at higher temperature, turbidity and less water current (Jain and Tiwari, 2024) [23]. Decrease in BOD values recorded during monsoon could be attributed to decrease in temperature and dilution in the concentration of dissolved organic matter due to heavy rains. Minimum value of BOD was observed during winter. Low BOD contents indicated that the riverine stretch was free from organic pollution.

A test called chemical oxygen demand is used to gauge how polluted household and commercial garbage is. COD provides us with a trustworthy metric to assess the level of water pollution (Shrivastava and Patil 2002) [25]. The measure of COD determines the quantities of organic matter found in water. This also provides direct measures of state of pollution in water bodies. High COD value at the discharge point could be due to high organic load of total solid and total suspended solid from industries. Highest value of COD indicates that most of pollution in study zone in Murna river in caused by contaminated with local sewage, local drains and domestic effluents. Similar results were also reported by Jain and Tiwari, (2024) [23].

Zooplankton creatures hold a central place in aquatic ecosystems' food webs. They contribute to the biological productivity of the freshwater ecosystem in addition to being an essential component of the lentic community (Wetzel, 2001) [26]. Due to short life cycle, zooplankton communities often respond quickly to environmental changes Sharma *et al.* (2007) [27]. In ecologically, zooplankton are one of the most important biotic components influencing all the functional aspects of an aquatic ecosystem, such as food chain, food webs, energy flow and cycling of matter, The zooplankton plays an integral role and serves bioindicators and it is well- suited tool for understanding water pollution status, Murugan *et al.* (1998) [28]; Sinha and Islam, (2002) [29].

Biodiversity of Zooplankton

There were three types of zooplankton: Copepoda, rotifera, and Cladocera. 18 different species of zooplankton have been identified in this study based on samples that were taken at four significant locations. From the research region in the Murna River, a total of sixteen genera were identified. Ten species of rotifers, five species of cladocerans, and three species of copepods are among them.

Rotifera: Among the plankton, rotifera are the most significant soft-bodied metazoans. The corona, an apparently rotating wheel of cilia employed for movement and moving food particles into the mouth, is whence they got their name. The Murna River's stations D and C had the greatest species variety. Because the water at station A is so pure, the species composition there is lowest. At stations B and C, the Brachionus genus of Rotifers was prevalent. The genus Brachionus is considered as a biological indicator for the eutrophication, Nogueira (2001) [30]. In the present study station B and C are the polluted sites.

Cladocera: Fish mostly eat the cladocera, often known as water fleas, which prefer to reside in deep water. As a result, they play a crucial role in the energy transformation and food chain (Uttangi, 2001) [12]. During the present study of river Murna in all stations total number of cladocera (05) five recorded. Zooplankton diversity was dominant by Daphnia and Ceriodaphnia at all sampling stations of river Murna. Among the total zooplankton population Cladocera species was reported as first in order of abundance in Murna river where river water very clean. In the present study species *Bosmina* found maximum at station C and *Moina* species minimum station C.

Copepoda: One of the main zooplankton populations found in all kinds of water bodies are freshwater copepods. Copepods are the principal phytoplankton consumers and the key prey of fish larvae and juveniles that connect pelagic food webs. Three copepod species (Table 2) were found in the Murna River during the current investigation. Low diversity of copepods was found in station A while higher population was found in station D. Pennak (1955) [31] opined that cyclops was found to indicate oligotrophic condition.

Conclusion

Zooplankton is extremely sensitive to environmental variation, changes in its abundance, species diversity, or community composition can serve as crucial indicators of environmental change or disturbance. Zooplankton are free floating creatures that are essential to the aquatic food web. The goal of the current study is to comprehend the Murna River's zooplankton biodiversity and water quality. River water is portable and can be used for a variety of tasks, including drinking, fishing, irrigation, industry, and leisure. Following independence, human activity and industrial expansion severely abused and contaminated the river. Finally, it is estimated that the river Murna's ecological conditions are gradually getting worse. If constructive actions are not done to make improvements, the river's ability to purify itself will be negatively impacted. These findings have thus demonstrated the necessity of doing integrated research that incorporates community studies as well as abiotic elements.

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