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Assessment of fish biodiversity in relation to physico-chemical characteristics of Kolar River, Madhya Pradesh, India

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Abstract
The present study was conducted on the Kolar River, a tributary of the Narmada River. The fish diversity of the Kolar River in the Sehore district of Madhya Pradesh, Central India, is represented in this view. It was investigated from February 2021 to June 2022. The Kolar River is a vital source of water for the people who live in nearby villages, primarily for domestic use. In the community, fishing for a living and food is a common practise. The study's goal was to investigate the Kolar River's water quality and fish fauna. During the investigation, six sampling stations were chosen for the collection of data: Near reservoir, Lawakhadi, Veerpur, Near old bridge, Dana baba temple, Amdoh, and Jholiyapur.
The study discovered 25 fish species from eight orders (Cypriniformes, Siluriformes, Perciformes, Osteoglossiformes, Synbranchiformes, Clupeiformes, and Beloniformes). Cypriniformes are the dominant order of fishes in this area (Kolar), with the highest number of ten species recorded. The recorded fishes were found to be widely distributed and abundant in the river.

Keywords: Fish biodiversity, Kolar River, physiochemical parameters, species diversity index

1. Introduction
Rivers play an important role in aquatic organisms' lives. The most productive source of fish culture is water. A sufficient amount of dissolved oxygen, food, suitable breeding sites, and specific characteristics such as pH and water temperature are required for fish survival. Lavudya and Pathak (2002) [30]. India has two biodiversity hotspots, the Western Ghats and the Eastern Himalayas, making it one of the world's 12-mega biodiversity countries. In terms of biodiversity, India ranks ninth in the world. 2017 (Kumar and Uchchariya) (Kumar and Uchchariya).
The recent study was carried out to investigate the fish diversity of the Kolar River in India's Sehore District (M.P.). The Kolar River is a well-known river in Madhya Pradesh, and it is a major tributary of the renowned Narmada River. The study's aim was to provide current data on fish diversity and physicochemical parameters of this river to help with a better understanding of fish diversity and to serve as a tool for conservation planning of aquatic environments in this region. This is the first study in this field, and several indigenous, commercially important, and economically valuable fish have been discovered.
(Namdeo and Singh 2021) [3]. Some studies were conducted on the Study on Species Diversity and Assemblage of Fish Fauna of Jamner River: A Tributary of the Narmada River (Vishwakarma and Vyas, 2014) [4] The fish fauna of the Bharathapuzha River in Kerala (Biju Kumar & Sushama, 1999) [5] and the Barna Stream Network in the Narmada basin (Central India) were also studied (Vishwakarma *et al*., 2014) [4].

2. Material and Method
2.1 Study Area
The current investigation was carried out on the Kolar River in the Madhya Pradesh district of Sehore. It is one of the most important Narmada River tributaries, located 35 kilometres southwest of Bhopal at 21°14′N and 79°10′E. The Kolar River runs for 101 kilometres. The Kolar River rises in Madhya Pradesh's Sehore district's Vindhya Range and flows south-west to meet the Narmada River near Nasrullah Ganj

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Table 1: Showing geographical locations of different Stations at Kolar River

S. No.	Sampling sites	Station name	Latitude and longitude
I	K-1	Near Reservoir	$22^0 57'36.84''$ N $77^0 20'52.30''$E
II	K-2	Lawakhadi	$22^0 58' 30.9''$ N $77^0 21'38.4''$E
III	K-3	Near old bridge	$22^0 59' 7.07''$ N $77^0 22'10.3''$E
IV	K-4	Dana baba temple	$22^0 57'56''$ N $77^0 20'34.''$E
V	K-5	Amdoh	$22^0 51'46.5''$ N $77^0 24'34.''$E
VI	K-6	Jholiyapur	$22^0 51'7.35''$ N $77^0 23' 48''$E

2.2 Physiochemical analysis

The current Kolar River study was carried out from 2020 to 2022 to investigate the river's water quality. Water samples were collected from six different locations during four different seasons: winter, summer, monsoon, and post-monsoon. The values of parameters such as air temperature, water temperature, pH, TDS, dissolved oxygen, conductivity, total alkalinity, chloride, total hardness, calcium hardness, nitrate, and orthophosphate were calculated using standard methods such as APHA (2005) [7] and Adoni et al, (1985) [6].

2.3 Collection of fishes

With the assistance of local fishermen, fish were collected from the Kolar River on a seasonal basis using a variety of active and passive gears such as cast nets and gill nets. After gathering information about the source of the fish, fish samples were collected from nearby local fish markets. Jayaram (1999) [8], Talwar (1991) [9], and Jhingran (1991) [9] provided standard keys for identifying the fishes (1999).

2.4 Fish Diversity Analysis

The fish assemblage structure was estimated for each type of habitat and it included: the Simpson index (1-D), Shannon diversity index (H'), Pielou's evenness index (J) and Margalef's species richness (S):
Simpson index is based on the following formula:

$$D = 1 - \sum ni\ (n-1)/N(N-1) \text{ (Simpson, 1949)} [26]$$

Where ni= is the number of individuals of taxon I, and N= is the total number of individuals.
The Shannon diversity index is based on the formula:

$$H = -\sum[(pi) \times \ln(pi)] \text{ (Shannon and Wiener, 1949)} [27].$$

Where, pi=n/N, H= the diversity index, ni = the relative abundance (S/N), S= the number of individuals for each species, and the N=total number of individuals.
Evenness index (J) is based on the following formula:

$$i / \ln((s-1) / \ln(n) \text{ (Pielou's, 1966)} [28].$$

Where, i = is the Shannon-Wiener's diversity index, the n=total number of individuals, and S = is the number of different species in the sample.
Species richness (S) is based on the following formula:
$$D = (S - 1) / \log(n) \text{ (Margalef, 1968)} [29] \text{ Where D} =$$

Margarlef's richness index, S = Number of different species in the sample, and N = Total number of individual species in the sample.

3. Result and Discussion

The data collected from sampling stations during the study period was used to estimate the fish diversity in the Kolar River. In the Kolar River, 25 fish species from 7 orders and 11 families were collected. According to the composition of species and their percent under various orders, 15 species are available under Cypriniformes (63%), 4 species under Osteoglossiformes (17%), 2 species under Clupeiformes (8%), and 1 species each under Beloniformes, Synbranchiformes, Perciformes, and Siluriformes (4%).During the current study, the following fish orders predominated: Cypriniformes (63%) > Osteoglossiformes (17%) > Clupeiformes (8%) > Beloniformes,= Synbranchiformes = Perciformes = Siluriformes (4%).
However, Lodhi et al., 2020 [11] discovered a similar result while researching the fish diversity of Atal Sagar Dam in Shivpuri district, Madhya Pradesh, India. According to the research, the fish fauna of Atal Sagar Dam consists of 22 species from 6 orders and 11 families. The Cypriniformes order has the most species, with ten, followed by the Siluriformes with five, Perciformes with four, Osteoglossiformes with one, Beloniformes with one, and Synbranchiformes with one. Vishwakarma et al. (2014) [4] worked on the Narmada basin's Barna Stream Network. The findings of this study reveal the presence of 33 fish species from 5 orders, 9 families, and 21 genera. The order Cypriniformes was discovered to be dominant (24 species), followed by Perciformes and Ophiocephaliformes (3 species each), and Mastacembeliformes (2 species) and Beloniformes (1 species), which is almost similar to the results of the present study.

Table 2: Order-wise fish distribution of fishes of Kolar River (MP)

S. No.	Order name	Number of fishes
1.	Osteoglossiformes	4
2.	Cypriniformes	15
3.	Clupeiformes	2
4.	Beloniformes	1
5.	Synbranchiformes	1
6.	Perciformes	1
7.	Siluriformes	1

3.1 Statistical analysis

During the study, various indices were used to assess the diversity of the Kolar River. The Shannon diversity index ranged between 2.22 and 3.345. Station-4 (3.345) had the highest value during the summer and Station-II (2.22) had the lowest value during the winter; however, the Simpson index values ranged from 0.8 to 0.96. Station-6 (0.96) had the highest value during the post-monsoon season, while Station-1 (0.8) had the lowest during the winter. Margalef's richness index ranged from 2.246 to 5.796. Station-4 (5.796) had the highest summer value and Station-2 (2.246) had the lowest winter value.
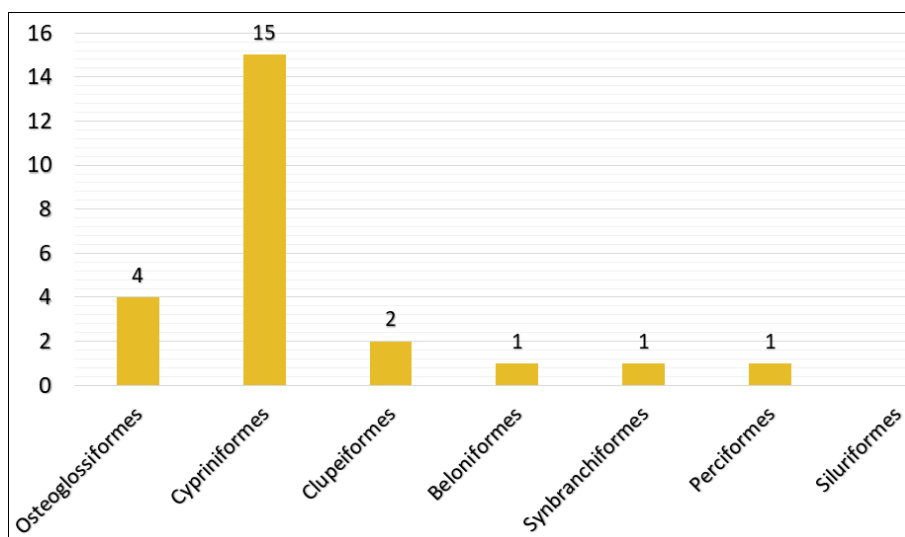
Fig 1: Fish distribution at Kolar River

3.2 Physiochemical properties at Kolar River
During the present study following results were attained for the physicochemical properties of the Kolar River. The detailed structure of physicochemical variation is given in Table 2.

3.2.1 Temperature
During the study period, the air temperature ranged from 21 °C to 42.5 °C. The highest atmospheric temperature was recorded at Station - 6 during the summer, and the lowest temperature was recorded at Station - 5 during the winter. The water temperature was measured between 19 °C to 32.7 °C. The highest recorded water temperature was 32.7 °C in the post-monsoon at Station, and the lowest recorded water temperature was 19 °C in the winter at Station - 6. In general, surface water temperature fluctuations appear to follow atmospheric temperature (Golterman, 1975; Hutchinson, 1976; Sharma *et al*., 2011) [12-14].

3.2.2 pH
During the current study, the pH of the water ranged from 7.2 to 9.15. The maximum pH value was 9.15 in the winter at Station - 5 and the minimum pH value was 7.2 in the post-monsoon at Station - 1. Similar results were obtained in the Narmada River in Madhya Pradesh (Sharma *et al*., 2011) [14] and the Yamuna River in Uttar Pradesh (Kumar *et al*., 2011) [15].

3.2.3 Total dissolved solids
Total dissolved solids in water ranged from 120 to 314 ppm during the current study. The maximum TDS value was 314 ppm in the summer at Station -6, and the minimum TDS value was 120 ppm in the post-monsoon at Station -1. Similar findings with 256-500 ppm in the Ganga River, Kanpur (Trivedi *et al*., 2009) [16] and 255-540 ppm in the Ganga River, Kanpur (Thareja *et al*., 2011) [17] support the current findings.

3.2.4 Electrical Conductivity
Water conductivity ranged from 129 mgl-1 to 400 mgl-1 in this study. The maximum conductivity at Station - 2 was 400 mgl-1 in the summer, and the minimum was 129 mgl-1 in the post-monsoon at Station - 4. Some researchers discovered electrical conductivity values of 272- 462 mhos in the Narmada River, 340-734 mgl-1 in the Yamuna River in Uttar Pradesh (Kumar *et al*., 2011a) [15], and 380-570s/cm in the Narmada River in Madhya Pradesh (Bashir *et al*., 2015) [18].

3.2.5 Chloride
The chloride concentration was varied from 6 mgl-1 to 71 mgl-1 during the current study. The highest value of chloride in water was recorded at Station - 6 in the summer, and the lowest value was recorded at Station - 5 in the winter. A similar range of chloride was recorded in the Cauvery River, Tamilnadu (Kalavathy *et al*., 2011) [19]; 29.61-66.68 mgl-1 in the Barna stream Narmada River basin, Madhya Pradesh (Bhawsar and Vyas, 2014) [20]; and 18-32 mgl-1 in the Yamuna River, Uttar Pradesh (Kumar *et al*., 2011) [15].

3.2.6 Total alkalinity
During the current study, the total alkalinity in water ranged from 72 mgl-1 to 239 mgl-1. The maximum value of total alkalinity in water was recorded 239 mgl-1 at Station - 3 during the monsoon, and the minimum value of total alkalinity in water was recorded 72 mgl-1 at Station - 4 after the monsoon. Some researchers have found a similar range of total alkalinity in the Yamuna River, Uttar Pradesh (Kumar *et al*., 2011) [15] and the Ram Ganga River, Uttar Pradesh (Chandra *et al*., 2011) [21], which supports the current values.

3.2.7 Calcium hardness
The calcium hardness value ranged from 25.2 mgl-1 to 294 mgl-1. The highest calcium value was recorded at Station - 4 during the monsoon, and the lowest value was recorded at Station - 2 during the winter. The range of calcium hardness was also discovered to be 330 - 396 mgl-1 in the Narmada River (Sharma *et al*., 2011) [14] and 212.1 - 289.8 in the Narmada River (Bashir *et al*., 2015) [18].

3.2.8 Total hardness
The total hardness of the water in this study ranged from 70 mgl-1 to 276 mgl-1. The maximum total hardness was 276 mgl-1 during the monsoon at Station -5, and the minimum was 70 mgl-1 during the post-monsoon at Station -4. The total hardness value in Ganga River, Kanpur was 106-246 mgl-1 (Thareja *et al*., 2011) [17]; 182.1-300 mgl-1 in Ram Ganga River, Uttar Pradesh (Chandra *et al*., 2011) [21]; and 148.66-236 mgl-1 in Barna stream Narmada River basin, Madhya Pradesh (Bhawsar and Vyas, 2014) [20], which supports the current findings.

3.2.9 Nitrate
During the current study, the nitrate concentration in the water ranged from 0.107 mgl-1 to 1.702 mgl-1. The maximum nitrate concentration was 1.702 mgl-1 at Station - 5 during the monsoon, and the lowest concentration was 0.107 mgl-1 at Station - 6 during the winter. Some researchers found nitrate levels ranging from 0.008 to 0.024 mgl-1 in the Chambal River (Saksena *et al.*, 2008) [22] and 1.38 to 2.6 mgl-1 in the Ganga River in Varanasi (Mishra *et al.*, 2009) [23].

3.2.10 Orthophosphate
During the present investigation, the orthophosphate in the water ranged from 0.121 mgl^{-1} to 1.360 mgl^{-1}. The maximum value of orthophosphate was 1.360 mgl-1at the Station - 1 in the post-monsoon and the minimum value was 0.121 mgl^{-1} in the winter at Station - 3. The concentration of Phosphate in the Narmada River water sample was found to be in the range of 0.16-0.28 mgl^{-1} (Sharma *et al.*, 2011) [14].

Table 3: Showing physiochemical parameters at Kolar River

S. No.	Parameters	Min value	Max value	Mean	Median	Mode	STD
1.	AT	21	42.5	28.52917	29.3	36	6.561845
2.	WT	19	32.7	24.05833	24.4	22	5.220188
3.	pH	7.2	9.15	7.845833	8	8.3	0.509031
4.	TDS	120	314	161.0417	162	168	20.55
5.	EC	129	400	229.6667	235.5	240	49.31502
6.	TA	72	239	124.9583	104	82	53.0967
7.	DO	6	10	7.9125	7.85	6.4	1.042702
8.	CL	6	71	25.55	23	23	12.57257
9.	Ca H	25.2	294	116.9042	99.5	295.3	70.23447
10.	TH	70	276	128.75	105	90	61.82742
11.	No3	0.107	1.702	0.667917	0.3875	0.2345	0.597922
12.	Po4	0.121	1.360	0.803708	0.6415	0.5439	0.505272

4. Conclusion
The work concluded with future strategies for the development of fish diversity in the Kolar River at Sehore (M.P.) India. Recent data on the fish diversity of the Kolar River aims to contribute to a better understanding of the fish diversity planning of aquatic environments in this region. According to the current study, the Kolar River has a diverse fish fauna with a large number of fish species, and their production in the river may be related to the suitable ecology of the water body, which provides a good breeding ground for fish. This also implies that the river's water parameters are within acceptable limits for fish and fisheries practises (according to WHO and BIS standards). The current study found 25 fish species from 7 orders, 15 families, and 24 genera. The species collected were mostly from the order Cypriniformes. Recent data on the fish diversity of the Kolar River, with the goal of improving understanding of fish diversity planning in this region's aquatic environments.

5. Abbreviations
APHA, American Public Health Association; AT, air temperature; WT, water temperature; pH, hydrogen ion concentration; DO, dissolved oxygen; EC, electrical conductivity TDS, total dissolve solid; TA, total alkalinity; CL, chloride; NO3, nitrate; PO4, orthophosphate; TH, total hardness; CaH, calcium hardness; TA, total alkalinity STD, standard deviation, and pH hydrogen ion concentration.

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