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Study of Zooplankton Diversity and its Ecological Role in the Son River Ecosystem

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Abstract: This research focuses on the diversity and abundance of zooplankton in the Son River over a two-year period. The study identified 34 zooplankton species, including 19 rotifers, 9 cladocerans, 4 copepods, and 2 ostracods, indicating a high level of biodiversity. The abundance of these species fluctuated throughout the year, with maximum species richness observed during the winter months of February and March, and lowest during the monsoon season in June and July. The study also examined the feeding habits and population growth of zooplankton species under different feeding conditions, suggesting that organic feeds such as chicken feed and baker's yeast significantly enhance zooplankton growth. The findings provide insight into the ecological dynamics of freshwater ecosystems and the factors affecting zooplankton populations in the Son River.

Keywords: zooplankton, Son River, biodiversity, species, temperature

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INTRODUCTION

Interactions between living things and their environments form ecological systems, which are both structural and functional units of ecology. Put another way, animals interact with their environment in a complex web that forms an ecosystem. "Ecosystem" was first coined in 1935 by an English botanist named A.G. Tansley. [1] From a little oasis in the desert to a vast ocean stretching hundreds of kilometers—ecosystems come in different sizes.

There are two main types of ecosystems: A. terrestrial and B. aquatic. Terrestrial ecosystems are those that do not extend beyond the surface of the earth. Various geological zones are home to a wide variety of terrestrial ecosystems. The three states of water—vapor, liquid, and ice—are described by [2].

Biological processes rely on the liquid phase the most. A molecule of water is composed of two hydrogen atoms bound together by covalent bonds with one oxygen atom. The four water molecules arranged in a tetrahedral pattern around a single core molecule is the most important structural feature of water. The structure, characteristics, and interactions of water with other molecules may be better understood in light of this. Water's unique properties set it apart from other liquids and make it an essential component in many scientific fields, including biology, chemistry, and environmental science. Unlike other types of liquids, ice compresses as it melts. Liquid water shrinks when heated below 4 degrees Celsius, whereas ordinary liquids expand at room temperature. Between its melting point and 46 degrees Celsius, water's compressibility drops, but for a typical liquid, it rises. [4] Unlike regular liquids, water's viscosity drops when pressure rises from 1 to 1,000 atm when temperatures are 30°C or below. Due to local intermolecular geometry, certain 'anomalies' occur. Because of its electrical characteristics, water is both a potent solvent

and an electrical conductor. [5]

After oxygen, water is the most essential element for all forms of life. We rely on fresh water for so many things in our everyday lives that it is an essential resource. Throughout human history, it has been essential for people to live in close proximity to bodies of water, such as rivers, lakes, seas, and oceans. Mesopotamia (located between the Tigris and the Euphrates rivers), the Indus Valley Civilization, ancient Egypt (along the Nile), and China's civilization all reaped the benefits of their river valley locations' availability of water. [6]

For domestic uses (drinking, washing, and toilet flushing), agricultural uses (irrigation), industrial uses (hydroelectric power production, among many others), and more, water is essential for all humans. Even a little amount of fluid loss—1%—can cause thirst in humans, and a significant amount of fluid loss—more than 10%—can put them in danger of mortality (ICRP Report, 1975). Ponds, streams, rivulets, and waterfalls make up the vast majority of the world's freshwater ecosystems. These little bodies of water are essential for the survival of freshwater species and are now being acknowledged for the crucial role they play in providing ecosystem services.[7]

Freshwater ecosystems harbor a diverse array of plants and animals. These organisms are found in many parts of freshwater ecosystems and interact with each other. [8] Plankton (such as zooplankton) are composed of organisms that drift passively, or float or swim weakly, due to water currents. [9]

Zooplankton are microscopic organisms that float within the water column. Like phytoplankton, these organisms have evolved drag-inducing body shapes and actively move appendages such as antennae or spines to avoid sinking into deeper water. Living in the water column has obvious advantages in terms of food, but the lack of refuges in this region makes zooplankton vulnerable to predators. [10]

RESEARCH METHODOLOGY

The Son River originates in the Amarkantak Plateau of Madhya Pradesh, India. The river flows north-northwestward from Madhya Pradesh, passing through areas such as Rewa and Sidhi, and then enters Bihar. The Son River is one of the largest tributaries of the Ganges and, after flowing approximately 784 kilometers, joins the Ganges near Patna. The Son River is primarily fed by the southwest monsoon between June and September, and the region it flows through receives an average annual rainfall of approximately 1,200 mm. The riverbed is wide and sandy, and it is known for its seasonal fluctuations. Major tributaries of the Son River include the Johila River, the Rihand River, and the Banas River. The river supports agricultural activities and is used for irrigation in the areas it flows through. Additionally, several dams and barrages have been built on the Son River for water management and hydroelectric power generation.

Zooplankton were collected using conical plankton nets (mesh size: 50µm). A sample was collected from three sampling sites along the Son River between 8 a.m. and 11 a.m., with three replicates. The net was lowered into the reservoir and pulled toward the shore. This was done at least five times. Samples were collected in 100 ml plastic bottles. Samples were preserved in 4% formalin and stored in appropriately labeled bottles. A few drops of glycerin were added to the samples to prevent them from drying out. Unwanted organisms (crustaceans, molluscs, etc.) and debris were removed from the samples using forceps.

Species-abundance relationships are given by relative abundances, which can be used as graphical or mathematical representations. Diversity indices can be grouped into a coherent system of diversity indices, including the derivation of species richness, the Simpson index, and the Shannon-Wenner index. The basic requirement of a diversity index is to obtain a quantitative estimate of biological variability.

RESULTS

A two-year zooplankton diversity and abundance study was conducted in the Son River. Thirty-four zooplankton species were documented during the two-year study. The Son River showed high diversity with 34 species. Nineteen rotifers, nine cladocera, four copepods, and two ostracods were observed in the study. The number of rotifers found in water bodies ranged from 14-19 in both years, while for cladocerans it was 4-9. The number of copepods ranged from 2-4, while two ostracods were observed in water bodies for the years 2020-22.

Table 1: Zooplankton diversity – Son River

Year/Group	Rotifera	Cladocera	Copepoda	Ostracoda
2020-21	19	9	4	2
2021-22	17	8	4	2

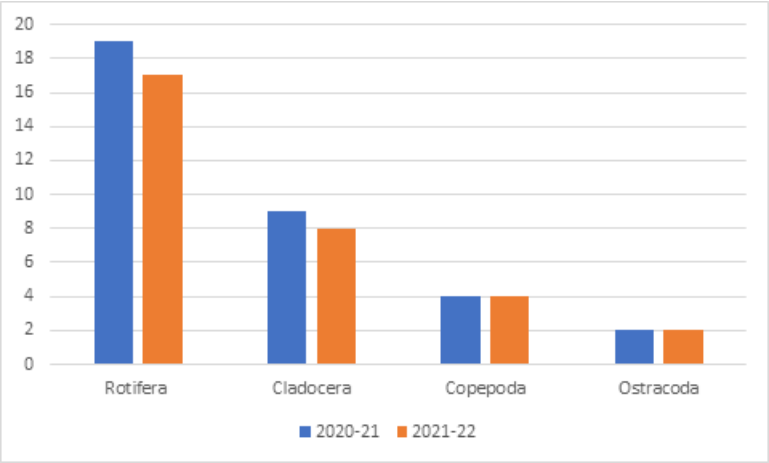

Figure 1: Zooplankton diversity – Son River

Table 2: Zooplankton species richness for local areas each year

Months	Son River	
	2020-21	2021-22

August	15	22
September	28	27
October	25	28
November	22	24
December	15	18
January	21	25
February	24	28
March	25	28
April	20	22
May	15	18
June	6	7
July	7	8

The maximum number of species at these locations was observed in the late winter months of February/March, while the minimum number of species was observed in the monsoon months of June/July. The zooplankton count per month on the Son River in 2020-21 ranged from 6-28. The zooplankton count per month on the Son River in 2021-22 ranged from 7-28. There was a large variation in zooplankton richness from month to month.

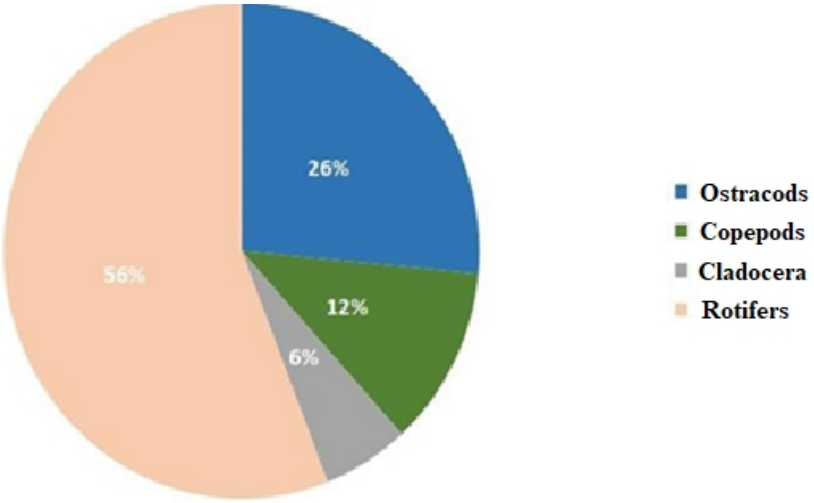

Figure 2: Zooplankton composition in the Son River over two years (2020-2022)

Based on higher taxonomic richness percentages, rotifers were the most species-rich group, accounting for over 50% of the total richness for the Son River. This was followed by cladocerans at 26%, while ostracods were the rarest group, with two species observed in the area. Rajagopal et al. (2010) reported 24 rotifers, 8 cladocera, 9 copepods, and 4 ostracods from Tamil Nadu. Mulani et al. (2009) reported 36 rotifers, 5 cladocera, 8 copepods, and 3 ostracods from the Panchganga River in Kolhapur. Dahivale (2008) also reported 4 rotifers, 13 cladocera, 8 copepods, and 1 ostracod from the Sukhana Dam in Marathwada. Chandrashekhar and Kodarkar (1994) found 4 rotifers, 5 copepods in Saroornagar Lake, Hyderabad. A study of Triveni Lake, Amravati, revealed that 19 zooplankton species were found, of which rotifers were the most common group (Khan et al., 2020).

The species richness structure for local areas was also similar for each year, with rotifers comprising more than 50% of the total species and ostracods less than 10%. Rotifers and copepods were slightly lower in the year 2021-33 for local areas, while the cladoceran and ostracod ratio remained the same.

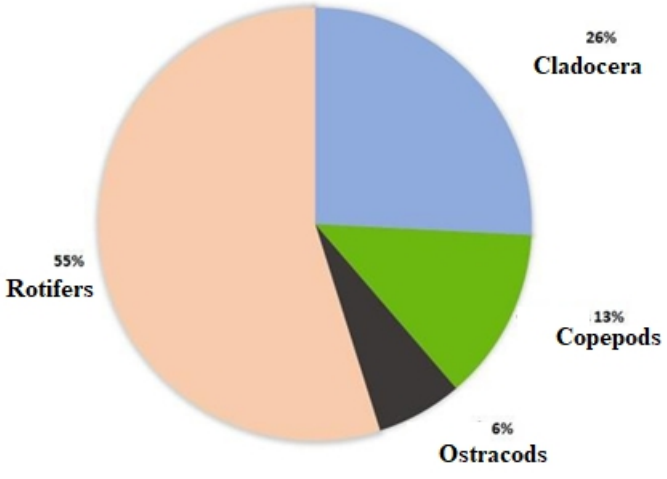

Figure 3: Zooplankton composition in the Son River for the collection year 2020-21

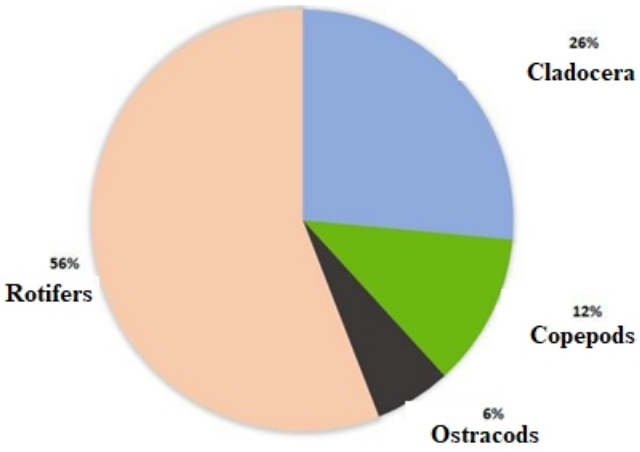

Figure 4: Zooplankton composition in the Son River for the collection year 2021-22

Cultivation of zooplankton

In recent times, zooplankton are considered live food organisms for the mass production of commercially important species such as fish. In this experiment, chicken manure, baker's yeast, peanut oil cake, and a mixture of these three were fed to Cyclops, Daphnia, and Brachionus to prevent population growth.

Table 3: Average number of individuals (mean ± SD) after 22 days of feeding on different types of feed.

Feed	Cyclops	Daphnia	Brachionus
Chicken Manure	3.9 ± 1.5	3.8 ± 1.8	3.9 ± 2.0
Baker's Yeast	3.8 ± 1.4	3.8 ± 1.7	3.9 ± 1.9
Peanut Oil Cake	2.8 ± 1.4	2.9 ± 1.5	2.9 ± 1.5
Mixture	3.6 ± 1.4	2.8 ± 1.4	3 ± 1.4
Control	1.4 ± 0.5	1.4 ± 0.5	1.3 ± 0.5

After 22 days, the average number of individuals was significantly higher in all feeds compared to the control. Chicken manure and baker's yeast had the highest number of individuals for all three zooplankton

species, while peanut oil cake feed had the lowest values. The mixture also had lower values than chicken manure and baker's yeast.

Zooplankton populations increased for 15 days and then began to decline. Our findings are similar to those of Punia (1988) and Khan et al. (2020). George et al. (2020) cultivated Daphnia in a similar manner and obtained similar results. Laboratory production of Daphnia was highest when fed with microalgae and active dry yeast.

The highest density of Daphnia was found in the mixed culture and the lowest in the control (Khan et al., 2020). Our results are consistent with these findings. Punia (1988) cultured Moina using various diets and found that chickpea and maize cake gave the best results. Shirgur (1971) obtained the highest density using oil cake and buffalo dung.

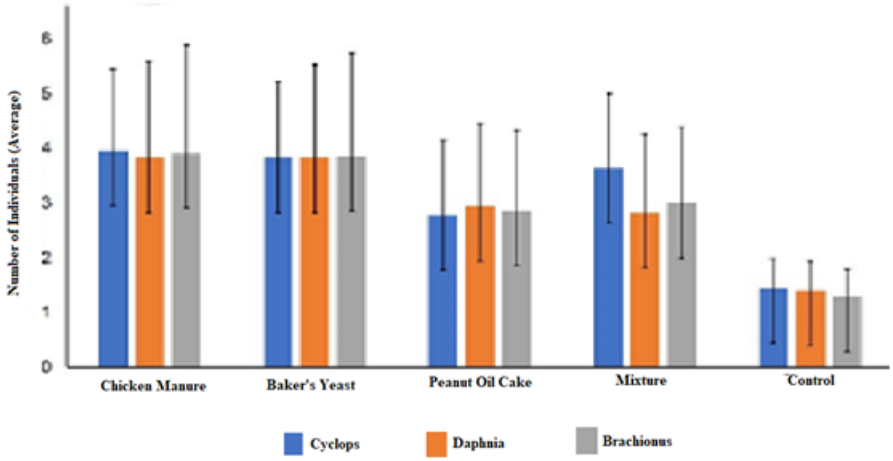

Figure 5: Average number of organisms after 22 days of feeding on different types of feed

The diagram above shows that chicken manure and baker's yeast are most suitable for increasing the number of organisms compared to peanut oil cake and the control. The mixed culture is more suitable for the growth of Cyclops than for Daphnia and Brachionus. Chicken manure and baker's yeast are rich in organic matter, phosphorus, B vitamins, and zinc, respectively. These compounds are extremely important for the growth of any organism. When added to a pond or culture, they stimulate phytoplankton growth because they are rich in nitrogen. The increase in phytoplankton will result in an increase in zooplankton populations.

The results of this study suggest that hatchery owners can use mixed diets. It is important to use good quality, clean, and pollution-free feed. The feed should not alter the water chemistry, as pH can affect the growth of phytoplankton and thus zooplankton. Baker's yeast is readily available in the market, and chicken feed is readily available to poultry farmers. Morris (1995) believes that organic fertilizers can promote desirable zooplankton species such as rotifers, copepods, Moina, and Daphnia. Wurts (2004) also concluded that organic fertilizers are effective in producing zooplankton, especially copepods and cladocerans.

CONCLUSION

This study reveals remarkable diversity and variation in zooplankton populations in the Son River over two

years, including significant seasonal fluctuations in species richness and abundance. The high biodiversity observed in the river supports the importance of freshwater ecosystems in sustaining aquatic life. Furthermore, experiments on the effects of different types of feed on zooplankton growth demonstrated that organic and nutrient-rich feeds, such as chicken feed and baker's yeast, effectively promote population growth. These results are consistent with previous studies and underscore the potential of enhancing zooplankton populations in aquaculture and ecosystem management. The findings highlight the need for further research into sustainable practices for zooplankton conservation and population management in river systems.

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