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Distribution and Diversity of Freshwater Fishes in Aami River, Gorakhpur, India

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Abstract: The fish diversity of the Aami River in relation to physicochemical parameters was studied by monthly samples taken from January 2011 to August 2012. The water of the River is used for industry, fishery and local area people. Cast net were used for fish sampling, which was done from 9:00 AM to 5:00 PM. The results of present investigation reveal the occurrence of 18 fish species belonging to 6 order, 11 family and 17genera. Among the collected species, order Cypriniformes was the most abundant in all sites besides this order Beloniformes, Mastacembelida, Symbranchiformes, Perciformes, Centropomidae, Amphipnoidae, Ophiocephalaidae, Clupeidae, Sisoridae, Clariidae, Bagridae, Saccobrachidae also were present but its number is very less in all sites. Over fishing, industrial, chemical, agricultural runoff and other form of pollution are the most important which should be restricted for the conservation of freshwater fish diversity. Therefore, it may be concluded that preparation of zone wise database of these information and their implementation through government and non-government organization would be the key tools for conservation of freshwater fish biodiversity.

Key words: Biodiversity · Fish · Freshwater

INTRODUCTION

Fishes are the important elements in the economy of many nations as they have been a stable item in the diet of many people. They constitute slightly more than one-half of total number of approximately 54,711 recognized living vertebrate species; there are descriptions of an estimated 27,977 valid species of fishes [1]. Biodiversity is essential for stabilization of ecosystem, protection of overall environmental quality for understanding intrinsic worth of all species on the earth [2]. Freshwater biodiversity has declined faster than either terrestrial or marine biodiversity over the past 30 years [3]. Biodiversity is often ambiguously misused or overused to describe population dynamics of a location or community [4]. Declining river flow rates (discharge) have been a major cause of species loss [5] and are likely to be further reduced by warming temperatures, reduced precipitation and increased water withdrawal for agriculture and other human uses [6, 7]. Future declines can therefore negatively affect freshwater biodiversity. Inland waters and freshwater biodiversity constitute a valuable natural resource, in economic, cultural, aesthetic, scientific and educational terms. Their conservation and management are critical to the interests of all human, nations and governments. The streams and rivers are facing number of environmental problems throughout the world largely associated with anthropogenic activities in their catchment areas [8]. The adverse effects of human activities have resulted in degradation of stream and reverie ecosystem [9] which ultimately alters the structure and function of stream biota [10]. Fish constitute almost half of the total number of the vertebrate in the world. They live in almost all conceivable aquatic habitat's 21,723 living species of fish has been recorded out of 39,900 species of vertebrate [11] of these 8,411 are freshwater species and 11,650 are marine in India is one of the mega biodiversity in the world and occupies the ninth position in turn of freshwater mega biodiversity [12]. Here we focused the fishes diversity of Aami River Distt Gorakhpur. The high industrial pollution effect the fish diversity of River Aami. It is clear from this study the pollution parameter like biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), pH and suspended solid are directly affect the fish diversity.

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MATERIALS AND METHODS

Study Area: Gorakhpur is a part of Eastern Uttar Pradesh (lies at 26°48'Nand 82° 08'E) its high above mean sea level is 114 m. River Aami belonging to Sant Kabir Nagar, close to Gorakhpur in India originated from River Ghaghra and merges into the River Rapti, covering distance of about 250 km. The river starts from Ghaghra in more or less unpolluted form, but during its route it receives heavy amount of effluent from industrial area. Aami River is not only important from the geo ecological point of view but also has a significantly potent socio- economic impact on the area through which it flows. The study was carried out at three sites in River Aami that is one is near to Rayana pulp and paper mill Industry, Santkabir Nagar (S1). Second is Chataye pull (S2) which receive effluents of Gorakhpur industrial area and Third site is Sahgura where Aami River merge in River Rapti (S3).

Data Collection and Analysis: Fish sampling was performed in 100 m reach of all the three sampling sites. Fishes were collected from different selected localities during the study period of Jan. 2011 to August 2012 with the help of local fishermen using different types of nets namely gill nets, cast nets and Dragnets. Immediately photographs were taken prior to preservation since formalin decolorizes the fish color on long preservation. Formalin solution was prepared by diluting one part of concentrated formalin or commercial formaldehyde (10% formalin). Fishes brought to the Laboratories were fixed in this solution in separate jars according to the size of species. Smaller fishes were directly placed in the formalin solution while larger fishes were given an incision on the abdomen before they were fixed. The fishes collected and fixed were labeled giving serial numbers, exact locality from where collected; date of the collection, the common local name of fish used in this region was labeled on each jar. Identifications were carrying out by Talwar and Jhingran [13].

Water sample were collected between 8 to 11 AM and further transported to the laboratory immediately for further analysis. Water temperature was measured at the time of sampling using mercury thermometer; pH was measured with standard pH meter, while other parameters were analyzed in the laboratory according to the methods suggested by American Public Health Association (APHA) [14].

Fish species diversity was subjected to diversity analysis using different indices like Shannon-Weiner index (H) [15]; Simpson Dominance index (D); Simpson index of diversity (1-D) [16].

Shannon-Weiner Index:

$$H = - \Sigma Pi \log2 Pi$$

where, H = Shannon – Weiner index

$$Pi = ni/N$$

Species diversity was calculated following Shannon-Weiner index (H) which depends on both the number of species present and the abundance of each species.

ni = Number of individuals of each species in the sample.
N = Total number of individuals of all species in the sample.

Abundance of fish population was calculated by the sum of all available species in different sites. Species richness was simply estimated by the variety of fish species in three different sites.

Data regarding threats faced by the fish fauna were obtained from both primary (direct observations and interaction with local stakeholders and fishermen) and secondary sources.

Simpson's Diversity Indices: Simpson's diversity index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species.

Simpson's Index of Dominance:

$$D = \Sigma \left. \frac{ni\,(ni - 1)}{N(N-1)} \right|$$

where:

ni = The total number of individuals of a Particular species.
N = The total number of individuals of all Species.

Simpson's index of diversity 1 – D

RESULTS

The diversity of the fishes mainly depends upon the biotic and a biotic factors and type of the ecosystem, age of the water body, mean depth, water level fluctuations, morph-metric features and bottom have great implications. The hydro-biological features of the collection centers also play an effective role in fisheries output to a greater extent. During the entire study period, a total of the occurrence of 18 fish species belonging to 6 order, 11 family and 17 genera. Among the collected species, order Cypriniformes was most abundant all sites besides this order Beloniformes, Mastacembelida, Clupeiforemes, Symbranchiformes, Perciformes also present but its number is very less in all sites. The distribution of fish species is quite variable because of environmental conditions.

Aami shows Shannon-Weiner index (H) in site-1 0.0213 followed by site-2 0.0088 and lowest in site-3 0.00422. The Simpson's dominance index (D) value shows high at site-1 .064 and site-2 0.0280 and low at site-1 0.0133. With this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower the diversity. The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity. In our study the Simpson's index of Diversity (1-D) for site 1 is .936, Site 2 is .72 and site 3 is .986. (Table 1).

The biodiversity status, abundance, richness and habitat of fishes of Aami River are given in Table 1. During the period of investigation the richness is high in site-2 and site-3 in comparison to site-1. Among the collected species, family Cyprinidae was most abundant in all sites after this siluridae was dominant besides this family sisoridae, mastacembelidae, Bagridae, Clariidae, Ophiocephalaidae is also present but its number is very less. The abundance is high in site-3 in comparison to site-1 and site-2 (Table 2).

Among 18 species of fishes, the family Cyprinidae was the most dominant in the assemblage composition with 39% followed Siluridae with 11%, Beloniformes, Mastacembelida, Symbranchiformes, Perciformes, Centropomidae, Amphipnoidae, Ophiocephalaidae, Clupeidae Sisoridae, Clariidae, Bagridae, Saccobrachidae each with 6 % respectively [Fig. 1].

Seasonal Variations in Physicochemical Parameters of Aami River: Among habitat attributes, pH, temperature, total dissolved solid, BOD, COD, DO and total solid were varying considerably from season to season.

Table 1: Fish species richness, abundance and biodiversity indices of Aami River

	Site-1	Site-2	Site-3
Species Richness	8	18	18
Abundance (N)	30	105	152
Shannon-Weiner index (H)	0.02139	0.0088	0.00422
Simpson's index of dominance (D)	0.064	0.0280	0.0133
Simpson's index of diversity (1-D)	0.936	0.72	0.9866

Table 2: Fish species density, abundance, richness and distribution in Aami River

No.	Species	Site-1	Site-2	Site-3	Richness	Abundance
	Family Cyprinidae					
1	*Catla catla*	5	8	12	3	25
2	*Labeo rohita*	4	10	16	3	30
3	*Labeo calbasu*	-	3	4	2	7
4	*Puntinus conchonius*	4	6	10	3	20
5	*Cirrhinus mrigala*	-	4	6	2	10
6	*Chela atpar*	-	6	8	2	14
7	*Ambly phryngodonmola*	-	9	10	2	19
	Family Saccobrachidae					
8	*Heteropneutes fossilis*	3	7	11	3	21
	Family Clariidae					
9	*Clarias batrachus*	5	10	12	3	27
	Family-Clariidae					
10	*Mystus bleekeri*	1	4	8	3	13
	Family-Siluridae					
11	*Wallago attu*	6	9	10	3	25
	Family-Clupeidae					
12	*Gudusia chapra*	-	6	8	2	16
	Family-Siluridae					
13	*Ompok bimaculatus*	-	4	8	2	12
	Family-Sisoridae					
14	*Bagarius bagarius*	-	4	6	2	10
	Family Ophiocephalaidae					
15	*Channa punctatus*	2	6	9	3	17
	Family Mastacembelidae					
16	*Macrognathus aculeatus*	-	4	6	2	10
	Family-Amphipnoidae					
17	Amphipnous	-	2	4	2	6
	Family-Centropomidae					
18	*Chanda hama*	-	3	4	2	7

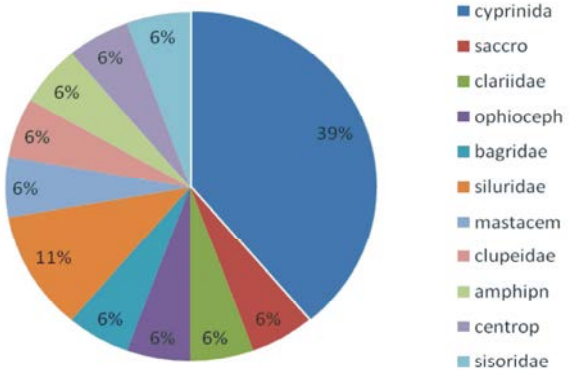

Fig. 1: Percentage occurrence of fish families of Aami River, India

Table 3: Seasonal variations of physicochemical parameters of Aami River

	pH			Suspended solid (g/l)			Total Dissolved oxygen (mg/l)			BOD(mg/l)			COD(mg/l)		
Season	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Winter	8.5	7.2	7.1	3.4	2.8	2.5	5.3	6.1	6.2	240	190	140	484	290	250
Summer	9.9	8.9	8.4	4.1	3.0	2.9	4.3	5.2	6.0	255	200	180	500	300	260
Rainy	7.9	7.7	7.2	4.9	3.6	3.5	3.3	4.1	5.9	60	25	15	276	210	160

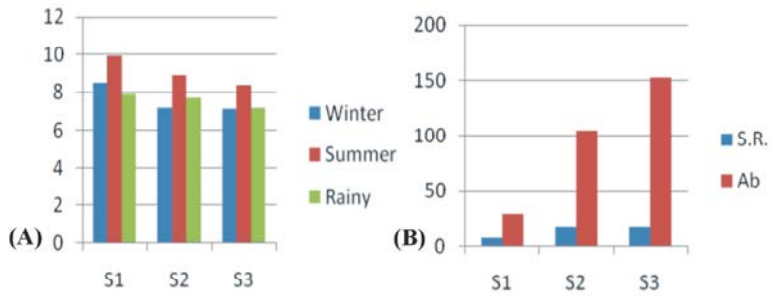

Fig. 2: Effect of (A) pH of Aami River compared with (B) species richness and abundance.

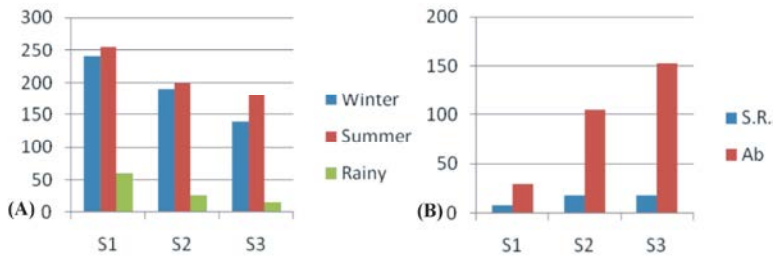

Fig. 3: Effect of (A) BOD of Aami River compared with (B) species richness and abundance.

Water temperature ranged from 26°C to 32 °C throughout the study period. Highest water temperature was recorded during summer season (32°C) whereas least was observed in winter season (26 °C) (Table 3). (S1=Site-1, S2=Site-2, S3=Site-3).

The pH was observed in the range of 7.1 (Site-3) to 9.9 (Site-1) which indicates that water was slightly alkaline in nature. pH also effect on the number of fish. In S1 the pH is high and species richness (SR) and abundance (Ab) is low and S2 pH is Low and richness and abundance is high (Fig. 2). Suspended solid ranged between 2.5g/l to 4.9g/l during study period. And it is highest in Site-1(4.9g/l) and lowest in Site-3(2.5g/l)

It is clear from following work that fish diversity is depending upon the physicochemical parameter. The BOD is very high in Site-1 and low in Site-3 in all seasons which directly affect the fish diversity (Fig. 3). In site-1 the fish diversity, abundance and richness is minimum because here the BOD level is very high and in site 2 or 3 BOD level is low. It means high level of pollution decline the fish diversity. In comparison to site 1the site 2 and site 3 pollution levels is low so here the diversity is high. But site 2 and site 3 fish diversity is minimum in comparison to the other water reservoir of Gorakhpur region.

Dissolved oxygen (DO) is the most important parameter which can be used as an index of water quality, primary production and pollution. DO values ranged from 3.3 to 6.2 Minimum values of DO were recorded in Site-1 and maximum in Site-3. Minimum DO in months may be due to high metabolic rate of organisms. Maximum DO may be due to low atmospheric temperature. Similar trends were made by Senthil *et al*. [17]. BOD has been used as a measure of the amount of organic materials in aquatic solution, which support the growth of micro organisms. During rainy season, BOD values were low; this is because the temperature retards the rate of reproduction of organisms. Similar observations were also made by Mane and Madlapure [18].

COD test is useful in pin pointing toxic conditions and presence of biochemical resistant substances. In the present investigation COD was maximum in Site-1 and minimum in Site-3 indicate lower microbiological activities and presence of oxidisable matter in the water body [19]

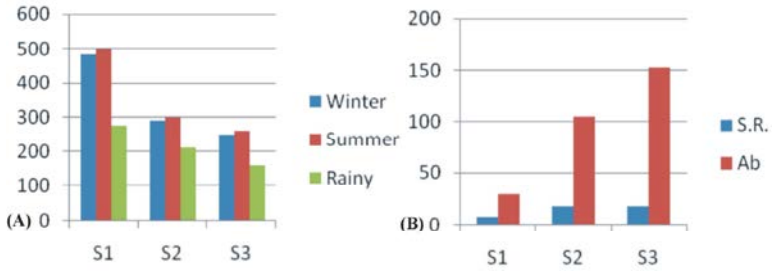

Fig. 4: Effect of (A) COD of Aami River compared with (B) species richness and abundance.

In site-1 the fish diversity, abundance and richness is minimum because here the COD level is very high and in site 2 or 3 COD level is low (Fig. 4).

DISCUSSION

Fish biodiversity of River essentially represents the fish faunal diversity and their abundance. River conserves a rich variety of fish species which support to the commercial fisheries [20]. There are plenty of cultivable species and any further introduction of exotic fish species is unnecessary. The present study revealed that the physical habitat variables play key role in the distribution of fishes in River Aami. We observed that among habitat attributes, dissolved oxygen and pH are key habitat features and correlated with the fish diversity and found the most important variables in shaping fish distributions. In the discharge area, microbial decomposition of these wastes exerts high BOD and creates anaerobic condition [21].

The study findings showed that fish diversity of the study area is reducing with the increase of water pollution. The reduced fish diversity eventually decreases the fish production of native species and creates extinction of several species. These consequences eventually create instability in the socio-economic sector of the study area in terms of increased poverty of local fishermen. It reveals that, a rapid decline in fish diversity at discharged zone (polluted) of the Aami River. This investigation would be used as a tool for controlling the water pollution at Aami River and conserving the fish species in the Aami River with the rapid increase in the human population and the increasing dependence on aquatic fishery resources including water and the continuing introduction of exotic species in natural water bodies, the loss of aquatic fish diversity is likely to increase further unless proper conservation measures are implemented. Any deviation would lead to further erosion of biodiversity that would be detrimental for fisheries and environment as a whole.

Biodiversity, the life Sustaining systems of the Biosphere has intrinsic value and its components have ecological, social, economic, scientific, educational, cultural and aesthetic value [22]. The best approach to the conservation of the species is to disseminate conservation information, education and practices to fishermen and other stakeholders about the danger of extinction of the species and the need for its conservation. This will go a long way towards protecting and preserving the species. Prevention now is not only better, but also cheaper than looking for ways of recalling the lost species. Once extinction occurs, it could not be easily reserved or recalled.

To this, fish biologists, limnologists, aquatic ecologist and conservationists have a major role to play in creating public awareness and support for the conservation mechanisms for the species pointed out the need for scientists to generate awareness for the conservation of fish species. This study highlighted the need for stakeholders to watchful of autogenic and anthropogenic threats, activities and harmful practices which may cause the extinction of fish species in the Aami River as well as in the freshwater system of Gorakhpur and the effects of this extinction and the ways by which it could be prevented. A holistic Approach to the conservation of fish species in the reservoir would be to integrate its conservation management strategies in to its water quality and production management Programs. As per economic importance and scope of fish and fisheries especially in Maharashtra, But it is natural to study the availability of fish from fresh water reservoir and tanks [23].

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