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Original Research Paper

Fish Biodiversity and Preferential Habitats of Fishes in Selected Stretch of Narmada River

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Fish biodiversity
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Preferential habitats
Substrate differentiation

ABSTRACT

The present study is aimed at assessing the existing fish fauna and their distribution pattern in River Narmada from Shahganj (Distt. Sehore) to Bandua (Distt. Hoshangabad), a stretch spread over 22 km in length, situated between 22°50'28" to 22°43'55"N and 77°36' 46 to 77°47'48" E. The investigation reveals presence of a total 47 species belonging to 29 genera, 15 families and 6 orders. The family Cyprinidae was observed as the most dominant of all, constituting 48 % of the total fish population followed by Bagridae constituting 12 % of the total collection. The study also encompasses the identification of preferential fish habitats (pools, riffles, runs and substrate differentiation) by means of analysing abundance and frequency of different species of fishes.

INTRODUCTION

Madhya Pradesh, the heart of India is blessed with a number of lotic and lentic water bodies. Lotic water resources of the state are of great significance as they cater to a major portion of the need of water to nearly all the major cities, towns and villages of the state. Among these water resources the Narmada basin covering an area of 98,796 km^2, situated between longitude 72°32" to 81°45" and 21'20" to 23'45" N latitude is by far the largest and the most important river system of the state. Most of the large cities like Indore, Jabalpur, Mandla, Hoshangabad, etc. depend on the river for water supply. Besides being the source of water for potable and other purposes, the river is also very important ecological hub and provide very productive and healthy ecosystem to a number of floral and faunal species.

Narmada river is the fifth largest river in India. It is also one of the most sacred rivers of India. It is known as the lifeline of M.P. and is the largest river of the state, flowing from east to west. During the present work fish biodiversity of Narmada river (Shahganj to Bandua village) has been studied. The study has been carried out between Shahganj (N 22°50'26" and E 77°47'48") and Bandua (22°43'55"N and 77°36'46"E), covering an area of 22 km in length which falls in the administrative control of two districts, viz., Hoshangabad and Sehore.

The microclimate provided by the different zones of the river attract different types of fish species depending on their preferential habitat, which in turn depend largely on factors like variability of nourishment, dissolved oxygen, light, flow, etc. in different zones of the river. The organization of fish assemblage reflects both biotic and abiotic sets of features occurring in a particular moment which influence the distribution, abundance and species interactions, most of them direct or indirect partitioned (Wootton 1998). The present study is aimed at assessing the microclimate present in the given stretch of the river and the fish species present in these microhabitats, thus, establishing the preferential habitat of the fish species, which may prove to be a vital information with regard to preferred fish culture for best yield.

MATERIALS AND METHODS

At the onset of the study, a meticulous survey was carried out using proper surveying techniques to decide sampling points in such a manner that they represent the average faunal composition of the Narmada river. Fish sampling was conducted at nine pre-selected locations from Shahganj to Bandua covering a 22 km stretch in the river (Shahganj, Hirani, Jahanpur, Bandrabhan, Joshipur, BudhniKund, Dongarwara, Hasalpur, Bandua) as shown in Fig. 1. The collections were made at the locations during December 2005 to June 2007. Changes in mesohabitat types were noted at their boundaries using a hand-held GPS. After noting the type by visual observations, other supporting parameters like mesohabitat length, average and maximum water depth, channel width and bed substrate were recorded. Length and width were measured with the help of a graduated string, and depth with the help of graduated anchor sufficient enough to tolerate the flow of river while lowering. For substrate composition, both visual observations and sampling were carried out. Samples were collected with the help of Ekman dredge and analysed for particle size and composition using standard sieves.

The fishes were collected using cast net and monofilamentous gillnets of different mesh sizes, i.e., 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 (Arun 1998). The fish samples were also collected from different fish landing sites located at Shahganj, Budhni and Dongarwara. The fishes were identified using the standard keys of Jayaram (1999), Jhingran (1991), Qureshi & Qureshi (1983) and Shrivastava (1998). All the samples were preserved in 4% formaldehyde.

RESULTS AND DISCUSSION

After meticulous survey of the available literature, it has been established that a total of 98 species of fishes have been reported by various workers. The referred studies have been carried out by different researches in different time periods in different stretches of the river Narmada (Dubey 1994). Hora & Nair (1941) were perhaps the first persons to work in this field and provided the information of the icthyofaunal assembly of River Narmada reporting 40 species from the hill stream that joins River

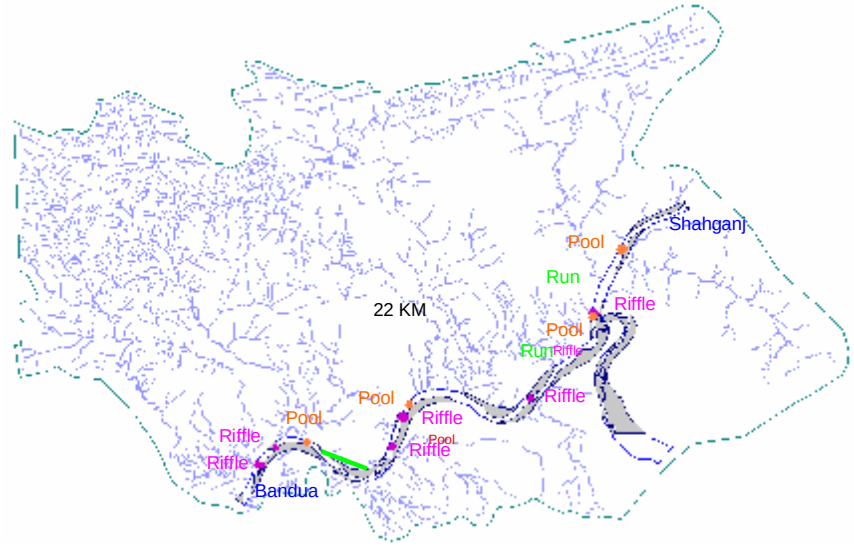

Fig. 1: Map of physical habitats in the present study.

Narmada in the Satpura range in Hoshangabad District. At the time of the study, flow of river was uninterrupted as no barrier was constructed on the streams/tributaries, and, therefore, these species may be considered as fishes of Narmada River as well (Dubey 1994). Ever since four surveys of fish fauna of the Narmada basin have been conducted, the first detailed survey was done by Karamchandani et al. (1967) reporting 77 fish species belonging to 41 genera, 19 families and 7 orders, inclusive of 11 recorded by Hora & Nair (1941), which was restricted to Hoshangabad area during the pre and postmonsoon period of 1959-64. Another study, which was executed by the Department of Fisheries, Govt. of M.P. in the year 1967-71 (Anon 1971), covers the stretch from Jabalpur to Khalghat reporting 46 species belonging to 27 genera, 14 families and 7 orders in the stretch. Rao et al. (1991) have undertaken preimpoundment survey at Punasa, Omkareshwar, Mandleswar, Maheshwar and Barwani pertaining to the river and have reported 84 fish species belonging to 45 genera, 20 families and 6 orders. Another survey of fish fauna of River Narmada was carried out by Balapure in the year 2001 which was restricted to the local market and landing site, and has reported 21 species belonging to 16 genera, 6 families and 4 orders. The earlier studies have reported a total number of 98 species in total, however, a new fish species has been reported again in the present investigation, viz., *Oxygaster gora,* which was first reported in an earlier investigation carried out by Balapure (2001). He also reported two other species, viz., *Hypopthalimenthys molitrix* and *Cyprinus carpio* as well, which have neither been reported in the earlier surveys nor in the present investigation. Both these species are exotic culturable species and their presence in the river indicates its proliferation in the river from any fish farm in the surrounding area. During the present investigation, however, a total of 47 species belonging to 29 genera, 15 families and 6 orders were recorded in the stretch from Shahganj to Bandua at nine stations representing different zones of the river (Table 1). The familywise percent composition of the fishes reported is given in Fig. 2. The first sampling station which is Run recorded seventeen species of fishes among which the dominant species were *Oxygaster bacaila, Puntius chrysopoma, Osteobrama cotio* and *Puntius conchonius.* At station II, a (pool), a total of nineteen species were recorded, the dominant species being *Oxygaster bacaila*, *Puntius conchonius* and *Labeo fimbriatus*. At station III, which represents Run, only four fish species have been recorded among

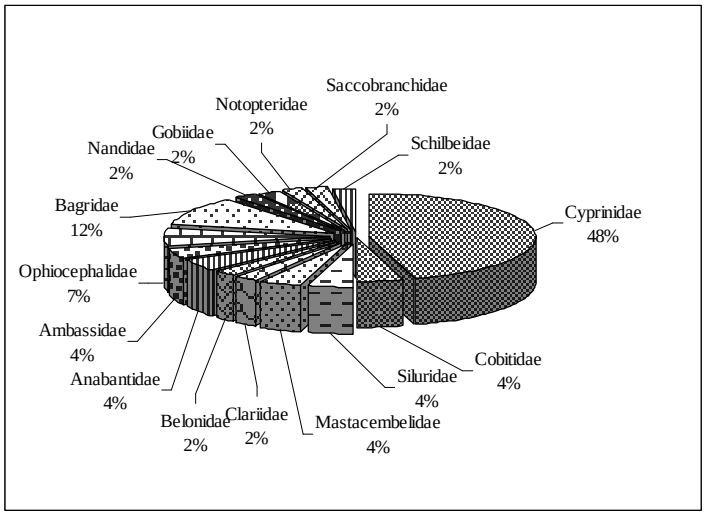

Fig. 2: Familywise percent composition of fishes in the stretch of the study.

Table 1: Distribution of Ichthyofauna at different stations in the Narmada river.

Species	Order	Family	St-1	St-2	St-3	St-4	St-5	St-6	St-7	St-8	St-9
Notopterus notopterus	Clupeiformes	Notopteridae	*			*					
Amblypharogodon mola	Cypriniformes	Cyprinidae				*					
Barilius barila	~	~	*						*		
Barilius bandelisis	~	~	*								
Chela laubuca	~	~	*	*					*		
Danio devario	~	~	*	*				*	*		
Oxygaster bacaila	~	~	*	*	*	*		*	*	*	*
Oxygaster gora	~	~		*				*	*		
Oxygaster clupeids	~	~		*	*					*	
Puntius conchonius	~	~	*	*				*	*		*
Puntius sophore	~	~	*	*				*			*
Puntius sarana	~	~						*		*	
Puntius ticto	~	~	*	*				*	*		
Puntius amphibius	~	~		*							
Puntius chrysopoma	~	~	*	*				*	*		
Labeo bata	~	~	*	*							
Labeo gonius	~	~		*	*				*		
Labeo fimbriatus	~	~	*	*				*			*
Labeo calbasu	~	~						*			
Rasbora daniconius	~	~	*					*	*		
Tor tor	~	~						*	*		
Osteobrama cotio	~	~	*	*	*						
Lepidocephalichthys guntea		Cobitidae							*		
Nemacheilus botia	~	~	*				*				
Ompok bimaculatus	~	Siluridae				*					
Wallago attu	~	~	*								
Clarius batrachus	~	Clariidae						*			
Mystus bleekeri	~	Bagridae							*	*	
Mystus aor	~	~		*							
Mystus tengra	~	~				*					
Mystus seenghala	~	~		*				*			
Rita rita	~	~							*		
Clupisoma garua	~	Schlibidae					*		*		
Heteropneustes fossilis	~	Saccobranchidae						*			
Mastacembelus armatus	Mastacembeformes	Mastacembelidae	*						*		
Mastacembelus pinnaculas		~	~	*	*					*	
Xenentodon cancila	Beloniformes	Belonidae	*						*		
Anabas testudineus	Perciformes	Anabantidae						*			
Colisa fasciatus	~	~							*		
Nandus nandus	~	Nandidae							*	*	
Glossogobius girus	~	Gobiidae		*					*		
Chanda nama	~	Ambassidae	*	*			*		*		*
Chanda ranga	~	~	*	*			*	*			
Channa gachua	Ophiocephaliformes	Ophiocephalidae	*	*							
Channa marulius	~	~						*			
Channa striatus	~	~						*			

which *Oxygaster bacaila* and *Oxygaster clupeoides* were dominant ones. At station IV (Riffle), five fish species and at station V (Run), four species of fishes were recorded. At station VI which represents pool habitat, nine species of fishes were recorded among which the dominant species were *Oxygaster bacaila* and *Oxygaster gora.* At station VII (Run) sixteen different fish species were recorded among which the dominant species were *Oxygaster bacaila* and *Puntius chrysopoma*. At station VIII (Rapid run) only three species were recorded among which the dominant species was *Oxygaster bacaila* and at station IX (Pool) five fish species were recorded where the dominant species was *Oxygaster bacaila*.

Preferential Fish Habitats in the Narmada River

The entire stretch of the River Narmada was studied and different types of mesohabitats were ascertained on the basis of various factors. Following are the mesohabitats recorded in the selected reach of the river.

Riffles: A riffle is an area of the river that has a swift moving current and water that is normally bubbling due to the rocky bed that enables diffusion of oxygen from the atmosphere. The increased concentration of oxygen supports a high number of invertebrates and resultantly high number of fishes feeding upon them. In streams, the structural complexity may be understood as a mosaic of mesohabitats patches (pools, runs or raceways, riffles), which are clearly delimited by different combinations of current, depth and substrate composition (Angermeier & Schlosser 1989). Pools and riffles usually support different species composition, which has been observed in temperate and tropical streams (Gorman & Karr 1978, Gelwick 1990). The stretch of River Narmada under the study has a total of 6 riffles in all. The riffles and their positions are given in Table 2.

Pools: In relation to river fisheries, the term 'pool' has been most often associated with the 'riffle and pool' system, a system of alternating shallow rapids followed by deeper pools in the upper mountainous stretches of river systems mainly associated with deep pools within the river, which were believed to be important breeding grounds for fish (Sjørslev 2000). The stretch of the river under the study has a total of 5 pools. The pools and their positions are given in Table 3.

Runs: Runs can be distinguished by moderate currents, medium depth and smooth water surfaces. Runs can have good mixture of aquatic life depending on the quality of the stream habitat (boulders, bogs, root wads, etc.). A total of 3 runs have been observed in the stretch of the river under the study. The runs and their positions are given in Table 4.

Substrate Differentiation in the River Bed

The substrate, i.e., the composition of the riverbed also changes with the change in the inflow current, land use and velocity of the flow of current. The bed substrate recorded in the stretch of River Narmada is as under:

Sand: This type of bed is usually found in runs.
Bed Rock: Found in riffles.
Gravel, Cobble and Boulders: Found in upstream and down stream of riffles.
Soil, Sand and Gravel: Found in runs.
Soil and Sand: Found in pools.

The river ecosystem is a very complex ecosystem and the life processes in the river are dependent on a number of biotic and abiotic factors. The velocity of flow has a direct impact of the bed structure and composition of the riverbed, which in turn has a direct effect on biota of the river. The velocity of flow upon the slope gradient and velocity affects deposition of silt at the riverbed. The deposition of

Table 2: List of riffle location in the study area.

S No.	Riffle location	Latitude	Longitude
1	Bandrabhan	22°48'10"	77°46'40"
2	Middle of Baghwara and Joshipur	22°45'58"	77°44'45"
3	Hoshangabad bridge	22°45'29"	77°40'57"
4	Dongarawara	22°44'38"	77°40'45"
5	Mahukala	22°44'43"	77°37'24"
6	Saptdhara	22°44'13"	77°36'49"

Table 3: List of pools location in the study area.

S No.	Pool Location	Depth	Latitude	Longitude
1	Mid of Hirani and Shahganj	7 meter	22°49'59"	77°47'31"
2	Bandrabhan	6.52 meter	22°48'10"	77°46'40"
3	Budhni	12 meter	22°45'46"	77°41'07"
4	Mahukala	7 meter	22°45'51"	77°38'12"
5	Bandua	4.47 meter	22°43'55"	77°36'46"

Table 4: List of Runs location in the study area.

S No.	Run Location	Latitude	Longitude
1	Ramnagar to Budhni	22°47'26" - 22°45'50"	77°46'28" - 77°41'15"
2	Dongarawara to Mahukala	22°44'11" - 22°44'26"	77°40'38" - 77°38'48"
3	Hirani to Bandrabhan up Jahanpur	22°49'39" - 22°48'47"	77°47'17" - 77°46'51"

silt is largely dependent on land use in catchment of the river. The soil erosion is greater if topsoil is exposed or denuded. Therefore, the land use, slope gradient, velocity of flow, etc. determine the substrate structure thereby affecting life processes in the river.

Habitat preferences: During the present study the preferential habitats of different fishes have been assessed on basis of personal observation, interaction with local fishermen and referring pertinent literature (Table 5).

Every organism by nature prefers the habitat that suits it most, but there are some instances where it is seen that the organisms have tendency to survive even in conditions of the habitats, which are least suitable. Such organisms have tendency to tolerate and survive even in unfavourable conditions. Sharma & Shrestha (2001) described habitat preferences in Tinau river of Nepal. The present investigation reveals the preferential habitats of some of the commonly found fishes in River Narmada.

Some species of fishes such as catfish (*Heteropneustes fossilis*) and snakeheaded fishes (*Channa* species), etc. bury themselves partially in sandy or muddy bottoms. These fishes also have a tendency to pass through wet vegetation during dry season. Fishes like *Puntius* and *Barilius* school near mid-water column for predation, while others like *Tor tor* school near subsurface water for feeding purpose and prefer stony rapids and pools possessing the ability to migrate from down-up stream. Johal (2002) has described habitat preference in hill streams fishes of Himachal Pradesh and Garhwal region. He described five distinct fish habitat types in hill streams. Kurup et al. (2004) described habitat preference of freshwater fishes in Kabbini river system, Kerala. He described distinct habitats

Table 5: Preferential habitat in the Narmada river of the fishes caught in the study.

S.No.	Species	Preferential Habitats	Substrate composition
1	*Anabas testudineus*	Riffles	Gravel, Cobble, Boulder
2	*Amblypharyngodon mola*	Riffles	Gravel, Cobble, Boulder
3	*Barilius barila*	Runs	Gravel, Coarse sand, Clay
4	*Barilius bandelisis*	Runs	Gravel, Coarse sand, Clay
5	*Chanda ranga*	Different habitats	Sand, Soil
6	*Chanda nama*	Different habitats	Sand, Soil
7	*Channa marulius*	Pools	Sand, Clay
8	*Channa striatus*	Pools	Sand
9	*Channa gachua*	Runs	Sand, Clay
10	*Clupisoma garua*	Runs	Sand, Soil
11	*Colisa fasciatus*	Riffles and Runs	Cobble, Coarse sand
12	*Clarius batrachus*	Pools	Sand, Clay
13	*Chela laubuca*	Runs	Sand, Soil
14	*Danio devario*	Riffles	Gravel, Cobble, Boulder
15	*Glossogobius giuris*	Riffles	Soil, Cobble
16	*Heteropneustes fossilis*	Pools	Sand, Clay
17	*Labeo bata*	Riffles	Gravel, Cobble, Boulder
18	*Labeo gonius*	Pools	Sand, Clay
19	*Labeo calbasu*	Pools	Sand, Clay
20	*Labeo fimbriatus*	Pools	Sand, Clay
21	*Cirrhinus mrigala*	Pools	Sand, Soil
22	*Lepidocephalichthys guntea*	Riffles	Soil, Sand, Cobble
23	*Mastacembelus armatus*	Riffles	Soil, Sand
24	*Mastacembelus pancalus*	Riffles	Soil, Sand, Boulder
25	*Mystus tengra*	Pools	Gravel, Cobble
26	*Mystus bleekeri*	Pools	Gravel, Cobble, Boulder
27	*Mystus aor*	Pools	Gravel, Cobble, Boulder
28	*Mystus singhala*	Pools	Sand, Soil
29	*Notopterus notopterus*	Riffles and Pools	Gravel, Cobble, Boulder
30	*Nemacheilus botia*	Riffles	Sand and Soil
31	*Nandus nandus*	Pools	Sand, Clay, Soil
32	*Ompok bimaculatus*	Riffles	Gravel, Cobble, Boulder
33	*Osteobrama cotio*	Runs	Soil, Gravel, Cobble
34	*Oxygaster bacaila*	Different habitats	Clay, Sand, Gravel, Cobble, Boulder
35	*Oxygaster Clupeoides*	Different habitats	Soil, Sand
36	*Oxygaster gora*	Different habitats	Clay, Sand, Gravel, Cobble
37	*Puntius conchonius*	Pools and Runs	Soil, Gravel, Cobble
38	*Puntius amphibius*	Runs	Sand, Clay
39	*Puntius cryoposoma*	Runs	Soil, Sand
40	*Puntius sophore*	Runs	Soil, Sand
41	Puntius sarana	Runs	Soil, Sand
42	*Puntius ticto*	Different habitats	Soil, Sand
43	*Rasbora daniconius*	Pools and Runs	Sand, Clay, Soil
44	*Rita rita*	Riffles and Pools	Sand, Soil, Pebble
45	*Tor tor*	Pools and Riffles	Gravel, Cobble, Sand
46	*Wallago attu*	Pools	Soil, Sand
47	*Xenontodon cancila*	Runs	Soil, Sand

are low pools, rocky pools, pools, riffle, runs, lands and rapids. Sivakumar (1998) studied fish biodiversity in relation to substratum based microhabitats and found variation in species richness in different substratum.

In the present study, however, out of 47 species, 14 species, viz., *Channa marulius, Channa striatus, Clarius batrachus, Mystus aor, Mystus singhala, Wallago attu, Heteropneustes fossilis, Labeo gonius, Labeo calbasu, Labeo fimbriatus, Cirrhinus mrigala, Mystus tengra, Mystus bleekeri* and *Nandus nandus* preferred pools habitats, Ten species preferred riffle habitats (*Anabas testudineus, Amblypharyngodon mola, Danio devario, Labeo bata, Ompok bimaculatus, Glossogobius giuris, Nemacheilus botia, Lepidocephalichthys guntea, Mastacembelus pancalus* and *Mastacembelus armatus*) and 11 species preferred run habitats (*Barilius barila, Barilius bandelisis, Channa gachua, Clupisoma garua, Chela laubuca, Osteobrama cotio, Puntius sophore, Puntius amphious, Puntius cryoposoma, Puntius sarana* and *Xenentodon cancila*). Out of the 47 species, six species preferred two habitats, three species prefer riffles-pools (*Notopterus notopterus, Rita rita, Tor tor*), two species pools-runs, (*Puntius conchonius Puntius, Rasbora daniconius*), one species in runs-riffles (*Colisa fasciatus*) and rest six species (*Chanda ranga, Chanda nama, Oxygaster bacaila, Oxygaster Clupeoides,* Oxygaster *gora*) have no preference for specific types of habitats and continued to move in different types of habitats.

Fishes like stone loach (*Nemacheilus*) mimic with dead log and woody material in water. Some fishes like *Nemacheilus botia* have restricted food habitat in sandy bottoms hiding under stones. Generally, fishes in Narmada river migrate during July-August in breeding season. The fishes belonging to genus *Danio* and *Notopterus* inhabiting the river prefer riffle and pools as their habitat, i.e., gravel, cobble and boulder as bed material. The fishes belonging to genus *Barilius, Xenentodon* and *Osteobrama* prefer runs as their habitat with gravel, coarse sand and clay. The fishes belonging to genus *Puntius* prefer deep pools and slow run with sandy and soil substrate. A few fishes prefer runs, riffles and rapids as habitat. These include genus *Glossogobius, Colisa* and *Mystus*. Those preferring both slow run and deep pool as their habitats include *Chanda, Labeo calbasu* and *Mastacembelus armatus,* and those preferring deep pools include *Clarius* and *Channa* species.

CONCLUSION

The present study reveals that the stretch under the study comprises of a number of meso habitats like pools, riffles, runs etc., which makes this particular patch suited to a large variety of fishes. Therefore this patch is a productive one, very rich in biodiversity. The presence of different meso habitats also provide different feed to the fishes like attached algae, organic debri etc., which is also helpful in supporting this rich biodiversity and density of life forms in the river. The different meso habitats also provide ideal breeding ground to the different fish species, which help them, reproduce and flourish in the ecosystem. Thus the presence of these meso habitats in a particular stretch of the river helps maintaining the rich biodiversity of the river.

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