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HETEROGENEITY IN HABITAT USE OF THREE THREATENED FRESHWATER CATFISHES (SILURIDAE: SILURIFORMES) IN FIVE MAJOR TROPICAL RIVERS OF INDIA

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ABSTRACT
Ompok panda, O. pabo, and O. bimaculatus were sampled from 40 different locations in the Tone, Gomti, Ganga, Bramhaputra, and Hoogly rivers to determine the most important habitats for these endangered catfish. It was determined that environmental circumstances impact species occurrences and assemblage traits via the use of canonical correspondence analysis. An analysis of the microhabitat, hydro morphological factors, depth, and velocity, followed by conductivity; temperature; TDS was shown to be crucial in structuring the three catfish species. It has been shown that the presence of O. panda in rivers with swift current and shallow depth is substantially related to the presence of O. bimaculatus, which prefers a slower current and greater depth. Other environmental factors, including conductivity, TDS, and pH, were also shown to influence the Ompok species' habitat preferences. Environmental factors have a significant impact on the Ompok species, and our findings demonstrate the need for their protection and management.

Keywords: Ompok species, Habitat, Aquatic Biodiversity, Riverine System

1.INTRODUCTION
All terrestrial and aquatic ecosystems rely on fresh water for their survival. Human activities, such as river management works, dam construction, and land-use change in the watersheds, are threatening the world's most varied vertebrate group: freshwater fishes. This is why freshwater biodiversity conservation tools are being studied and different approaches and tactics are being presented. Rare or endangered species and pristine streams need special protection, as do freshwater environments.
Protected areas in India include 509 wildlife sanctuaries, 96 national parks, and three conservation reserves under the "Wildlife (Protection) Act," which covers 4.74 percent of India's total land area (NBAP 2008). All of the protected areas have been designated for comprehensive habitat and ecosystem protection. In contrast, an evaluation of India's protected area network has shown that freshwater fish biodiversity is not well represented. National Biodiversity Action Plan has recently been established by India's Ministry of Environment and Forests to assist conserve biodiversity in both terrestrial and marine areas India is home to a wide variety of aquatic species. There are over 2 319 fish species reported in India, of which 838 are found in freshwaters.
As a result of its mountainous genesis, the Gerua River flows south through Nepal's Royal Bardi National Park before finally reaching India's Terai region, where it enters India at the Katerniaghat Wildlife Sanctuary (also known as the Kateraniaghat Pashu Vihar Sanctuary by the United Nations Environment Programme 2005). The river has a huge annual average discharge of around 1500 m3/s, which makes sense given its size. About the location, discharge, and cross-sectional area, the river channel's breadth varies greatly. The river's aquatic ecosystem benefits from the existence of a protected area upstream and forest cover in the middle section. Except for the contractors' high fish captures in the sanctuary's buffer zone and the occasional hidden use of pesticides by local fishermen, there has been no significant damage to the environment inside the sanctuary. The Girijapuri Barrage, located downstream of the sanctuary, diverts part of the Gerua River's water flow for agriculture before joining the Ghagra River, a major tributary of the Ganges.

2. LITERATURE REVIEW
Archana Srivastava (2015) Diverse researchers studied the fish flora of various bodies of water. In Lucknow, there has been little research on the ichthyofauna of the Gomti River. The fish fauna of Lucknow's Gomti river is the subject of this paper (Latitude: 26o 51N and Longitude: 80o 58E). We've compiled a list of 70 species,

including two endangered, six vulnerable, twelve unclassifiable, and fifty species that haven't been appraised, all of which fall into nine suborders, twenty-one families, and forty-two genera. Each species' scientific names, physical characteristics, fin formula, local name, and popular name were examined, providing an overview of the finfish found in Lucknow.

Uttam Kumar Sarkar (2014) To better understand the freshwater fish flora and fauna at various scales of the Ken River, which is slated for interlinking in India, systematic studies were carried out. A total of 57 species from 42 genera and 20 families were discovered in the investigated river for the first time. Of the 57 species, seven are classified as "endangered" and 13 are classified as "vulnerable." Tor, Bagarius vagaries, Chitala Chautala, Pangasius pangasius, Sperata for, Wallago Attu, Ompok panda, Ompok bimaculatus, Labeo calabash, Channa marvelous, and Macrognathus pancakes were significant species in addition to Indian big carps. Other notable species included This river has never seen any of these species before. Fish variety is higher in upper portions of the river because of the presence of a protected region and forest cover than in lower stretches, which are vulnerable to many human activities. Distribution, community dominance index, evenness index, similarity index, and trophic ecology have all been explored in this article." Many different fish species may be found in a single section of the river's ecosystem. Using the findings of this research, it is possible to forecast changes in fish diversity after interlinking a river by developing a baseline of fish diversity in the pre-interlinking period.

Raizada, Sudhir & Lal (2013) Butter catfish (Ompok bimaculatus, Bloch 1794) was successfully bred in captivity at the National Bureau of Fish Genetic Resources in Lucknow, an endangered silurid of the Indian subcontinent. The fish were subjected to ten induced breeding tests, and the results showed that GnRH analog and dopamine antagonists may be used to naturally spawn the fish under controlled settings. For females, the optimal dosage was assessed to be 0.7 ml kg1 body weight, whereas, for males, it was 0.5 ml kg1. It took 7–8 hours for a spawn to take place at 27 0.5 °C in a flow-through system, and the fertilization and hatching rates were from 75–90% and 80–90%, respectively. At a temperature of 27 0.5 °C, the egg hatched in 21 hpf, and the yolk-sac was absorbed in 48 hpf. For reasons including low food acceptance and cannibalism, the survival rate of the larvae decreased significantly after 5 days of upbringing to 10.4% after 10 days of rearing. When given hormone dosages within 36 hours of being removed from the pond, the fish reacted effectively, but after that time had passed, they did not, most likely owing to stress. These experiments might help standardize O. bimaculatus ex-situ breeding techniques.

Ahmad, Shahnawaz & Dharan (2013) It is shown in this research that the Tunga and Bhadra rivers in the Western Ghats of India have distinct fish distribution patterns, endemism, and species richness. A total of 77 species were found, including 36 unique to the Western Ghats, 12 indigenous to India, and 26 endemics to the Indian Subcontinent. These species were distributed throughout seven orders, 16 families, and 44 genera. The Tunga River is more diverse and has a greater level of endemism than the Bhadra River, according to our examination of distribution patterns. The Jacquard index was used to determine how similar the species mix was at different locations within these two rivers. These rivers' sample sites were shown to have a decreasing similarity index as the distance between them increased. More than half of the 77 fish species we gathered fall into the Critical, Moderate, or Low-Risk categories, respectively; the remaining 18 fish species fall into the Low-Risk group. Adequate conservation efforts are needed to preserve the diversity of fish species in the Tunga and Bhadra rivers.

U. K. Sarkar (2012) The Ganges River is India's largest and fifth-longest river. Much research has been done on fish ecology and systematics in the Ganges to enhance fisheries, but fish diversity and their distribution patterns from a conservation perspective have not been effectively addressed. Freshwater fishes in the River Ganges were studied and assessed from April 2007 to March 2009 in this regard. We recorded and characterized 143 freshwater fish species across the river, which is a larger number than previously reported. Some species were found to have changed their geographic distribution. Pterygoplichthys anisette is one of a total of 10 alien fishes detected in the Ganges for the first time. The most significant hazard to the fish of the Ganges seems to be the alteration of the hydrological pattern owing to numerous hydro projects. The Ganges River's fish variety is under danger from several other factors, including indiscriminate and illegal fishing, pollution, water abstraction, siltation, and the introduction of foreign species. The findings of this research support the idea that the Ganga Basin's most important fish habitats should be identified and designated as conservation reserves to help stem the tide of fish extinctions along this massive river.

Lakra, Wazir & Sarkar (2010**)** It was found that a Central Indian river (River Betwa, which is part of India's first river-linking plan) had an ecology of habitat, species richness, distribution, and several indicators of fish biodiversity management investigated in the current communication. Fish diversity and water quality were found to be highly correlated, with water depth, dissolved oxygen, and pH serving as the most significant determinants. Fish species from 20 families and 45 genera were gathered from five sample sites located in the upper, middle, and lower streams of the study area. After Cyprinids, Bagridae, and Schilbeidae, 26 species from 15 genera were the most dominant, followed by six species from three genera in the Bagridae (4 species from 4 genera). Nearly 10% of the species were found at all the locations, indicating that they migrate across great distances. One may see a wide variety of values in Shannon-diversity Weiner's index. 10 species had no data on their condition, 29 that were at low risk, 14 were vulnerable, and 8 were endangered. The remaining two species were imported. Our research demonstrates that the River supports a wide range of fish species and is vital for conservation, however around 34% of the fish fauna is either vulnerable or endangered. It was found that the river maintains a large amount of food, decorative, and recreational fish (89.47 percent, 49.12 percent, and 4.91) (5.26 percent). The open river, shallow water, and deep pools were the habitats that contributed the most variety out of the eight different kinds of fish habitats found over the whole river's length.

3.OBJECTIVES OF THE STUDY

- There were 40 sample points in the Tones, Gomti, Ganga, and Bramhaputra rivers to investigate how habitat factors affect the organization of fish assemblages.
- To conduct an in-depth investigation For the Ompok species, various environmental characteristics including conductivity and TDS/pH were shown to influence their habitat selection.

4.MATERIALS AND METHODS

4.1 Samples Collection

As a representation of the landscapes in all the analyzed rivers, 40 fish samples were obtained from 40 chosen places at each of the four studied rivers, namely Chak Ghat, Lucknow, Malda, Guwhati, and Kolkata (River Hoogly). During the premonsoon, monsoon, and postmonsoon seasons from 2007 to 2010, each site was sampled five times for each season. 318 Ompok species were studied, including O. pabda, O. pabo, and O. bimaculatus. Fishing has been done both at night (17 h to 7 h) and during the day at each of these sample locations (7 H to 13 H). A weighted bottom set of nets (75 x 1.35 m, 50 x 1 m, and 30 x 1 m) was used for each of the three nets. According to Jayaram (1999) and Talwar and Jhingran (1999), all fish specimens were identified (1991).

4.2 Pysicochemical Characterization

At the same location where fish were sampled, environmental factors were recorded. The variance in species composition was analyzed using eleven environmental factors (Table 1). Thermal (°C) and chemical variables included NTU, NTU, NTU, turbidity, water flow, depth, conductivity, TDS (ppm), DO, and pH, which were all monitored. The Cyber Scan Waterproof PC 300 multiparameter was used to assess water temperature, conductivity, pH, TDS, and DO at the sample sites. Transects within each sampling site were used to determine the overall proportion of each substrate type in the sample. Inspection and hitting the river bottom with a bamboo rod indicated the predominant substrate material at each sample location. According to Bain and Stevension (1999), sand (0.06–2 mm), gravel (2–64 mm), and cobble (64–250 mm) were the most common substrate classifications.

Table 1. Each river's 40 sample points yielded an average (standard deviation in parentheses) and a range of environmental variables

Variables	Mean	Range
Water flow (cm/sec)	22.6 (10.5)	11.21-39.70
Depth (m)	3.38 (1.7)	1.10-6.47
Temperature (ºC)	22.98 (3.6)	16.22-26.8
Dissolved Oxygen (mg/L)	5.4 (1.1)	3.3-7.20
pH	7.14 (.4720)	7.0-8.4
Turbidity (NTU)	17.88 (13.3)	6.21-80.2
Conductivity (µS/cm)	414.16 (207)	165-667
Total Dissolved Solids (ppm)	223.4 (127.1)	110-589
Fine Substrate (%)	46.75 (32.4)	0.01-86.2
Fine Gravel (%)	22.2 (16.2)	0.01-65.2
Coarse Gravel (%)	16.37 (17.7)	0.01-69.3

4.3 Statistical Analysis

Data from each of the 40 sample locations were compiled into a data matrix, including habitat values and catch counts per species. The mean value for each habitat variable was calculated when several measurements were taken in different seasons. Before doing a PCA, the 11 environmental variables were reduced in dimensionality and examined for the first time the effect of habitat features. Log10(x + 1) transformations are applied to all variables before data analysis to ensure normalcy. Principal components with eigenvalues greater than one were used in PCA on the correlation matrix for environmental variables. When organizing the stream based on the Chatfield and Collins technique, loading variations greater than 0.25 were taken into account (1980). To compare environmental factors, we used a MANOVA analysis of variance. From the total number of individuals collected across all sampling locations, the relative abundance of each species was derived. Environmental factors and fish assemblages were studied using Canonical Correspondence Analysis (CCA). For the Monte Carlo randomization procedure, which randomly allocates the values for the species data to environmental factors, the results of CCA were evaluated. After removing variables with inflation factors of greater than 10, partial CCAs were used to estimate the variation explained by individual variables. Every one of the statistical evaluations was carried out by use of the MVSP trial version 3.1

5. RESULTS AND DISCUSSION

5.1 Physicochemical Characterization

A total of 68.6 percent of the environmental variance in the locations could be explained by the PCA's three axes of analysis (Table 2). The water flow, depth, temperature, turbidity, and TDS loadings on the first axis were very high. Temperature, dissolved oxygen, pH, and TDS loadings were all high on the second axis. High loadings for conductivity and dissolved oxygen were found on the 3rd axis. A total of eleven environmental variables were analyzed and eight of the eleven exhibited strong loadings on at least one of the principal component axes evaluated. On the other hand, none of the first three axes were heavily loaded in the case of the fine substrate, fine gravel, or coarse gravel samples. It was found that there was a significant variation in habitat structure across sample locations (F =8.55, p0.05).

Table 2. Results from PC analysis of physical habitat structure and physiochemical environmental factors at 40 sample locations

Variables	PC1	PC2	PC3
Water flow (m/sec)	-0.32	-0.04	-0.02
Depth (m)	0.34	-0.01	0.04
Temperature (ºC)	-0.31	-0.32	0.17
Dissolved Oxygen (mg/L)	0.02	0.54	0.31
Conductivity (µS/cm)	-0.05	-0.02	0.54
Turbidity (mg/L)	0.32	0.18	-0.16
pH	-0.15	0.61	-0.23
Total Dissolved Solids (ppm)	-0.29	0.27	-0.20
Fine Substrate (%)	0.01	0.07	0.15
Fine Gravel (%)	-0.08	0.16	-0.10
Coarse Gravel (%)	-0.18	0.05	0.02

Table 3. Canonical correspondence analysis summary data for each river's sampled fish and environmental conditions. Eigen analysis (tolerance set at 1E-009) Patterns of Fish Assembly and Habitat Use

	Axis 1	Axis 2
Eigenvalues	0.41	0.17
Species - Environment Correlations	0.90	0.64
Cumulative Percentage Variance		
Explained by Species Only	44.83	18.62
Explained by Species + Environmental Variables	44.83	63.46
Interest Correlations with Axis		
Water Flow (m/sec)	0.83	-0.07
Depth (m)	-0.72	-0.01
Temperature (ºC)	0.79	0.09
Dissolved Oxygen (mg/L)	0.05	-0.01
Conductivity (µS/cm)	0.23	0.44

As a consequence of this forward selection method, eight variables were retained as important contributors to ordination variability. The species data's variation was explained by 44.83 percent by the first ordination axis and 18.62 percent by the second ordination axis (Table 3). Species abundances (P=0.001 along axis one and two, Monte Carlo test with 1,000 permutations) were strongly associated with environmental parameters. To begin with, it was discovered that the flow rate was directly proportional to the temperature and the TDS concentration in the sample; on the other hand, the relationship between the two was antagonistic (Figure 1). The second ordination axis had a favorable correlation with conductivity. In terms of the species-environment correlations, the first one was 0.90, while the second one was 0.64. (axis 2). An environmental factor's magnitude is represented by the length of a vector emanating from its source. In terms of important habitat traits, O. pabda, O. pabo, and O. bimaculatus were separated greatly from one another in habitat space. This species was found in places where the water was rapid and shallow with a high concentration of dissolved particles and a higher water temperature. On the other hand, O. bimaculatus was linked to locations with slow water current and turbidity, whereas O. pabo was linked to areas with greater conductivity.

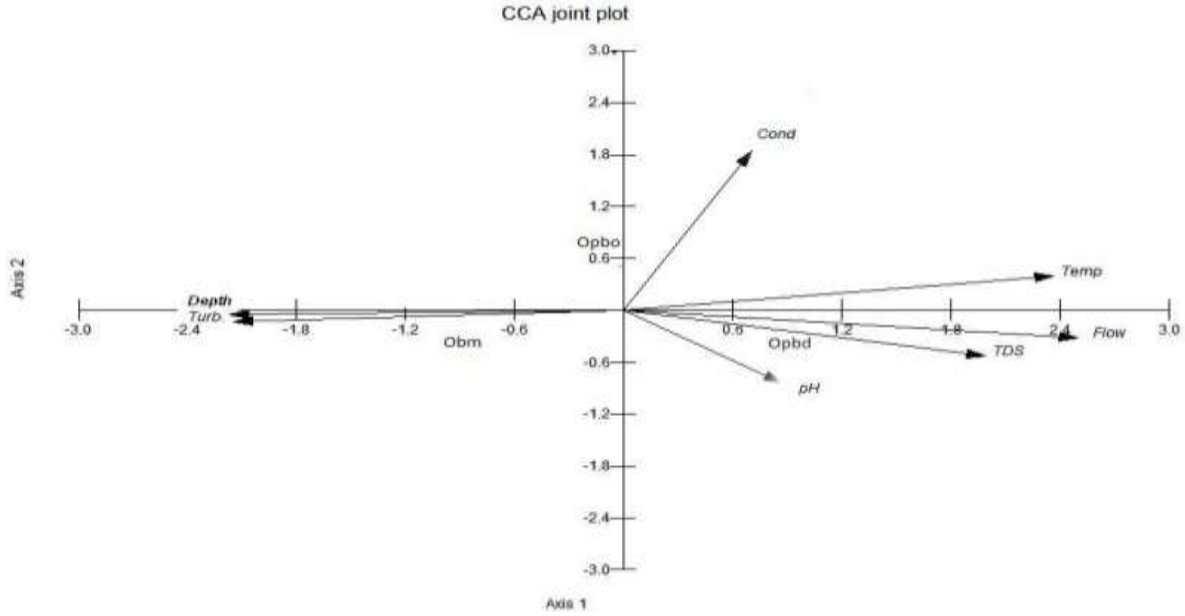

Figure 1. According to Canonical Correspondence Analysis (CCA), species composition and environmental factors correlate

ID: Opbo = Ompok pabo; Opbd = Ompok pabda; Obm = Ompok bimaculatus.

Environmental effects at many geographic scales shape local fish communities. Species in this research have a wide range of habitat preferences. According to Gorman and Karr (1978), Angremeier and Schlosser (1989), Copp et al. (1994), Garner (1996), and Sarkar and Bain (1996), water flow and depth were the most relevant environmental factors for the assemblage of Ompok species in various rivers (2007). In all the rivers tested, Lamouroux et al. (1999), Lamouroux and Souchon (2002), and Carter et al. (2003) found that endangered O. panda preferred slower and deeper water as its preferred habitat (2004). In several Cyprinids, Sarkar and Bain (2007) found a preference for slow water currents as a habitat preference.

Aside from the velocity and depth of the tropical rivers studied in India, the physicochemical variables conductivity, pH, and temperature were shown to be relevant in structuring the sites and assemblages of the three Silurids (O. pabda, O. pabo, and O. bimaculatus). The abundance of O. pabo connected with conductivity in our investigation indicated that these species may thrive in these circumstances. Across a wide area, researchers like Taylor et al. (1993) and Wilkie and Wood (1981) found that conductivity was the most significant factor in organizing fish communities at small spatial scales. (p. Using CCA forward selection processes, environmental determinants influencing the abundance of three Ompok species may be identified.

6.CONCLUSION

In the first study of its sort in tropical rivers in India, researchers uncovered a substantial, complete dataset where depth and flow are vital components. Indian Silurid fish distributions are shaped by water depth and velocity, which are the most significant habitat variables in determining fish distributions. The results of this

research will help conservationists identify the best channel habitats for three vulnerable Silurid fishes, providing detailed advice on the depths, substrates, and current velocities required to sustain the threatened species. As a consequence of our findings, we believe that environmental factors affecting vulnerable fish populations may be utilized to inform conservation efforts and aid in the restoration of previously untouched fish habitats. Habitat needs and their link to local fish assemblages should be taken into consideration when developing conservation strategies.

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