

# BIODIVERSITY AND CONSERVATION STATUS OF FISHES OF PROTECTED WETLAND, BAKHIRA LAKE (SANT KABIR NAGAR), FOR CONSERVATION

A. K. Pandey and Prakash Chandra

ICAR-National Bureau of Fish Genetic Resources, Canal Ring Road, Lucknow - 22 6002, India.

e-mail: akpandey.ars@gmail.com

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**ABSTRACT :** Fish diversity studies of the protected Bakhira Lake (Sant Kabir Nagar) revealed existence of 54 species belonging to 9 orders, 20 families and 40 genera. The details being Clupeiformes 3 species (Clupeidae- *Gudusia chapra*, *Gonialosa manmina*, *Setipinna phasa*), Osteoglossiformes 2 (Notopteridae- *Notopterus notopterus*, *Chitala chitala*), Cypriniformes 21 (Cyprinidae- *Catla catla*, *Labeo rohita*, *L. bata*, *L. calbasu*, *L. dero*, *L. goni*, *L. gonius*, *Cirrhinus mrigala*, *C. reba*, *Amblypharyngogon mola*, *Aspidoparia morar*, *Osteobrama cotio*, *Oxygaster (Salmophasia) bacaila*, *Danio devario*, *Puntius sarana*, *P. sophore*, *P. ticto*, *Crossocheilus latius*, *Esomus danricus*, *Chela laubuca*, *Rasbora daniconius*; Botiidae- *Botia lohachata*), Siluriformes 11 (Siluridae- *Ompok bimaculatus*, *Wallago attu*; Bagaridae- *Sperata aor*, *S. seenghala*, *Mystus tengara*, *M. vittatus*, *Rita rita*; Sisoridae- *Bagarius bagarius*; Pangasidae- *Pangasius pangasius*; Clariidae- *Clarias magur*; Heteropneustidae- *Heteropneustes fossilis*), Perciformes 11 (Channidae- *Channa punctatus*, *C. gachua*, *C. marulius* and *C. striatus*; Anabantidae- *Anabas testudineus*; Ambassidae- *Chanda nama*, *C. baculis*, *Parambassis ranga*; Nandidae- *Nandus nandus*, *Sciaena coitar*); Osphronemidae- *Colisa fasciatus*, Mugiliformes 1 (Mugilidae- *Rhinomugil corsula*), Synbranchiformes 3 (Mastacembelidae- *Mastacembelus armatus* and *M. pancalus*; Synbranchidae *Monopterus (Amphipnous) cuchia*), Beloniformes 1 (Belonidae- *Xenentodon cancila*) and Tetradontiformes 1 (Tetradontidae- *Tetradon cutcutia*). As per species-wise fish diversity of Bakhira Lake is concerned, Cypriniformes dominated with 21 species, followed by Siluriformes 11, Perciformes 9, Clupeiformes 3, Synbranchiformes 2, Osteoglossiformes 2, Mugiliformes 1, Beloniformes 1 and Tetradontiformes 1. Present conservation status of these fishes being- 2 species Data deficient (DD), 1 Endangered (EN), 44 Least concerned (LC), 4 Lower risk-near threatened (LR-nt), 2 Not evaluated (NE) and 1 Vulnerable (VU). None of the exotic species was recorded from Bakhira Lake. It is important to note that the lake has good population of murrels (*Channa punctatus*, *C. nama*, *C. ranga*, *C. striatus* and *C. marulius*) which have been drastically declined in other freshwater bodies of Uttar Pradesh. Since this lake is protected as Bird Sanctuary since 1990, there is no outside stocking of fingerlings of the commercially important fishes. As such, the lake harbours the fish stocks getting access to this water body during floods.

**Key words :** Fish biodiversity, conservation, protected Bakhira Lake, Sant Kabir Nagar, India.

## INTRODUCTION

The Convention on Biological Diversity (CBD) reaffirms the sovereign rights of the member nations over their entire genetic resources and envisages conservation, sustainable use and equitable sharing of the benefits arising from the biological resources. More than 28,400 finfish species have been reported throughout the world which represents about half of the entire vertebrate diversity (Nelson, 1994, 2006; Hilton-Taylor, 2000; Vie' *et al*, 2008). India is one of the mega biodiversity centres for the genetic resources in the world and the same is true also in case of fishes. Nearly 2,868 species of fishes belonging to 42 orders, 426 families and 1,019 genera are found in different ecosystems of this country. The approximate ecosystem-wise distribution of fish germplasm resources of India are- freshwater (877;

30.6%), brackishwater (113; 3.9%) and marine (1368; 65.5%). Out of these, about 258 species are commercially important which include cultured, cultivable and wild taxa, 199 endemic and 275 game fishes. Further, more than 447 exotic species have been introduced in Indian waters, mostly for ornamental purpose (Lakra and Pandey, 2009; Anon, 2015).

Due to various anthropogenic stresses, a number of fishes are showing declining trends in their catches from the conventional fishing grounds and some have become threatened too (Minckley and Deacon, 1991; Casey and Meyers, 1998; Lakra and Pandey, 2009; Hossain *et al*, 2010). As per recent Red Data Book of IUCN, 16,928 taxa of life forms are threatened globally which includes 1,275 species of fishes (Vie' *et al*, 2008). Though the decline of individual species is very often related to more



Fig. 1 : Bakhira Lake showing the four sampling stations.

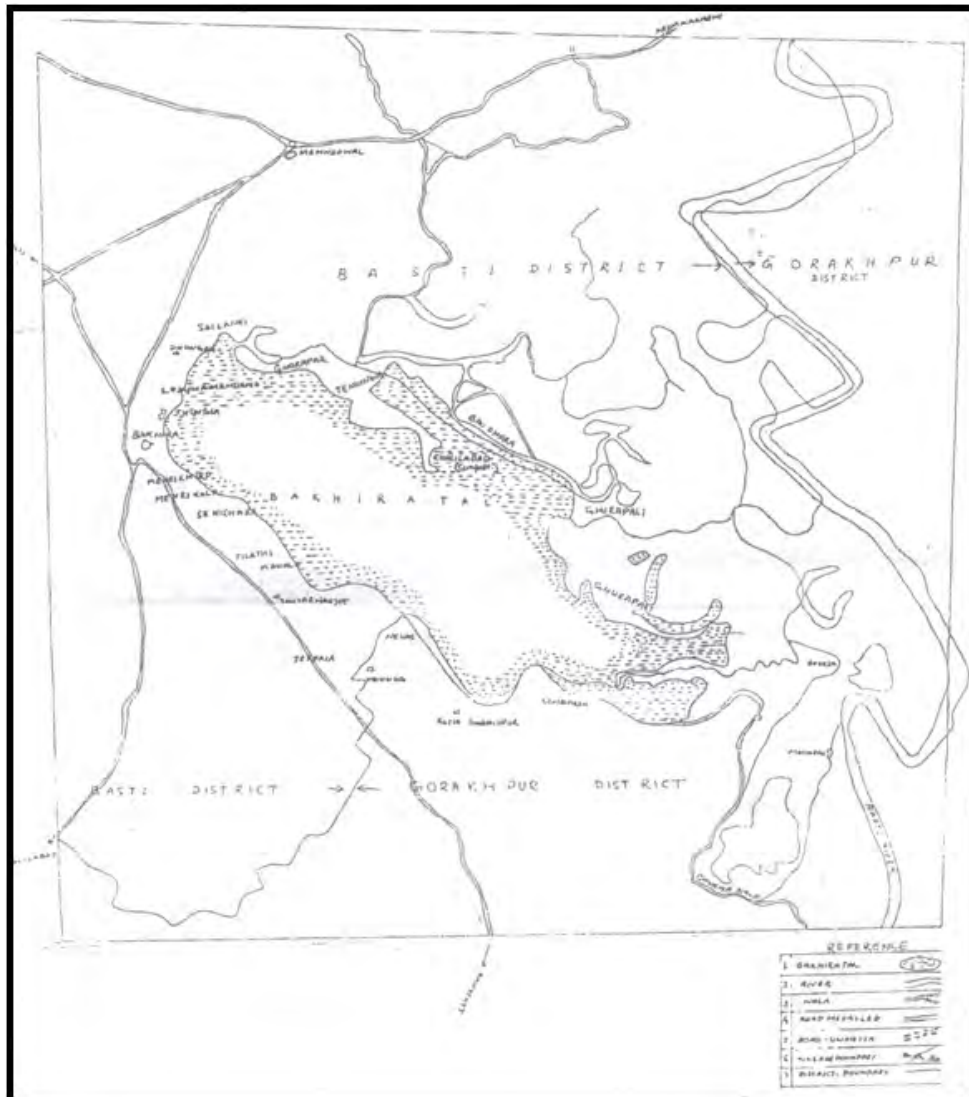


Fig. 2 : Bakhira Lake, Sant Kabir Nagar (Uttar Pradesh).



**Fig. 3 :** View of Bakhira Lake.



**Fig. 4 :** Bakhira Bird Sanctuary.



**Fig. 5 :** Bahawa nallah (downstream) draining water to Bakhira Lake.



**Fig. 6 :** Churma nallah near Chadrao.



**Fig. 7 :** Barrage on Churma nallah (near Pali), Sahajanwa (Gorakhpur).



**Fig. 8 :** Irrigation channel from Bakhira Lake at Navas.

**Table 1** : Fish biodiversity of Bakhira Lake.

| Order             | Family                         | Scientific name                        |
|-------------------|--------------------------------|--|
| Clupeiformes      | Clupeidae                      | <i>Gadusia chapra</i>                  |
|                   |                                | <i>Gonialosa manmina</i>               |
|                   |                                | <i>Setipinna phasa</i>                 |
| Osteoglossiformes | Notopteridae                   | <i>Notopterus notopterus</i>           |
|                   |                                | <i>Chitala chitala</i>                 |
| Cypriniformes     | Cyprinidae                     | <i>Catla catla</i>                     |
|                   |                                | <i>Labeo rohita</i>                    |
|                   |                                | <i>Labeo bata</i>                      |
|                   |                                | <i>Labeo calbasu</i>                   |
|                   |                                | <i>Labeo dero</i>                      |
|                   |                                | <i>Labeo gonius</i>                    |
|                   |                                | <i>Cirrhinus mrigala</i>               |
|                   |                                | <i>Cirrhinus reba</i>                  |
|                   |                                | <i>Amblypharyngodon mola</i>           |
|                   |                                | <i>Aspidoparia morar</i>               |
|                   |                                | <i>Osteobrama cotio</i>                |
|                   |                                | <i>Oxygaster (Salmophasia) bacaila</i> |
|                   |                                | <i>Danio devario</i>                   |
|                   |                                | <i>Puntius sarana</i>                  |
|                   |                                | <i>Puntius sophore</i>                 |
|                   |                                | <i>Puntius ticto</i>                   |
|                   |                                | <i>Crossocheilus latius</i>            |
|                   |                                | <i>Esomus danricus</i>                 |
|                   |                                | <i>Chela laubuca</i>                   |
|                   |                                | <i>Rasbora daniconius</i>              |
|                   | Botiidae                       | <i>Botia lohachata</i>                 |
| Siluriformes      | Siluridae                      | <i>Ompok bimaculatus</i>               |
|                   |                                | <i>Wallago attu</i>                    |
|                   | Bagaridae                      | <i>Sperata aor</i>                     |
|                   |                                | <i>Sperata seenghala</i>               |
|                   |                                | <i>Mystus tengara</i>                  |
|                   |                                | <i>Mystus vittatus</i>                 |
|                   |                                | <i>Rita rita</i>                       |
|                   | Sisoridae                      | <i>Bagarius bagarius</i>               |
|                   | Pangasidae                     | <i>Pangasius pangasius</i>             |
|                   | Clariidae                      | <i>Clarias magur</i>                   |
| Heteropneustidae  | <i>Heteropneustes fossilis</i> |  |
| Perciformes       | Channidae                      | <i>Channa punctatus</i>                |
|                   |                                | <i>Channa gachua</i>                   |
|                   |                                | <i>Channa marulius</i>                 |
|                   |                                | <i>Channa striatus</i>                 |
|                   | Anabantidae                    | <i>Anabas tesudinaeus</i>              |
|                   | Ambassidae                     | <i>Chanda nama</i>                     |

Table 1 continued....

than one proximate factors, the various causes of imperilment of fishes in different ecosystems have been grouped as- (i) physical habitat loss due to construction of dams and weirs across the rivers, soil erosion due to deforestation and excessive utilization of waters, (ii) chemical pollution due to industrial and municipal wastes, (iii) over-exploitation and indiscriminate killing of juveniles and brood fishes, (iv) competition from the introduced non-indigenous species and (v) spread of dreaded diseases. Since maintenance of habitats and preservation of biodiversity including fish is being viewed as prerequisite even for human well-beings (Meffe, 1986; Franklin, 1993; Das and Pandey, 1998, 1999; Lal and Pandey, 1999; Pandey *et al*, 1999; Dudgeon, 2005; Helfrich and Neves, 2009; Lakra and Pandey, 2009; Hossain *et al*, 2010; Carthew, 2012), an attempt has, therefore, been made to document the present status of fish diversity of Bakhira Lake (Sant Kabir Nagar) which has been declared as Bird Sanctuary in 1990 providing a wintering and staging ground for a number of local and migratory birds.

## MATERIALS AND METHODS

Regular surveys of Bakhira Lake were conducted during March 2013-February 2015 at the four sampling sites for documenting the fish diversity and conservation status. Market surveys were also conducted to record the assembling of fishes and their seasonal abundance (including from other areas) for local consumption. Samples were collected routinely at monthly intervals, fixed in aqueous formaldehyde solution (10%) and analyzed by consulting standard literature (Srivastava, 1988, 2002; Talwar and Jhingran, 1991; Nelson, 1994, 2006; Jayaram, 2010). Changing pattern of piscine diversity in the lake on a time-scale was also evaluated by referring earlier work (Swarup *et al*, 1976) and discussion with the fishermen from the nearby villages. For assigning conservation status of the taxa, criteria standardized by Hilton-Taylor (2000), Vie' *et al* (2008), IUCN (2010), Vidthayanon (2012), Rema Dei and Ali (2013) and Rema Devi and Dahanukar (2013) were followed.

## RESULTS AND DISCUSSION

### Location of the lake

Bakhira Lake (also known as Badhanch Tal or Moti Jheel) is the largest natural flood plain wetland of about 44 km (water speared area of



Fig. 9 : Bakhira Lake infested with aquatic weeds.



Fig. 10 : Bakhira Lake infested with aquatic weeds.



Fig. 11 : Bakhira Lake heavily infested with aquatic weeds.



Fig. 12 : Bakhira Lake infested with aquatic weeds.

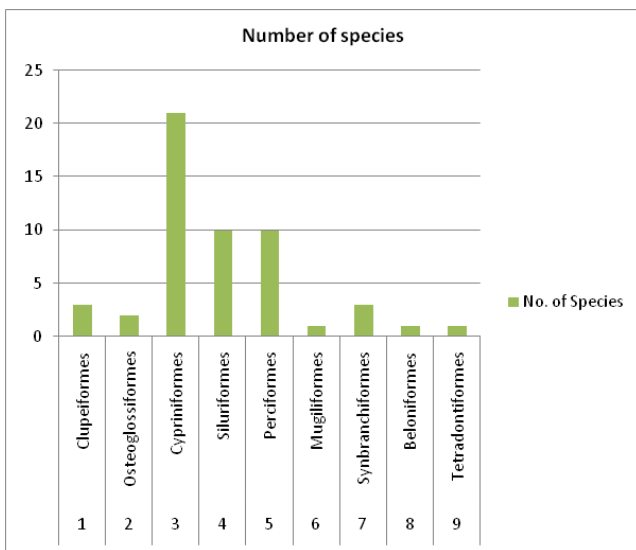


Fig. 13 : Order-wise occurrence of fish species in Bakhira Lake.

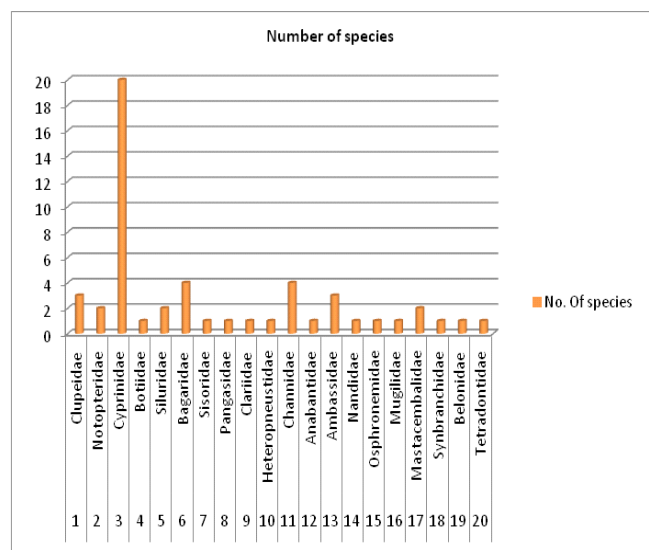


Fig. 14 : Number of species occurring in each Family of Bakhira Lake.

Table 1 continued....

|                  |                 |                                       |
|------------------|-----------------|---------------------------------------|
|                  |                 | <i>Chanda baculis</i>                 |
|                  |                 | <i>Parambaasis ranga</i>              |
|                  | Nandidae        | <i>Nandus nandus</i>                  |
|                  |                 | <i>Sciaena coitar</i>                 |
|                  | Osphronemidae   | <i>Colisa fasciatus</i>               |
| Mugiliformes     | Mugilidae       | <i>Rhinomugil corsula</i>             |
| Synbranchiformes | Mastacembalidae | <i>Mastacembelus armatus</i>          |
|                  |                 | <i>Mastacembelus pancalus</i>         |
|                  | Synbranchidae   | <i>Monopterus (Amphipnous) cuchia</i> |
| Beloniformes     | Belonidae       | <i>Xenentodon cancila</i>             |
| Tetradontiformes | Tetradontidae   | <i>Tetradon cutcutia</i>              |

29 square km) of eastern Uttar Pradesh. It is located in Sant Kabir Nagar (26°52'-26°56'N; 83°52'-85°5'E), about 54 km from Gorakhpur on Khalilabad-Mendawal Road. Bakhira Lake is a perennial water body which covers an area of 1,582.35 ha, however, it inundates about 1,296.64 ha more in monsoon season thus extending the total water area up to 2,878.99 ha (Fig. 1-4). Field surveys conducted during March 2013-February 2015 revealed that this lake receives water through a number of nullahs like Ghaghara nallah, Nevas (26°52'36.4"N; 083°08'46.2"E), Baraka Ghaghra nallah, Govindpur (26°52'12.7"N; 083°09'05.8"E), Baraipar nallah (26°54'40.9"N; 083°05'39.3"E), Vandah nallah, Bakhira (26°55'41.9"N; 083°05'16.4"E) and Van Rakshak Chauki, Dhaurapar (26°56'36.7"N; 083°06'05.0"E) but the most important being the perennial Bahwa nallah (26°56'15.5"N; 083°07'41.2"E) draining water from the vast catchment areas covering Bansi (Siddharthnagar) (Fig. 5). Bakhira Lake drains into river Rapti (near Pali Block, Gorakhpur) through the eastern Churma nullah (26°50'00.1"N; 083°13'25.4"E) (Fig. 6, 7). Earlier the lake got connected with river Rapti for about six months but with the erection of Barrage at Pali (in 1998), inflow of water from Rapti has been stopped, however, outflow is regulated to protect the people inhabiting in the low-lying area and standing crops being cultivated in the catchment areas of the lake. Water from Bakhira Lake is being drained out through two canals at Nevas and Dhodha for irrigation of agricultural crops (Fig. 8). Water column of the lake has been reduced due to poor rain during 2013-2015. It is pertinent to remark that this lake is heavily infested with aquatic weeds like *Ipomaea aquatica*, *Eichhorhia crassipes*, *Hydrilla verticillata*, *Ceratophyllum demersum*, *Nymphoides* spp., *Elecharis* spp., *Jussieua repens*, *Vallisneria spiralis*, *Potamogeton crispus*, *Naja* spp., *Spirodela polyrrhiza*, *Chara* spp., *Spirogyra* spp., *Oedogonium* spp., *Nitella* spp., *Eichornia crassipes* and *Aurundo*

*donax* which have affected fishery of the lake (Fig. 9-12).

### Fish diversity of the lake

Fish diversity study of the lake revealed the existence of 54 species of teleosts belonging to 9 orders (Clupeiformes, Osteoglossiformes, Cypriniformes, Siluriformes, Perciformes, Mugiliformes, Synbranchiformes, Beloniformes and Tetradontiformes), 20 families (Clupeidae, Notopteridae, Cyprinidae, Botiidae, Siluridae, Bagaridae, Sisoridae, Pangasidae, Clariidae, Heteropneustidae, Channidae, Anabantidae, Ambassidae, Nandidae, Osphronemidae, Mugilidae, Mastacembalidae, Synbranchidae, Belonidae and Tetradontidae) and 40 genera (Table 1). The details being Clupeiformes 3 species (Clupeidae- *Gudusia chapra*, *Gonialosa manmina*, *Setipinna phasa*), Osteoglossiformes 2 (Notopteridae- *Notopterus notopterus*, *Chitala chitala*), Cypriniformes 21 (Cyprinidae- *Catla catla*, *Labeo rohita*, *L. bata*, *L. calbasu*, *L. dero*, *L. gonius*, *Cirrhinus mrigala*, *C. reba*, *Amblypharyngogon mola*, *Aspidoparia morar*, *Osteobrama cotio*, *Oxygaster (Salmophasia) bacaila*, *Danio devario*, *Puntius sarana*, *P. sophore*, *P. ticto*, *Crossocheilus latius*, *Esomus danricus*, *Chela laubuca*, *Rasbora daniconius*; Botiidae- *Botia lohachata*), Siluriformes 11 (Siluridae- *Ompok bimaculatus*, *Wallago attu*; Bagaridae- *Sperata aor*, *S. seenghala*, *Mystus tengara*, *M. vittatus*, *Rita rita*; Sisoridae- *Bagarius bagarius*; Pangasidae- *Pangasius pangasius*; Clariidae- *Clarias magur*; Heteropneustidae- *Heteropneustes fossilis*), Perciformes 11 (Channidae- *Channa punctatus*, *C. gachua*, *C. marulius* and *C. striatus*; Anabantidae- *Anabas testudineus*; Ambassidae- *Chanda nama*, *C. baculis*, *Parambaasis ranga*; Nandidae- *Nandus nandus*, *Sciaena coitar*); Osphronemidae- *Colisa fasciatus*, Mugiliformes 1 (Mugilidae- *Rhinomugil corsula*), Synbranchiformes 3 (Mastacembelidae- *Mastacembelus armatus* and *Mastacembelus pancalus*; Synbranchidae *Monopterus (Amphipnous) cuchia*), Beloniformes 1 (Belonidae- *Xenentodon cancila*) and Tetradontiformes 1 (Tetradontidae- *Tetradon cutcutia*) (Table 1; Fig. 13-16). As per species-wise fish diversity of Bakhira Lake is concerned, Cypriniformes dominated with 21 species, followed by Siluriformes 11, Perciformes 9, Clupeiformes 3, Synbranchiformes 2, Osteoglossiformes 2, Mugiliformes 1, Beloniformes 1 and Tetradontiformes 1. Details of fish biodiversity of the lake and the nets used for their capture have been shown in Figs. 13-44.

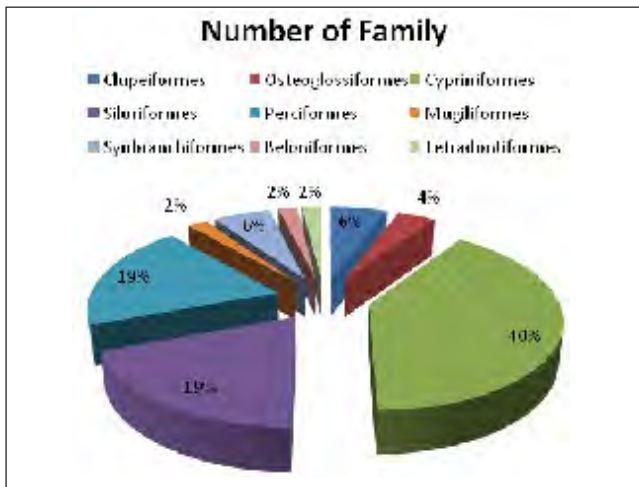


Fig. 15 : Percentage occurrence of species of Bakhira Lake of each Order.

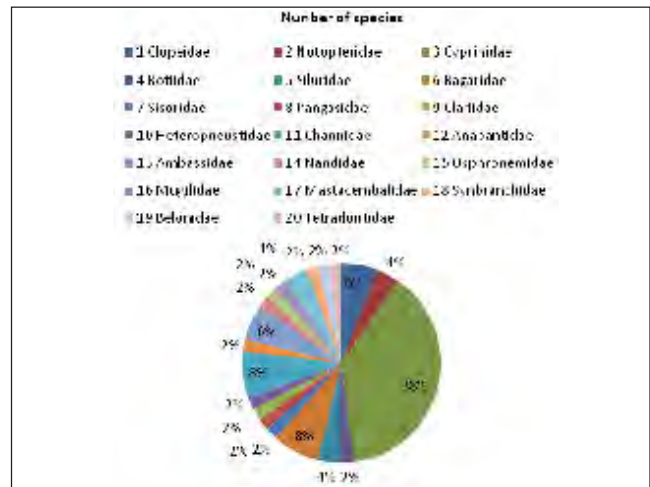


Fig. 16 : Percentage occurrence of species of Bakhira Lake of each Order.



Fig. 17 : Fish collected from Bakhira Lake in cast net.



Fig. 18 : Fish haul from Bakhira Lake.



Fig. 19 : Patra (*Notopterus notopterus*) from Bakhira Lake.

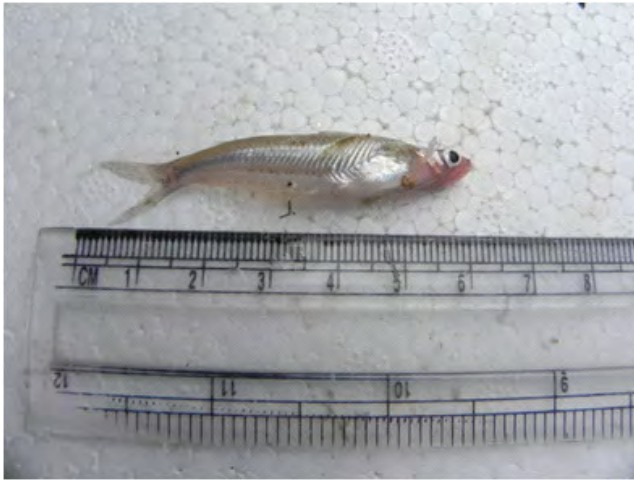


Fig. 20 : Endangered *Chitala chitala* from Bakhira Lake.

**Table 2 :** Conservation and commercial status of fishes inhabiting Bakhira Lake.

| Sl. No. | Zoological Name                        | Local Name                                | Conservation Status |                           |
|---------|--|---|---------------------|---------------------------|
|         |  |   | IUCN Status         | Commercial Status (Local) |
| 1       | <i>Gadusia chapra</i>                  | Suhia (Indian river shad)                 | LC (decreasing)     | Low demand                |
| 2       | <i>Gonialosa manmina</i>               | Majhali suhia (Ganges river gizzard shad) | LC (decreasing)     | Low demand                |
| 3       | <i>Setipinna phasa</i>                 | Phasi (Gangetic hairfin anchovy)          | LC (decreasing)     | Average demand            |
| 4       | <i>Notopterus notopterus</i>           | Patra (bronze featherback)                | LC (decreasing)     | High demand               |
| 5       | <i>Chitala chitala</i>                 | Moy (Chital)                              | LR-nt               | High demand               |
| 6       | <i>Catla catla</i>                     | Bhakur                                    | LC                  | High demand               |
| 7       | <i>Labeo rohita</i>                    | Rohu                                      | LC                  | High demand               |
| 8       | <i>Labeo bata</i>                      | Bata                                      | LC                  | High demand               |
| 9       | <i>Labeo calbasu</i>                   | Karochhar (orange-fin labeo)              | LC                  | Average demand            |
| 10      | <i>Labeo dero</i>                      | Arangi/Basanha-varaia)                    | LC                  | High demand               |
| 11      | <i>Labeo gonius</i>                    | Kursi                                     | LC                  | Average demand            |
| 12      | <i>Cirrhinus mrigala</i>               | Nain                                      | LC                  | High demand               |
| 13      | <i>Cirrhinus reba</i>                  | Raia                                      | LC                  | Average demand            |
| 14      | <i>Amblypharyngodon mola</i>           | Dhvai                                     | LC                  | High demand               |
| 15      | <i>Aspidoparia morar</i>               | Kewachi/Harda                             | LC                  | Low demand                |
| 16      | <i>Osteobrama cotio</i>                | Gurda                                     | DD                  | Low demand                |
| 17      | <i>Oxygaster (Salmophasia) bacaila</i> | Chalhawa                                  | LC                  | Average demand            |
| 18      | <i>Danio devario</i>                   | Patukari                                  | LC                  | Low demand                |
| 19      | <i>Puntius sarana</i>                  | Darahee                                   | EN                  | High demand               |
| 20      | <i>Puntius sophore</i>                 | Sidhari                                   | LC                  | Low demand                |
| 21      | <i>Puntius ticto</i>                   | Sidhari                                   | LC                  | Low demand                |
| 22      | <i>Crossocheilus latius</i>            | Petphorani                                | LC                  | Average demand            |
| 23      | <i>Esomus danricus</i>                 | Dendua (Indian flying barb)               | LC                  | Low demand                |
| 24      | <i>Chela laubuca</i>                   | Dendula                                   | VU                  | Low demand                |
| 25      | <i>Rasbora deniconius</i>              | Dendua                                    | LC                  | Low demand                |
| 26      | <i>Botia lohachata</i>                 | Bagha                                     | NE                  | Low demand                |
| 27      | <i>Ompak bimaculatus</i>               | Jalkapur                                  | LR-nt               | High demand               |
| 28      | <i>Wallago attu</i>                    | Parni/Barari                              | LR-nt               | High demand               |
| 29      | <i>Sperata aor</i>                     | Dariyai tengra                            | LC                  | High demand               |
| 30      | <i>Sperata seenghala</i>               | Giant river catfish                       | LC                  | High demand               |
| 31      | <i>Mystus tengra</i>                   | Tengra                                    | LC                  | High demand               |
| 32      | <i>Mystus vittatus</i>                 | Tengna                                    | LC                  | Low demand                |
| 33      | <i>Rita rita</i>                       | Huna                                      | LC                  | Low demand                |
| 34      | <i>Bagarius bagarius</i>               | Gonchh                                    | LR-nt               | Low demand                |
| 35      | <i>Pangasius pangasius</i>             | Payas                                     | LC                  | High demand               |
| 36      | <i>Clarias magur</i>                   | Magur                                     | LC                  | High demand               |
| 37      | <i>Heteropneustes fossilis</i>         | Singhi                                    | LC                  | High demand               |
| 38      | <i>Channa punctatus</i>                | Girai                                     | LC                  | Low demand                |
| 39      | <i>Channa gachua</i>                   | Chagana                                   | LC                  | Low demand                |
| 40      | <i>Channa marulius</i>                 | Saur                                      | LC                  | High demand               |
| 41      | <i>Channa striatus</i>                 | Dharivali girai                           | LC                  | High demand               |
| 42      | <i>Anabas testudineus</i>              | Kawai/Sumha (Climbing perch)              | DD                  | Average demand            |
| 43      | <i>Chanda nama</i>                     | Chanari                                   | LC                  | Low demand                |
| 44      | <i>Chanda baculis</i>                  | Chanari                                   | LC                  | Low demand                |
| 45      | <i>Parambassis ranga</i>               | Chanari                                   | LC                  | Low demand                |
| 46      | <i>Nandus nandus</i>                   | Dhebari                                   | LC                  | Low demand                |
| 47      | <i>Sciaena coitar</i>                  | Bhola/Patharchatti                        | NE                  | Low demand                |
| 48      | <i>Colisa fasciata</i>                 | Khosti                                    | LC                  | Low demand                |

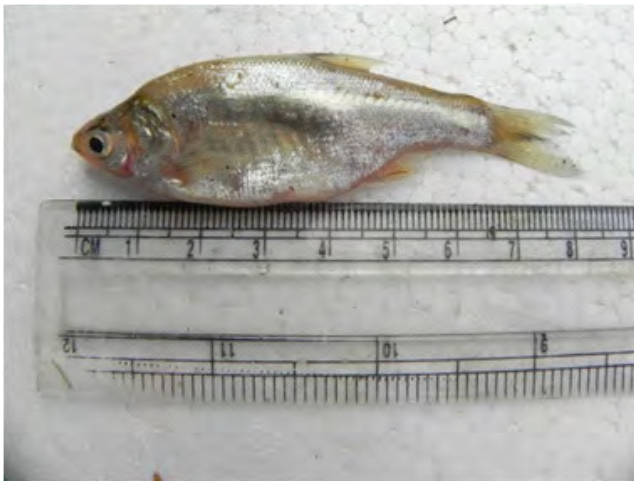
Table 2 continued....



**Fig. 21 :** Phansi (*Setipinna phasa*) from Bakhira Lake.



**Fig. 22 :** *Puntius ticto* from Bakhira Lake.



**Fig. 23 :** *Amblypharyngodon mola* from Bakhira Lake.



**Fig. 24 :** *Labeo rohita* from Bakhira Lake.



**Fig. 25 :** *Cirrhinus reba* from Bakhira Lake.



**Fig. 26 :** *Labeo calbasu* collected from Bakhira Lake.

Table 2 continued...

|    |                                       |            |    |             |
|----|---------------------------------------|------------|----|-------------|
| 49 | <i>Rhinomugil carsula</i>             | Hudra      | LC | High demand |
| 50 | <i>Mastacembelus armatus</i>          | Patya      | LC | Low demand  |
| 51 | <i>Mastacembelus pancalus</i>         | Malga      | LC | Low demand  |
| 52 | <i>Monopterus (Amphipnous) cuchia</i> | Anha Bam   | LC | Low demand  |
| 53 | <i>Xanantodon cancila</i>             | Kauva fish | LC | Low demand  |
| 54 | <i>Tetradon cutcutia</i>              | Galfulani  | LC | Low demand  |

**Abbreviations:** Data deficient (DD), Endangered (EN), Least concerned (LC), Lower risk-near threatened (LR-nt), Not evaluated (NE), Vulnerable (VU).

### Conservation and commercial status of fishes

As per International Union of Nature and Natural Resources (Hilton-Taylor, 2000; Vie' *et al*, 2008; IUCN, 2010, Vidthayanon, 2012; Rema Devi and Ali, 2013; Rema Devi and Dahanukar, 2013) categorization, the conservation and commercial status of some important fishes inhabiting Bakhira Lake have been summarized in Table 2. According to the recent IUCN conservation status, 2 species are Data deficient (DD), 1 Endangered (EN), 44 Least concerned (LC), 4 Lower risk-near threatened LR-nt), 2 Not evaluated (NE) and 1 Vulnerable (VU).

### Surveys of fish markets

Fish markets of Bakhira (morning and evening) and Mehdawal (evening) were surveyed to know the fish diversity and quantum of consumption in this area (Sant Kabir Nagar). Details regarding daily availability of different species in both the fish markets during September 2014 have been summarized in Table 3. However, it is important to note that the availability of commercially important species in the markets was low during monsoon (June-August), moderate during summer (March-May) and high during winter season (September-February).

Uttar Pradesh has vast freshwater resources offering considerable scope for inland fisheries and aquaculture development (Yadava and Sugunan, 1992; Pathak *et al*, 2004; Kumar *et al*, 2013). However, information on ichthyofaunal diversity of different parts of the state are insufficient (Menon, 1949; Sinha and Shiromany, 1953; Chaudhary and Khandelwal, 1960; Verma and Saxena, 1962; Singh and Shiromany, 1964; Mahajan, 1966; Srivastava, 1968, 1988; Pandey, 1977; Tilak and Juneja, 1990; Kumar *et al*, 2013; Nagma and Khan, 2013). The present study revealed the occurrence of 54 species of teleosts in the protected Bakhira Lake (Sant Kabir Nagar) belonging to 9 orders (Clupeiformes, Osteoglossiformes, Cypriniformes, Siluriformes, Perciformes, Mugiliformes, Synbranchi-formes, Beloniformes and Tetradontiformes), 20 families (Clupeidae, Notopteridae, Cyprinidae, Botiidae, Siluridae, Bagaridae, Sisoridae, Pangasidae,

Clariidae, Heteropneustidae, Channidae, Anabantidae, Ambassidae, Nandidae, Osphronemidae, Mugilidae, Mastacembalidae, Synbranchidae, Belonidae and Tetradontidae) and 40 genera. Present conservation status of these fishes following the guidelines given by Hilton-Taylor (2000), Vie' *et al* (2008), IUCN (2010), Vidthayanon (2012), Rema Devi and Ali (2013) and Rema Devi and Dahanukar (2013) being- 2 species Data deficient (DD), 1 Endangered (EN), 44 Least concerned (LC), 4 Lower risk-near threatened LT-nt), 2 Not evaluated (NE) and 1 Vulnerable (VU). In a preliminary study conducted during early seventies, Swarup *et al* (1976) recorded 46 species of teleosts belonging to Clupeiformes 5, Cypriniformes 26, Beloniformes 1, Mugiliformes 1, Ophiocephaliformes 4, Perciformes 6, Mastacembeliformes 2 and Tetradontiformes 1. In another study, 42 native and 5 exotic (total 47) species of fishes belonging to 9 orders (Clupeiformes, Osteoglossiformes, Cypriniformes, Siluriformes, Perciformes, Mugiliformes, Synbranchiformes, Beloniformes and Tetradontiformes), 17 families (Clupeidae, Notopteridae, Cyprinidae, Siluridae, Bagaridae, Sisoridae, Pangasidae, Clariidae, Heteropneustidae, Channidae, Ambassidae, Osphronemidae, Mugilidae, Mastacembelidae, Synbranchidae, Belonidae and Tetradontidae) and 33 genera were recorded from Ramgarh Lake (Gorakhpur) (Pandey and Chandra, 2016), Though 5 exotic species, introduced for enhancing fish production, were observed in Ramgarh Lake (Pandey and Chandra, 2016), none of these species was encountered from Bakhira Lake during the period.

Fish biodiversity of water bodies (ponds and lakes) of the country has also been documented during the recent years. Sarma *et al*. (2012) recorded 97 species belonging to 26 families and 56 genera from the lower reaches of Brahmaputra river (Assam) during February 2009-February 2010 while Nath and Deka (2012) reported occurrence of 63 species in Chandubi Tectonic Lake, West Kamrup district (Assam). It is important to note that Assam harbours more than 217 fish species belonging to 104 genera, 37 families and 10 orders. During the



**Fig. 27 :** *Labeo gonius* from Bakhira Lake.



**Fig. 28 :** *Puntius sarana* from Bakhira Lake.



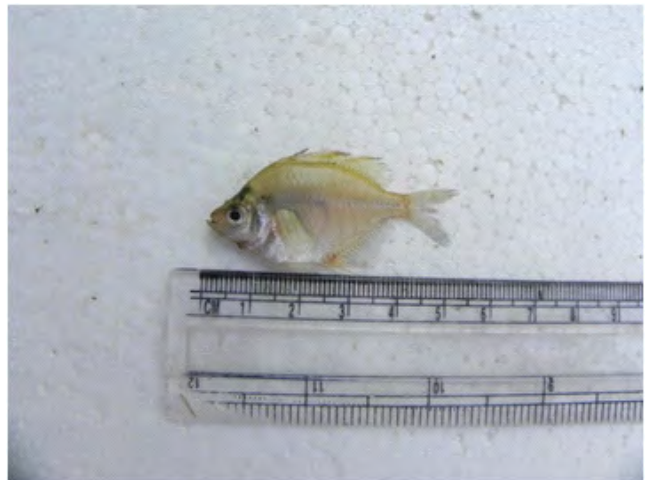
**Fig. 29 :** *Oxygaster (Salmophasia) bacaila* from Bakhira Lake.



**Fig. 30 :** Haul of *Oxygaster (Salmophasia) bacaila* from the lake.



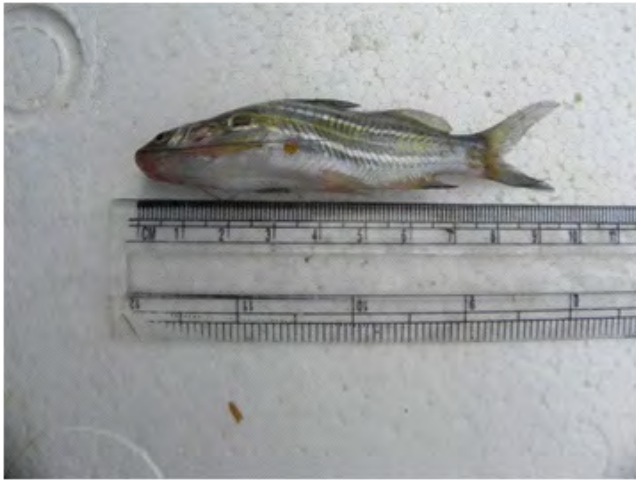
**Fig. 31 :** *Colisa fasciatus* from Bakhira Lake.



**Fig. 32 :** *Chanda nama* from the lake.

**Table 3 :** Details of fishes assembled daily in Bakhira and Mehdawal Fish Market (Sant Kabir Nagar) in September 2014.

| Sl. No. | Fish species                         | Common name         | Nature (live/dead) | Total intake | Total consumption | Source                               | Price (Rs/kg) |
|---------|--------------------------------------|---------------------|--------------------|--------------|-------------------|--------------------------------------|---------------|
| 1       | <i>Heteropneustes fossilis</i>       | Singhi              | Live               | 5.0          | 5.0               | Bakhira Lake/local ponds             | 300           |
| 2       | <i>Mastacmbelus armatus</i>          | Kawa                | Dead               | 4.0          | 3.0               | Bakhira Lake/local river/ ponds      | 120           |
| 3       | <i>Pangasius pangasius</i>           | Payas               | Dead               | 4.0          | 4.0               | Bakhira Lake/local river             | 150           |
| 4       | <i>Pangasius sutchi</i>              | Payas               | Dead               | 30.0         | 28.0              | Andhra Pradesh                       | 140-160       |
| 5       | <i>Labeo rohita</i>                  | Rohu                | Dead/live          | 50.0         | 50.0              | Bakhira Lake/local ponds             | 210-220       |
| 6       | <i>Wallago attu</i>                  | Padhani             | Dead /live         | 15.0         | 15.0              | Bakhira Lake/local taal/ local river | 140-150       |
| 7       | <i>Cirrhinus mrigala</i>             | Nain                | Dead               | 8.0          | 8.0               | Bakhira Lake/local ponds             | 180           |
| 8       | <i>Channa punctatus</i>              | Girai               | Dead/live          | 4.0          | 4.0               | Bakhira Lake/local river             | 120           |
| 9       | <i>Catla catla</i>                   | Bhakur              | Dead               | 30.0         | 25.0              | Andhra Pradesh/ local ponds          | 200           |
| 10      | <i>Bagarius bagarius</i>             | Gonch               | Dead               | 10.0         | 7.0               | Local taal/ local river              | 120           |
| 11      | <i>Clarias magur</i>                 | Magur               | Live               | 03.0         | 3.0               | Local ponds/ rivers                  | 250           |
| 12      | <i>Clarias gariepinus</i>            | Videshi Magur       | Live               | 15.0         | 15.0              | Local ponds                          | 240           |
| 13      | <i>Mystus vittatus</i>               | Tengana             | Dead               | 7.0          | 7.0               | Bakhira Lake                         | 250           |
| 14      | <i>Channa punctatus</i>              | Girai               | Dead/live          | 5.0          | 5.0               | Bakhira Lake/ local ponds            | 170           |
| 15      | <i>Channa marulius</i>               | Saur                | Live/dead          | 5.0          | 5.0               | Bakhira Lake                         | 210           |
| 16      | <i>Channa striatus</i>               | Sauri               | Live               | 10.0         | 10.0              | Local pond/ local river              | 200           |
| 17      | <i>Mastacembelusaculeatus</i>        | Malga/Ptya          | Dead               | 2.0          | 2.0               | Bakhira Lake/local river             | 120           |
| 18      | <i>Notopterus notopterus</i>         | Patra               | Dead               | 7.0          | 7.0               | Bakhira Lake/local ponds             | 120           |
| 19      | <i>Mystus seenghala</i>              | Tengar              | Dead               | 10.0         | 10.0              | Bakhira Lake/local river/ ponds      | 160           |
| 20      | <i>Nandus nandus</i>                 | Dhebari             | Dead               | 2.0          | 2.0               | Bakhira Lake/local river             | 120           |
| 21      | <i>Labeo bata</i>                    | Kursi               | Dead               | 5.0          | 5.0               | Bakhira Lake/local river             | 120           |
| 22      | <i>Sciaena coitor</i>                | Patharchatti/ Bhola | Dead               | 1.0          | 1.0               | Bakhira Lake                         | 120           |
| 23      | <i>Clupisoma garua</i>               | Bekar/Karahi        | Dead               | 10.0         | 10.0              | Local pond/local river               | 120           |
| 24      | <i>Rita rita</i>                     | Hunna               | Dead               | 12.0         | 12.0              | Bakhira Lake/Local river             | 140           |
| 25      | <i>Cirrhinus reba</i>                | Raiya               | Dead               | 1.0          | 1.0               | Bakhira Lake/local river/ ponds      | 160           |
| 26      | <i>Labeo calbasu</i>                 | Karaunchar          | Dead               | 5.0          | 4.0               | Bakhira Lakelocal ponds              | 120           |
| 27      | <i>Ailia coila</i>                   | Patasi/Minti        | Dead               | 2.0          | 1.0               | Local river/ponds                    | 110           |
| 28      | <i>Puntius sophore</i>               | Sidhari             | Dead               | 5.0          | 5.0               | Ramgarh Lake/ local river            | 120           |
| 29      | <i>Puntius ticto</i>                 | Sidhari             | Dead               | 3.0          | 3.0               | Bakhira Lake/local river             | 120           |
| 30      | <i>Hypophthalmichthys molitrix</i>   | Silver carp         | Dead               | 30.0         | 30.0              | Andhra Pradesh                       | 220           |
| 31      | <i>Ctenopharyngodon idella</i>       | Grass carp          | Dead               | 25.0         | 25.0              | Andhra Pradesh                       | 185           |
| 32      | <i>Aristichthys nobilis</i>          | Bighead             | Dead/live          | 35.0         | 35.0              | Andhra Pradesh                       | 175           |
| 33      | <i>Cyprinus carpio var. communis</i> | Common carp         | Dead/live          | 20.0         | 18.0              | Andhra Pradesh/local ponds           | 155           |
| 34      | <i>Piaractus brachypomus</i>         | Pacu (exotic)       | Dead               | 20.0         | 20.0              | Andhra Pradesh                       | 175-180       |



**Fig. 33 :** *Mystus vittatus* from Bakhira Lake.



**Fig. 34 :** *Pangasius pangasius* from the lake.



**Fig. 35 :** *Rita rita* from Bakhira Lake.



**Fig. 36 :** *Sperata aor* in Bakhira fish market collected from Rapti river.



**Fig. 37 :** *C. punctatus*, *C. marulius* and *C. striatus* from Bakhira Lake.



**Fig. 38 :** *Channa marulius* (3.5 kg) from the lake.

survey conducted from February 2009-July 2010, Patra *et al* (2011) reported 55 species belonging to 8 orders, 20 families and 31 species from Karala river, a tributary of Teesta river at Jalpaiguri district (West Bengal). However, Bera *et al* (2014) recorded 39 species belonging to 7 orders, 15 families and 26 genera from Kangsabati reservoir (West Bengal). Murugan and Prabhakaran (2012) found 35 species of fishes in Kamala basin of Darbhanga district (Bihar). Fish biodiversity of Jagdahawa Lake (Kaimur, Bihar) during January-December 2013 comprised 28 species from 8 orders, 12 families and 19 genera (Prasad, 2014). Based on survey conducted during January-December 2008, Verma and Murmu (2010) reported 40 fish taxa belonging to 7 orders, 15 families and 28 genera from Dimna Lake, East Singhbhum (Jharkhand). During the 8 months (February-September 2011) survey, Mondal *et al* (2014) found 25 species from 5 orders, 11 family and 20 genera from Pakhanjore Dam (Chhattisgarh) while Minj and Agrawal (2015a) documented 42 fish species belonging to 4 orders, 11 families, 21 genera during one year (July 2009-June 2010) from the same water body. In the twin 75 year-old man-made Dandia and Mahurband ponds of North Bastar district (Chhattisgarh), 39 species of fish from 5 orders, 11 families and 22 genera were recorded (Minj and Agrawal (2015b). Sahu (2015) recorded 22 species belonging to 5 orders, 12 families and 13 genera at Chandrapur stretch of Mahanadi (Chhattisgarh).

Yousuf *et al* (2012) recorded 29 fish species belonging to 7 orders, 10 families and 15 genera from Halali reservoir of Vidisha district (Madhya Pradesh) while Rana and Shammi (2015) reported 43 fish species from 6 orders, 14 families and 27 genera from Upper and Lower lakes of Bhopal. Though Tiwari (2006) reported 41 species belonging to 13 families and 25 genera in the natural water body (Sagar Lake) whereas in a recent survey conducted during March 2012-April 2014, only 21 species belonging to 6 orders, 11 families and 17 genera were reported from this water body (Wani and Gupta, 2014). Uchhariya *et al* (2012) recorded 40 species from 6 orders, 12 families and 23 genera in man-made Tighra reservoir (Gwalior) while Harsi reservoir (Gwalior) harbours 51 species of fishes belonging to 7 orders, 16 families and 33 genera (Prakash, 2015). Kumar and Rathore (2007) reported decline of fish taxa from 42 species to 26 during the last 50 years in Pichhola Lake (Rajasthan) which has been attributed to the drought conditions during the two consecutive years 1971 and 1972 turning the lake to a small muddy pool resulting in the mass mortality of fishes. Pawar (2009) reported 24 species belonging to 2 orders and 17 genera in Sadatpur

Lake (Ahmednagar) in the surveys conducted during January-December 2005. Pandarkar *et al* (2014) found 15 fish species belonging to 5 orders, 7 families and 12 genera in Vasapur reservoir (Ahmednagar) while Bobdey (2014) reported 63 fish taxa belonging to 8 orders and 17 families from a lake and river ecosystems of Bhandara district (Maharashtra). Thirumala *et al* (2011) recorded the occurrence of 33 species from 2 orders, 8 families and 25 genera in Bhadra reservoir (Karnataka) whereas Devaraju (2014) reported 29 native (+ 4 exotics) fish species from the three major lakes of Mandya district (Karnataka). Rao *et al* (2014) recoded 66 fish species from 9 orders, 22 families and 38 genera during January-December 2011 in river Sarada, Visakhapatnam (Andhra Pradesh). Ramachandrarao and Mukundarao (2015) reported 22 species belonging to 5 orders from man-made Madduvasala reservoir in Srikakulam (Andhra Pradesh). Srikanth *et al* (2015) reported the presence of 33 species belonging to 6 orders, 14 families and 23 genera from Rammappa Lake of Warangal district (Andhra Pradesh). Survey conducted during November 2005–October 2006, revealed the occurrence of 25 species from 4 orders, 9 families and 18 genera from Anjanapura reservoir (Karnataka) (Basavaraja *et al*, 2014). Based on the surveys conducted during January-December 2013, Manickam *et al*. (2014) reported 71 fish taxa belonging to 8 orders, 21 families and 48 genera from Stanley reservoir, Tamil Nadu (South India).

It is pertinent to remark that very few studies have been conducted on fish and fisheries of the eastern Uttar Pradesh (Swarup, 1967; Srivastava, 1968, 1988, 2002; Srivastava *et al*, 2006; Singh *et al*, 2009; Pandey *et al*, 2010). In Ramgarh Lake (Gorakhpur), the declining trends in precious carp fishery during sixties has been attributed primarily due to indiscriminate fishing of juveniles (24-28%) and increase in population of predatory fishes like *Wallago attu*, *Mystus (Sperata) seenghala*, *Mystus (Sperata) aor*, *Mystus cavasius*, *Ompok pabda*, *Notopterus notopterus*, *Notopterus (Chitala) chitala*, *Channa punctatus*, *C. gachua*, *C. marulius*, *C. striatus*, *Heteropneustes fossilis*, *Clarias batrachus (magur)*, *Monopeterus (Amphipnous) cuchia*, *Nandus nandus*, *Glossogobius giuris* and *Xenentodon cancila* (Swarup, 1967; Swarup and Rajbanshi, 1970). Decline in carp fisheries and the dominance of catfishes has been reported in Ganga river at Allahabad as changing pattern on time-scale (Dehadrai *et al*, 1994). Pandey (1977) recorded the existence of 74 species of native fishes from Faizabad district of Uttar Pradesh. The data collected for six years revealed the existence of 74 native and 5 exotic (total 79) species belonging to 9 orders, 21 families



**Fig. 39 :** *Mystus vittatus* and synbranchifom fishes from Bakhira Lake.



**Fig. 40 :** *Heteropneustes fossilis* and synbranchifom fishes from the lake.



**Fig. 41 :** *Xenantodon cancila* from Bakhira Lake.



**Fig. 42 :** Fisherman of Shanichara village with cast-net.



**Fig. 43 :** Fisherwoman of Jaswal village involved in selecting fishes from cast-net.



**Fig. 44 :** Fisherwomen of Shanichara village with cast-net.

and 55 genera in this district (Pandey, 1999). Based on six months collection data during 2010-2011, Kumar *et al* (2013) found 62 fish species belonging to 9 orders, 20 families and 41 genera in Faizabad which was 17 species less reported by Pandey (1999) and 15 species less as recorded by Dwivedi *et al* (2004, 2007). The less number of species reported from the same district by Kumar *et al* (2013) has been attributed to large study areas and period covered in earlier two reports. Though, Singh *et al* (2009) recorded 40 species belonging to 6 orders, 16 families and 25 genera from Suraha Tal located in Ballia district (Uttar Pradesh), Pandey *et al* (2010) reported the presence of 59 species of teleosts belong to 8 orders, 22 families and 40 genera from the same water body.

Srivastava (1968) reported the occurrence 87 fish species from eastern Uttar Pradesh and 111 taxa from Uttar Pradesh and Bihar (Srivastava, 1988) whereas 30 species are described in stretches of river Ganga at Allahabad (Srivastava, 2002). From western Uttar Pradesh, 45 fish species were documented from Hindon river at Saharanpur (Tilak and Juneja, 1990) and 36 taxa belonging to 6 orders, 11 families and 23 genera from rivers, reservoirs and ponds of Bijnore (Nagma and Khan, 2013). Sixty six (66) fish taxa belonging to 20 families and 45 genera were reported from river Betwa (a tributary of Ganga basin) in Uttar Pradesh (Lakra *et al*, 2010). More recently, 92 fish species belonging to 58 genera and 24 families were recorded by NBFGR from river Ganga in Uttar Pradesh. Another report revealed the presence of 56 species belonging to 42 genera, 20 families and 7 orders from river Gomti (Sarkar *et al*, 2010), however, Srivastava and Singhal (2015) recorded 70 fish taxa belonging to 9 orders, 21 families and 42 genera from the same river at Lucknow. Lakra (2010) reported occurrence of about 123 fish species in Uttar Pradesh, however, the recent assessment, Sarkar (2014) recorded 124 species belonging to 26 families and 74 genera from this state with river Ganga harbouring 90 species followed by Ghaghara and Gerua with 85 species each. As far as species richness is concerned, Cypriniformes with 21 species dominated the fish diversity of Bakhira Lake. Cypriniformes are the dominant species in most of the water bodies studied so far (Pandey, 1977, 1999; Tilak and Juneja, 1990; Balasundaram *et al*, 2001; Dwivedi *et al*, 2004, 2007; Kumar and Rathore, 2007; Singh *et al*, 2009; Chakraborty *et al*, 2010; Lakra, 2010; Pandey *et al*, 2010; Sarkar *et al*, 2010; Verma and Murmu, 2010; Yousuf *et al*, 2012; Kumar *et al*, 2013; Nagma and Khan, 2013; Basavaraja *et al*, 2014; Devaraju, 2014; Manickam *et al*, 2014; Pandarkar *et al*, 2014; Rana and Shammi, 2015; Rao *et al*, 2014; Srivastava

and Singhal, 2015). Though commercially important fishes are being cultured in pond and tanks and sold in the markets of Bakhira and Mehdawal (Sant Kabir Nagar), importance of small indigenous freshwater fishes (SIFs) for sustained nutritional security of poor people residing in nearby localities may not be overlooked (Sarkar and Lakra, 2010).

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