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PRESENT STATUS OF FISH BIODIVERSITY OF RAMGARH LAKE, GORAKHPUR (UTTAR PRADESH) FOR CONSERVATION AND SUSTAINABLE UTILIZATION

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ABSTRACT: Regular surveys of Ramgarh Lake revealed the occurrence of 42 native and 5 exotics species of finfishes (total 47) belonging to 9 orders, 17 families and 33 genera during March 2013-February 2015. The details of the species recorded in the lake were- Clupeiformes 3 (Clupeidae- *Gadusia chapra, Gonialosa manmina, Setipinna phasa*), Osteoglossiformes 2 (Notopteridae- *Notopterus notopterus, Chitala chitala*), Cypriniformes 17 species (Cyprinidae- *Catla catla, Labeo rohita, L. bata, L. calbasu, L. dero, L. gonius, Cirrhinus mrigala, C. reba, Hypophthalmichthys molitrix, Ctenopharyngodon idella, Aristichthys nobilis, Cyprinus carpio* var. *communis, Amblypharyngodon mola, Aspidoparia morar, Oxygaster bacaila, Puntius sarana, P. ticto*), Siluriformes 12 (Siluridae- *Ompok bimaculatus, Wallago attu*; Bagaridae- *Sperata aor, S. seenghala, Mystus tengara, M. vittatus, Rita rita;* Sisoridae- *Bagarius bagarius*; Pangasidae- *Pangasius pangasius, Pangasius sutchi;* Clariidae- *Clarias magur;* Heteropneustidae- *Heteropneustes fossilis*), Perciformes 7 (Channidae- *Channa punctatus, C. striatus, C. marulius, C. gachua*; Ambassidae- *Chanda nama, C. ranga*; Osphronemidae- *Colisa fasciatus*), Mugiliformes 01 (Mugilidae- *Rhinomugil carsula*), Synbranchiformes 3 (Mastacembelidae- *Mastacem belus armatus, M. pancalus*; Synbranchidae- *Monopterus* (*Amphipnous*) *cuchia*), Beloniformes 01 (Belonidae- *Xenantodon cancila*) and Tetradontiformes 01 (Tetradontidae- *Tetradon cutcutia*). As per species-wise fish diversity of Ramgarh Lake is concerned, Cypriniformes dominated with 17 species, followed by Siluriformes 12, Perciformes 7, Clupeiformes 3, Synbranchiformes 3, Osteoglossiformes 2, Mugiliformes 1, Beloniformes 1 and Tetradontiformes 1. Though commercially important fishes are being cultured in Ramgarh Lake, importance of small indigenous freshwater fishes (SIFs) present in this water body for sustained nutritional security of poor people residing in nearby localities may not be overlooked.

Key words : Fish biodiversity, conservation, sustainable utilization. Ramgarh Lake, Gorakhpur, India.

INTRODUCTION

The Convention on Biological Diversity (CBD) which came into force in 1993 after the United Nations Conference on Environment and Development (UNCED) (June 03-14, 1992), Rio de Janeiro (Brazil) reaffirms the sovereign rights of the member nations over their entire genetic resources. It also envisages conservation, sustainable use and equitable sharing of the benefits arising from the biological resources. There exist reports on the existence of more than 28,400 finfish species throughout the world representing more than half of the entire vertebrate diversity (Nelson, 1994, 2006; Hilton-Taylor, 2000). India has been identified as one of the mega biodiversity centres for the genetic resources in the world and the same is true in case of fishes too. Nearly 2,868 species of finfishes belonging to 42 orders, 426 families and 1,019 genera have been recorded from different ecosystems of this subcontinent. 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%) (Lakra and Pandey, 2009; Anon, 2015). Out of these, about 258 species are commercially important which include cultured, cultivable and wild taxa, 199 endemic and 275 game fishes. Further, there is record of the introduction of 447 exotic species in Indian waters, most of which are of ornamental value (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 (Lakra and Pandey, 2009; Hossain *et al*, 2010). Though the decline of individual fish species is very often related to more than one proximate factors, the various causes of imperilment of fishes in the different ecosystems have been identified 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)

Fig. 2 : Ramgarh Lake receiving water from Bichhia nallah. Railway track of NER from Gorakhpur-Howrah.

Fig. 3 : Bichhia nallah near Kuraghat on Gorakhpur-Deoria Road.

Fig. 4 : Gurrah nallah of Ramgarh Lake near Sahara Nagar (Siktaur) draining excess water to Rapti river.

Fig. 5 : Ramgarh Lake near Padleyganj sampling site (S-3).

Fig. 6 : Ramgarh Lake near Kuraghat heavily infested with water hyacinth.

Fig. 7 : Sewage treatment plant near Bichhia nallah, Kuraghat, Gorakhpur.

Fig. 8 : Sewage treatment plant near Avas Vikas Colony, Jharkhandi Mahadeo.

Fig. 9 : Sewage treatment plant near Sahara Nagar (opposite Siktaur).

Fig. 10 : Heavy infestation of water hyacinth at Daudpur, Gorakhpur.

Fig. 11 : Heavy infestation of water hyacinth in Ramgarh Lake (near Bilandpur).

Fig. 12 : Rangarh Lake before de-weeding (near NER Colony), Mohaddipur.

Fig. 13 : Rangarh Lake near Budhha Vihar before de-weeding.

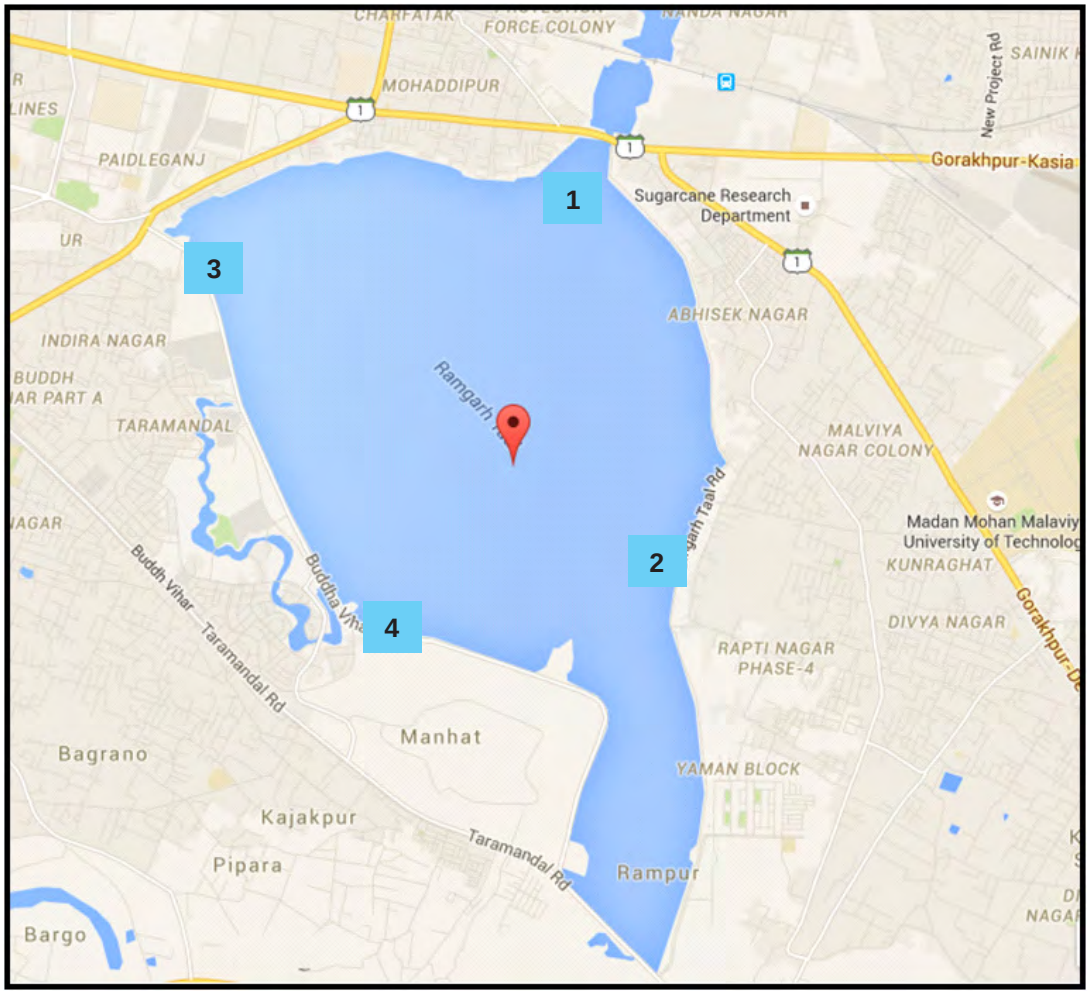

Fig. 1 : Ramgarh Lake showing the four sampling stations.

competition from the introduced non-indigenous species and (v) spread of dreaded diseases. Since maintenance and preservation of fish biodiversity along with other biotic resources is being viewed as prerequisite even for human well-beings (Das and Pandey, 1998, 1999; Lal and Pandey, 1999; Pandey *et al*, 1999; Lakra and Pandey, 2009; Hossain *et al*, 2010), an attempt has, therefore, been made to document the present status of fish diversity of Ramgarh Lake (Gorakhpur) for conservation and sustainable utilization.

MATERIALS AND METHODS

Regular surveys of Ramgarh Lake were conducted during March 2013-February 2015 at the four sampling sites for documenting the fish diversity, their seasonal abundance and conservation status. Market surveys were also conducted to record the assembling of fishes 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 along with their abundance on a time–scale in the lake was also evaluated by referring earlier works (Swarup, 1967; Swarup and Rajbanshi, 1970) and discussion with the local fishermen depending on the water body for their livelihood. For assigning conservation status of the taxa, criteria standardized by Hilton-Taylor (2000) and IUCN (2010) were followed.

RESULTS AND DISCUSSION

Location of the lake: Ramgarh Lake (Tal) is a natural oxbow-lake formed by river Rapti (95 m above msl), situated to the southeast of Gorakhpur (Uttar Pradesh) ($26^0$13'-$27^0$29' N; 83^0 05'-$83^0$56'E) and covers an area of about 723 ha (in 1970s) with the catchment area around 11,500 ha, out of which 494 ha land is under Gorakhpur Development authority (GDA) (Fig.1). Rapti river flows about 2-3 km south-west of the water body. Bichhia nullah from NER Colony and Railway Yard (7 km) (Figs. 2, 3), Gordhaiya nullah (10 km), Mohaddipur

Fig. 14 : Strengthening of bundh near Kuraghat, Gorakhpur.

Fig. 15 : De-weeding of Ramgarh Lake near Avas Vikas Colony, Jharkhandi Mahedeo.

Fig. 16 : De-weeding of Ramgarh lake near Kuraghat.

Fig. 17 : View of Ramgarh lake after de-weeding.

Fig. 18 : Ramgarh lake after de-weeding at Kuraghat.

Fig. 19 : Ramgarh lake with clear water after de-weeding near Budhha Park.

Table 1 : Fish biodiversity of Ramgarh Lake.

Order	Family	Scientific name
Clupeiformes	Clupeidae	*Gadusia chapra*
		Gonialosa manmina
		Setipinna phasa
Osteoglossiformes	Notopteridae	*Notopterus notopterus*
		Chitala chitala
Cypriniformes	Cyprinidae	*Catla catla*
		Labeo rohita
		Labeo bata
		Labeo calbasu
		Labeo dero
		Labeo gonius
		Cirrhinus mrigala
		Cirrhinus reba
		Hypophthalmichthys molitrix
		Ctenopharyngodon idella
		Aristichthys nobilis
		Cyprinus carpio var. *communis*
		Amblypharyngodon mola
		Aspidoparia morar
		Oxygaster bacaila
		Puntius sarana
		Puntius ticto
Siluriformes	Siluridae	*Ompok bimaculatus*
		Wallago attu
	Bagaridae	*Sperata aor*
		Sperata seenghala
		Mystus tengara
		Mystus vittatus
		Rita rita
	Sisoridae	*Bagarius bagarius*
	Pangasidae	*Pangasius pangasius*
		Pangasius sutchi
	Clariidae	*Clarias magur*
	Heteropneustidae	*Heteropneustes fossilis*
Perciformes	Channidae	*Channa punctatus*
		Channa striatus
		Channa marulius
		Channa gachua
	Ambassidae	*Chanda nama*
		Chanda ranga
	Osphronemidae	*Colisa fasciatus*
Mugiliformes	Mugilidae	*Rhinomugil carsula*
Synbranchiformes	Mastacembelidae	*Mastacem belus armatus*
		Mastacem belus pancalus
	Synbranchidae	*Monopterus* (*Amphipnous*) *cuchia*
Beloniformes	Belonidae	*Xenantodon cancila*
Tetradontiformes	Tetradontidae	*Tetradon cutcutia*

nullah from Electric Power House (4 km), Daudpur nullah draining sewage of the main city (12 km), Padleyganj nallah (4 km) and 10-12 numbers of mini-ducts (6-8 km) drain into this water body. Ramgarh Lake gets connected to river Rapti (16 km) through Gurrah nallah (near Sahara Nagar) which discharges excess water of the lake during flood situations (Fig. 4). This lake was developed under Tourist Complex Scheme in 1987 with water sports complex, Buddha Museum, planetarium, tourist bungalow and Champa Vihar Park around the water body. The pollution threat to the lake comes mainly from the residential colonies located in (1) Maharwa-ki-Bari, (2) Navalpura, (3) Bhagta, (4) Siktaur, (5) Parsahia Tola, (6) Rampur, (7) Buddha Vihar, (8) Sorahia Tola, (9) Bilandpur, (10) Gopalapur, (11) Padleyganj, (12) Champa Park, (13) Mohaddipur, (14) Kuraghat, (15) Jharkhandi Mahedeo, (16) Avas Vikas Colony, (17) Shivpuri and (18) Bhairavpur discharging more than 1,090 quintals of wastes into this water body every day. Generally, the wastes from households contain nitrate and phosphate causing eutrophication in the lake resulting in low dissolved oxygen content. Ramgarh Lake was heavily infected with the water hyacinth during the period (Fig. 3, 5-6, 10-13).

Restoration of Ramgarh Lake under the National Lake Conservation Plan (NLCP) was approved by the Ministry of Environment & Forests (MOEF), Government of India, New Delhi and an amount of Rs. 186.0 crore released to Gorakhpur Development Authority (GDA) for implementation of the programmes. Under NLCP, three sewage treatment plants (STPs) are being constructed at (1) Bichhia nallah (Kuraghat) (Fig. 7), Avas Vikas colony (Jharkhandi Mahadev) (Fig. 8) and Sahara Nagar (bye-pass, opposite Siktaur) (Fig. 9). Bandhs around Ramgarh Lake are being strengthened to contain (stop) encroachment (Fig. 14). Work contracts for de-weeding and de-siltation of the lake have been awarded to Uttar Pradesh Jal Nigam, Lucknow (Fig. 15, 16). Major portion of de-weeding work has been completed (Fig.17-20) by February 2015 and de-silting process of the bed has been initiated, primarily near Budhha Vihar Park (Fig. 21).

Fish diversity of the lake: Present study revealed the occurrence of 42 native and 5 exotics species of finfishes (total 47) belonging to 9 orders, 17 families and 33 genera (Table 1). The details of the species recorded in Ramgarh Lake were-

Fig. 20 : Ramgarh lake after de-weeding at Jharkhandi Mahadeo, Gorakhpur.

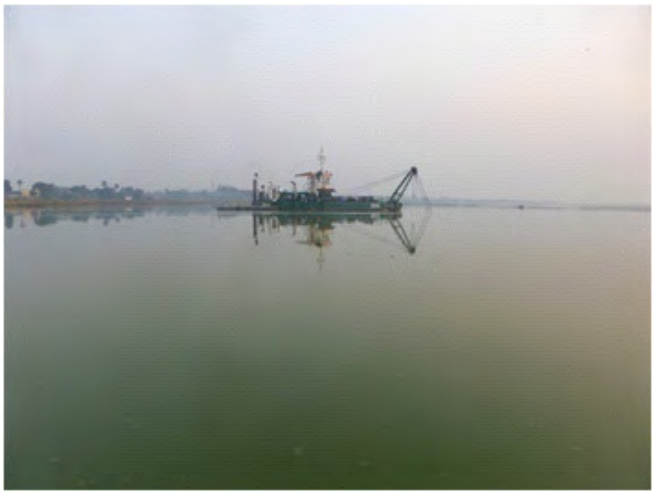

Fig. 21 : De-siltation process initiated near Budhha Vihar, Gorakhpur.

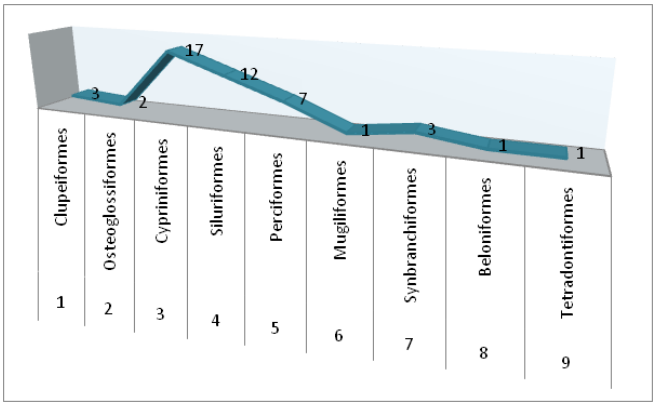

Fig. 22 : Order-wise occurrence of fish species in Ramgarh Lake.

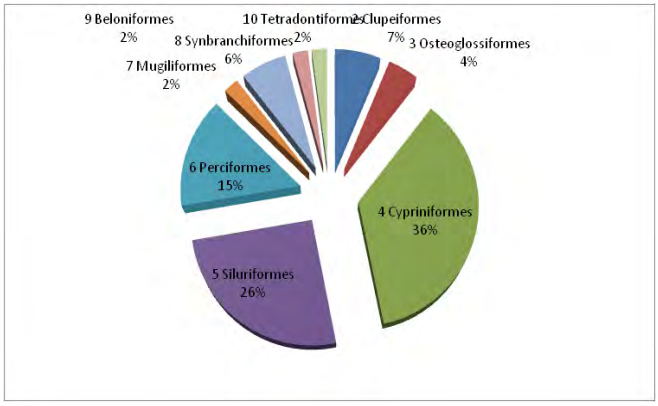

Fig. 24 : Percentage occurrence of species of each order in Ramgrah Lake.

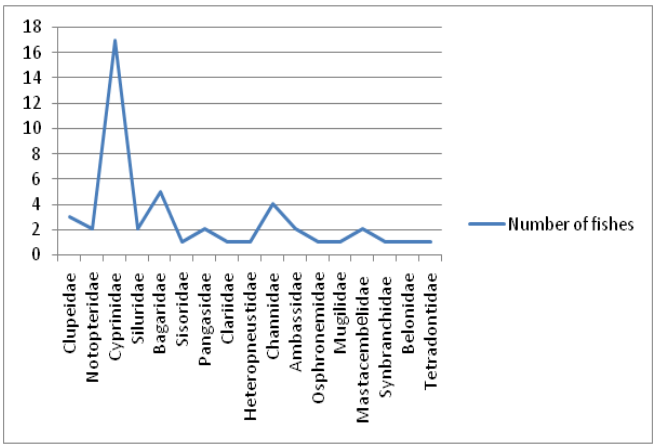

Fig. 23 : Number of species occurring in each family of Ramgarh Lake.

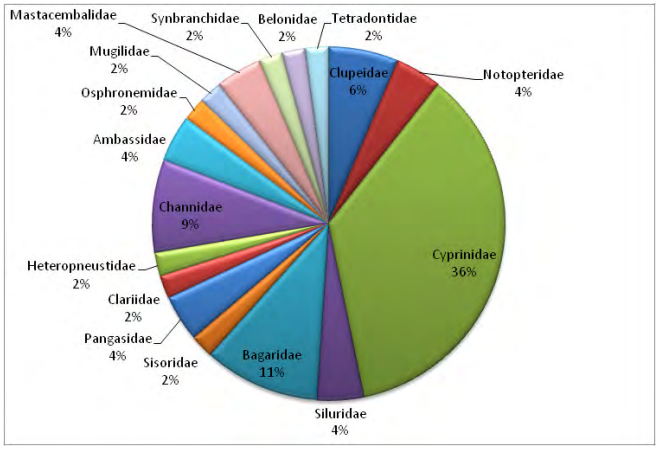

Fig. 25 : Percentage occurrence of fish species in each family in Ramgarh Lake.

Clupeiformes 3 (Clupeidae- *Gadusia chapra*, *Gonialosa manmina*, *Setipinna phasa*), Osteoglossiformes 2 (Notopteridae- *Notopterus notopterus, Chitala chitala*), Cypriniformes 17 species (Cyprinidae- *Catla catla, Labeo rohita, L. bata, L. calbasu, L. dero, L. gonius, Cirrhinus mrigala, C. reba, Hypophthalmichthys molitrix, Ctenopharyngodon idella, Aristichthys nobilis,*

Table 2 : Conservation and commercial status of fishes inhabiting Ramgarh lake (including 5 exotic species).

Sl. No.	Zoological Name	Local Name	Conservation Status	
			IUCN Status	Commercial Status (Local)
1	*Gadusia chapra*	Suhia (Indian river shad)	LC (decreasing)	Low demand
2	*Gonialosa manmina*	Majhali suhia (Ganges river gizzard shad)	LC (decreasing)	Low demand
3	*Setipinna phasa*	Phansi (Gangetic hairfin anchovy)	LC (decreasing)	Average demand
4	*Notopterus notopterus*	Patra (Bronze featherback)	LC (decreasing)	High demand
5	*Chitala chitala*	Moy (Chital)	LR-nt	High demand
6	*Catla catla*	Bhakur	LC	High demand
7	*Labeo rohita*	Rohu	LC	High demand
8	*Labeo bata*	Bata	LC	High demand
9	*Labeo calbasu*	Karaunchar (orange-fin labeo)	LC	Average demand
10	*Labeo dero*	Arangi/Basanhava raia)	LC	High demand
11	*Labeo gonius*	Kursi	LC	Average demand
12	*Cirrhinus mrigala*	Nain	LC	High demand
13	*Cirrhiuns reba*	Raia	LC	
14	*Hypophthalmichthys molitrix*	Silver carp (Exotic)	LR-nt	High demand
15	*Cten]opharyngodon idella*	Grass carp (exotic)	NE	High demand
16	*Aristichthys nobilis*	Bighead/Brigade (exotic)	DD	High demand
17	*Cyprinus carpio* var. *communis*	Common carp (exotic)	VU	Low demand
18	*Amblypharyngodon mola*	Dhawai	LC	High demand
19	*Aspidoparia morar*	Kenwachi/Harda	LC	Low demand
20	*Oxygaster* (*Salmophasia*) *bacaila*	Chalhawa	LC	Average demand
21	*Puntius sarana*	Daraheei	EN	High demand
22	*Puntius ticto*	Sidhari	LC	High demand
23	*Ompak bimaculatus*	Jalkapoor	LR-nt	High demand
24	*Wallago attu*	Padhani/Barari	LR-nt	High demand
25	*Sperata aor*	Dariai tengar	LC	High demand
26	*Sperata seenghala*	Dariai tengar (giant river catfish)	LC	High demand
27	*Mystus tengara*	Tengana	LC	High demand
28	*Mystus vittatus*	Tengra	LC	Low demand
29	*Rita rita*	Hunna	LC	Low demand
30	*Bagarius bagarius*	Gonchh	LR-nt	Low demand
31	*Pangasius pangasius*	Payas	LC	High demand
32	*Pangasius sutchi*	Sutchi (exotic)	EN	High demand
33	*Clarias magur*	Magur	LC	High demand
34	*Heteropneustes fossilis*	Singhi	LC	High demand
35	*Channa punctatus*	Girai	LC	Low demand
36	*Channa striatus*	Saur	LC	High demand
37	*Channa marulius*	Saur	LC	High demand
38	*Channa gachua*	Chanaga	LC	Low demand
39	*Chanda nama*	Chanari	LC	Low demand
40	*Chanda ranga*	Chanari	LC	Loe demand
41	*Colisa fasciata*	Khotda	LC	Low demand
42	*Rhinomugil carsula*	Hudra	LC	High demand
43	*Mastacembelus armatus*	Patya	LC	Low demand
44	*Mastacembelus pancalus*	Malga	LC	Low demand
45	*Monopterus (Amphipnous) cuchia*	Anha Bam	LC	Low demand
46	*Xanantodon cancila*	Kauva	LC	Low demand
47	*Tetradon cutcutia*	Galfulani	LC	Low demand

Abbreviations: DD, Data deficient (1); EN, Endangered (02); LC**,** Least concerned (37); LR-nt, Lower risk-near threatened (05); NE, Not evaluated (01) and VU, Vulnerable (01).

Fig. 26 : Small boats (Dongi) being operated in Ramgarh Lake.

Fig. 27 : Fishes caught in Ramgarh Lake near Kuraghat.

Fig. 28 : Small indigenous fishes (SIFs) near Bichhia nallah, Kuraghat.

Fig. 29 : Fish assembly centre in of Ramgarh Lake near Budhha Vihar.

Fig. 30 : Sorting of different fishes at assembling centre in April 2013.

Fig 31 : Assembling of smallfishes (*Puntius* spp.) during April 2013.

Table 3 : Details of the leasing of Ramgarh Lake, Gorakhpur.

Year	Amount (Rs. in lakh)
Auction by Nagar Nigam, Gorakhpur	
1987-1989 (2 years)	0.86
1989-1991	3.00
1991-1993	32.00
1993-1995	66.00
1995-1997	66.00
1997-1999	67.00
1999-2001	68.00
2001-2003	68.20
2003-2005	69.20
2005-2007	70.50
2007-2009	74.00
Auction by GDA (Gorakhpur Development Authority), Gorakhpur	
2009-2012 (3 years)	78.00
20112-2013	No auction due to court case
2014-2018 (5 years)	**226.75**

Cyprinus carpio var. *communis, Amblypharyngodon mola, Aspidoparia morar, Oxygaster bacaila, Puntius sarana, P. ticto*), Siluriformes 12 (Siluridae- *Ompok bimaculatus*, *Wallago attu*; Bagaridae- *Sperata aor, S. seenghala, Mystus tengara, M. vittatus, Rita rita;* Sisoridae- *Bagarius bagarius*; Pangasidae- *Pangasius pangasius, Pangasius sutchi;* Clariidae- *Clarias magur;* Heteropneustidae- *Heteropneustes fossilis*), Perciformes 7 (Channidae- *Channa punctatus*, *C. striatus, C. marulius, C. gachua*; Ambassidae- *Chanda nama*, *C. ranga*; Osphronemidae- *Colisa fasciatus*), Mugiliformes 01 (Mugilidae- *Rhinomugil carsula*), Synbranchiformes 3 (Mastacembelidae- *Mastacem belus armatus, M. pancalus*; Synbranchidae- *Monopterus* (*Amphipnous*) *cuchia*), Beloniformes 01 (Belonidae- *Xenantodon cancila*) and Tetradontiformes 01 (Tetradontidae- *Tetradon cutcutia*). As per species-wise fish diversity of Ramgarh Lake is concerned, Cypriniformes dominated with 17 species, followed by Siluriformes 12, Perciformes 7, Clupeiformes 3, Synbranchiformes 3, Osteoglossiformes 2, Mugiliformes 1, Beloniformes 1 and Tetradontiformes 1. Order-wise, family-wise and species-wise occurrence of fishes in Ramgarh Lake have been summarized in Fig. 22-25. The details of fishing methods, fish diversity and post-harvest drying have been depicted in Fig. 26-51.

Conservation and commercial status of fishes : As per International Union of Nature and Natural Resources (Hilton-Taylor, 2000; IUCN, 2010) categorization, the conservation and commercial status of the fishes occurring in Ramgarh Lake have been summarized in Table 2.

Since Ramgarh Tal was not leased for one year (April 2003-April 2004) due to the Court Case, it was not stocked with the seeds of the commercially important fishes like *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Aristichthys nobilis*, *Hypophthalamichthys molitrix* and *Cyprinus carpio*, hence the catch of the fishes during May 2003-July 2014 was dominated by miscellaneous as well as catfishes and contribution of the above carps were minimum (Fig. 34-44).

Exotic fishes in the lake : Ramgrah Lake is being stocked by the three Indian major carps (*Catla catla, Labeo rohita* and *Cirrhinus mrigala*) and three exotic carps (silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio* var. *communis*) since 1989 in order to augment production of the water body. It was found that the production of lake was enhanced from 825 quintal/year in 1993 to 985 quintal/year in 1998 after stocking the seed of Indian major and exotic carps. Fishermen are rather hesitant to give the exact figure regarding landing/capture of the fish from the lake. Ramgarh lake has become a closed-water body which hardly gets connected with river Rapti. Only excess water of the lake is being discharged by Gurrah nallah during rainy season leaving less scope of the migration/visit of juveniles of the commercially important fishes from the river. Hence culture-based capture fishery is being practiced (Sugunan, 2009) by the fishermen of the Fisheries Cooperative Society (Matsya Jivi Sahakari Samiti), Meharwa-ki-Bari/ or Fisheries Cooperative Society (Matsya Jivi Sahakari Samiti), Surahia Tola, Gorakhpur. Since this lake is getting connected only with river Narayani during high floods, the fish stocking through natural sources rarely occur. This lake received water from river Narayani (Nepal) and Rapti in 1998, 2003 and 2012.

After getting auction from Gorakhpur Development Authority (GDA) on 10.05.2014, the lake has been stocked with the advanced fingerlings of the three Indian major carps, silver carps, grass carp, common carp (less in number) and bighead on 24.06.2014. Advanced fingerlings were supplied from Howrah and Malda (West Bengal) and the suppliers are transporting the seed to the lake site itself by collecting the transportation and packing charges. During the visits, it was found that the exotic

Fig. 32 : Catch of *M. armatus, O. bacaila, M. vittatus etc* from Ramgarh Lake in April 2013.

Fig. 33 : Haul for fishes from Ramgarh Lake during October 2013.

Fig. 34 : Malga/Pataya (*Macrognathus pancalus*).

Fig. 35 : Khosti (*Colisa fasciatus*).

Fig. 36 : Assembly of fishes from Ramgarh Lake in October 2013.

Fig. 37 : Sun-drying of the small fishes caught from Ramgarh Lake during October 2013.

bighead (*Aristicthys nobilis*) locally called "Brigade Fish" grew to the harvestable size (1.250-1.750 kg) within 5-6 months while *Catla catla* could grow to 500-750 g during this period. With this culture practice, the fishermen will get 2 (two) crops of bighead in one year. In market, the price of bighead is Rs. 170/- per kg while the Indian major carps are sold on price of Rs. 210/- per kg.

Auction procedure of the lake: Auction of Ramgarh Lake was initiated by Nagar Nigam, Gorakhpur since 1987 (for 3 years). Preference for leasing is given

Table 4 : Details of fishes assembled in Kuraghat and Dharamsala markets of Gorakhpur in August 2014.

Sl. No.	Fish species	Common name	Nature (live/dead)	Total intake	Total consumption	Source	Price (Rs/kg)
1	*Heteropneustes fossilis*	Singhi	Live	10.0 kg	6.0 kg	Ramgarh Lake/local taal	400
2	*Mastacmbelus armatus*	Kawa	Dead	3.0 kg	2.0 kg	Ramgarh Lake/local river/local taal	120
3	*Pangasius pangasius*	Payas	Dead	5.0 kg	5.0 kg	Ramgarh Lake/local river	150
4	*Pangasius sutchi*	Payas	Dead/live	30.0 kg	25.0 kg	Andhra Pradesh	150
5	*Labeo rohita*	Rohu	Dead/live	120.0 kg	120.0 kg	Local taal	220
6	*Wallago attu*	Padhani	Dead /live	40.0 kg	20-30 kg	Ramgarh Lake/local taal/local river	150
7	*Cirrhinus mrigala*	Nain	Dead	5.0 kg	3.0 kg	Ramgarh Lake/river	180
8	*Channa punctatus*	Girai	Dead	1.0 kg	1.0 kg	Ramgarh Lake/local river	120
9	*Catla catla*	Bhakur	Dead	30.0 kg	25.0 kg	Local taal/ Andhra Pradesh	200
10	*Bagarius bagarius*	Gonch	Dead	10.0 kg	7.0 kg	Local taal/local river	120
11	*Clarias magur*	Magur	Live	03.0 kg	3.0 kg	Local taal	250
12	*Clarias gariepinus*	Videshi Magur	Live	35.0 kg	35.0 kg	Local ponds	240
13	*Mystus vittatus*	Tengana	Dead	8.0 kg	8.0 kg	Ramgarh Lake	250
14	*Channa marulius*	Saur	Live/dead	5.0 kg	4.0 kg	Ramgarh Lake	250
15	*Channa striatus*	Sauri	Live	10.0 kg	10.0 kg	Local pond/local river	170
16	*Mastacem belus aculeatus*	Malga/Ptaya	Dead	2.0 kg	1.5 kg	Ramgarh Lake/local river	120
17	*Notopterus notopterus*	Patra	Dead	10.0 kg	8.0 kg	Local taal/local river	120
18	*Mystus seenghala*	Tengar	Dead	10.0 kg	10.0kg	Ramgarh Lake local river/ local pond	200
19	*Nandus nandus*	Dhebari	Dead	4.0 kg	2.0 kg	Ramgarh Lake/local river	120
20	*Labeo bata*	Kursi	Dead	5.0 kg	4.0 kg	Ramgarh Lake/local river	120
21	*Sciaena coitor*	Patharchatti/ Bhola	Dead	1.0 kg	1.0 kg	Local river	120
22	*Clupisoma garua*	Bekar/karahi	Dead	10.0 kg	10.0 kg	Local pond/local river	160
23	*Rita rita*	Hunna	Dead	10.0 kg	10.0 kg	Local river	160
24	*Cirrhinus reba*	Raiya	Dead	1.0 kg	1.0 kg	Local river/Ramgarh Lake	160
25	*Labeo calbasu*	Karaunchar	Dead	5.0 kg	4.0 kg	Local pond	100
26	*Ailia coila*	Patasi/Minti	Dead	2.0 kg	1.0 kg	Local river	120
27	*Puntius sophore*	Sidhari	Dead	5.0 kg	5.0 kg	Ramgarh Lake/local river	120
28	*Puntius ticto*	Sidhari	Dead	3.0 kg	3.0 kg	Ramgarh Lake/local river	120
29	*Hypophthalamichthys molitrix*	Silver carp	Dead	35.0 kg	30.0 kg	Ramgarh Lake/local ponds	220
30	*Ctenopharyngodon idella*	Grass carp	Dead	25.0 kg	20.0 kg	Ramgarh Lake/local ponds	185
31	*Aristichthys nobilis*	Bighead	Dead/live	35.0 kg	30.0 kg	Ramgarh Lake/local ponds/ Andhra Pradesh	175
32	*Cyprinus carpio*	Common carp	Dead/live	25.0 kg	22.0 kg	Ramgarh Lake/local ponds	155
33	*Piaractus brachypomus*	Pacu (exotic)	Dead	25.0 kg	25.0 kg	Andhra Pradesh	175

Fig. 38 : Sun-drying of the small fishes (SIFs)caught from Ramgarh Lake during November 2013.

Fig. 39 ; Sun-drying of the small fishes (SIFs) caught from the lake during November 2013.

Fig. 40 : Chalhwa (*Oxygaster bacaila*).

Fig. 41 : Rohu (*Labeo rohita*).

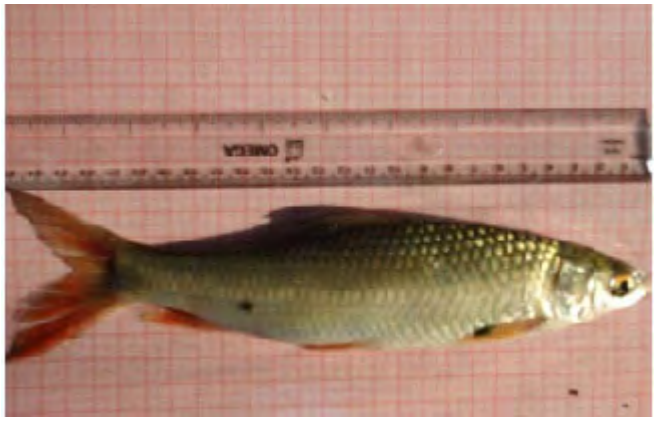

Fig. 42 : Nain (*Cirrhinus mrigala*).

Fig. 43 : Silver carp (*Hypophthalmichthys molitrix*).

to the Fisheries Cooperative Society being operated in Gorakhpur and nearby areas (Table 3). This information was furnished by Sri Mewa Lal Sahani, Former President and Sri Baldeo Sahani, Secretary, Fisheries Cooperative Society (Matsya Jivi Sahakari Samiti), Meharwa-ki-Bari, Kuraghat and Sri Nand Kishore Sahani, President, Fisheries Cooperative Society (Matsya Jivi Sahakari Samiti), Sorahia Tola (near Budhha Vihar), Gorakhpur.

Macrophytes and planktons

Macrophytes : These are the macroscopic plants in water and grow mostly in shallow region of the lake. Submerged aquatic plants of Ramgarh Lake were represented by *Hydrilla verticillata*, *Chara chara* and

Naja minor while floating plants were *Lemina minor Sprirodella polyrrhiza* and *Eichornia crasipes*. The floating plants were drifted with the direction of the wind *e.g.* when the wind is coming from west direction, the floating plants were drifted towards east side of the lake and *vice versa*.

Planktons : These are the microscopic free-floating organisms which are divided into two groups-phytoplankton and zooplankton based on their affinities. Phytoplankton are microscopic autotrophic plants whose movement is dependent on the direction of the water current while zooplanktons are assemblage of minute floating animal forms, though possess locomotory structures but not capable of moving against the water current. Preliminary studies revealed the presence of *Diaptomus*, *Cyclops*, *Ceridaphnia*, *Sida*, *Moina*, *Macrothrix*, Cyclpois cyclops, *Moinodaphnia*, *Horaella*, *Volvox*, *Ulothrix*, *Oscillatoria*, *Nostoc*, *Anabaena*, *Bosmina* and *Brachionus*.

Survey of fish markets : Gorakhpur is an important fish assembling centre in eastern Uttar Pradesh. Fish from Andhra Pradesh are being received at Navin Mandi, Gorakhpur and distributed to Kushinagar, Deoria, Maharajganj, Sant Kabir Nagar, Basti, Siddharthnagar, Gonda, Azamgarh, Mau and Ballia. Fish markets of Kuraghat (morning and evening) and Dharamsala Bazar (evening) were surveyed regularly to record fish diversity of Gorakhpur district. Interestingly, 5-6 small ponds have also been constructed near Fish Market, Kuraghat for keeping the commercially important fish in live condition which are being sold at a little higher price (Rs. 20-30) as compared to the dead ones (Fig. 52-59). Details regarding daily availability of different species of fish in both fish markets of Gorakhpur in August 2014 have been summarized in Table 4. However, it is important to note that the quantum of 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).

It is important to note that the exotic fishes like bighead (*Aristichthys nobilis*) and Sutchi (*Pangasius sutchi*) are being cultured in the ponds of Gorakhpur, Maharajganj and Kushinagar because their breeding (seed production) and culture technologies have been standardized. Further, fish farmers in the region are getting seed supply on their pond site itself from West Bengal (Howrah and Malda) and the fish are attaining marketable size (1.50-1.75 kg) within 5-6 months of stocking of advanced fingerlings. Pacu fish (*Piaractus brachypomus*), an exotic species in Indian waters coming from Andhra Pradesh, is being sold in the markets in name of "Pomfret Fish". This fish is available in both the fish markets of Gorakhpur. This species is also present (but less in quantity) in the markets of Sant Kabir Nagar (Bakhira and Mehdawal), Kushinagar, Deoria and Maharajganj.

Uttar Pradesh has vast potential of aquatic bioresources and offers considerable scope for inland fisheries development and aquaculture (Swarup and Singh, 1976; Yadava and Sugunan, 1992; Pathak *et al*, 2004; Kumar *et al*, 2013). However, information on ichthyofauna 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). The present study revealed the occurrence of 42 native and 5 exotic (total 47) species of fishes in Ramgarh Lake (Gorakhpur) 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. However, 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, Mastacembelidae, Synbranchidae, Belonidae and Tetradontidae) and 40 genera were recorded in Bakhira Lake (Sant Kabir Nagar) (Pandey and Chandra, 2016). Though 5 exotic species, introduced during 1989 for enhancing fish production, were observed in Ramgarh Lake, none of the exotic species encountered from Bakhira Lake during the period under report (Pandey and Chandra, 2016).

Scanning of the literature revealed that very few information is available on fish and fisheries of Rangarh Lake (Swarup, 1967; Srivastava, 1968, 1988; Srivastava *et al*, 2006). However, there existed reports indicating about 24-28% juveniles contributing to the fishery of the lake pointing to indiscriminate exploitation of the fishery resources (Swarup, 1967; Swarup and Rajbanshi, 1970). Swarup (1967) reported the declining trends in the precious carp fishery of Rangarh Lake during sixties

Fig. 44 : Grass carp (*Ctenopharyngodon idella*).

Fig. 45 : Common carp (*Cyprinus carpio* var. *communis*).

Fig. 46 : Sorting and conditioning of fishes near assembling centre, Budhha Vihar (Novembber 2014).

Fig. 47 : Assembling of bighead and exotic fishes in November 2014.

Fig. 48 : Bighead (4.0 kg) caught from Ramgarh Lake (November 2014).

Fig. 49 : *Wallago attu* (8.0 kg) caught from Ramgarh Lake (November 2014).

primarily due to indiscriminate fishing of the juvenile carps 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 *Xenantodon cancila*. Decline in carp fisheries followed by dominance of

catfishes has been reported in Ganga river at Allahabad as changing pattern on time-scale (Dehadrai *et al*, 1994). In 1998, there were about 28 species of fishes in this lake which was reduced to 18 in 2006 (Srivastava *et al*, 2006).

Fish biodiversity of other water bodies (ponds and lakes) have also been documented during the recent years. Verma and Murmu (2010) reported 40 fish species belonging to 7 orders, 15 families and 28 genera from Dimna Lake, East Singhbhum district of Jharkhand based on survey conducted during January-December 2008. During the 8 months (February-September 2011) survey, 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. Pandarkar *et al* (2014) found 15 fish species belonging to 5 orders, 7 families and 12 genera in Vasapur Reservoir, Ahmednagar (Maharashtra) while Devaraju (2014) reported the existence of 29 native (+ 4 exotics) fish species in 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). 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). 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. Harsi Reservoir (Gwalior) harbours 51 species of fishes belonging to 7 orders, 16 families and 33 genera (Prakash, 2015). The observed rich fish diversity of Ramgarh Lake in the present study may probably be due to the high flood in river Narayani (Nepal) and Rapti occurred in 1998, 2003 and 2008 as there are reports on the connectivity of Ramgarh Lake with Rapti river during high floods.

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 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 as reported by Pandey (1999) and 15 species less 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.

There exist reports on the occurrence 87 fish species from eastern part of Uttar Pradesh (Srivastava, 1968) and 111 species have been recorded from Uttar Pradesh and Bihar (Srivastava, 1988) whereas 30 taxa are described in stretches of river Ganga at Allahabad (Srivastava, 2002; Lakra, 2010**)**. Forty five (45) species of fishes have been documented from Hindon river at Saharanpur district of western Uttar Pradesh (Tilak and Juneja, 1990). 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 the occurrence of about 123 fish species in Uttar Prades, however, the recent assessment, Sarkar (2014) recorded 124 species belonging to 26 families and 74 genera from the state with Ganges harbouring 90 species followed by Ghaghara and Gerua with 85 species each. As far species richness is concerned, fishes belonging to Cypriniformes dominated the diversity of Ramgrah Tal with 17 species. 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; Devaraju, 2014; Manickam *et al*, 2014; Pandarkar *et al*, 2014; Rao *et al*, 2014; Rana and Shammi, 2015; Srivastava and Singhal, 2015). Though commercially important fishes are being cultured in Ramgarh Lake, importance of small indigenous freshwater fishes (SIFs) present in this water body for sustained nutritional security of poor people residing in

Fig. 50 : Selling of fishes at assembling centre near Budhha Vihar (November 2014).

Fig. 51 : Packaging of fishes in ice at the assembling centre (November 2014).

Fig. 52 : Fish market near Bichhia nallah at Kuraghat, Gorakhpur.

Fig. 53 : Fishes being kept in live condition at Kuraghat, Gorakhpur.

Fig. 54 : Small ponds constructed near fish market, Kuraghat (Gorakhpur).

Fig. 55 : *Labeo rohita* and *L. calbasu* being sold at Kuraghat, Gorakhpur.

nearby localities may not be overlooked (Sarkar and Lakra, 2010).

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Fig. 56 : Freshly caught *Labeo rohita* being sold in Dharamsala Bazar, Gorakhpur.

Fig. 57 : Different types of fishes in Dharamsala Bazar, Gorakhpur (⟶ Pacu).

Fig. 58 : *Rita rita* (Hunna) in Dharamsala Bazar.

Fig. 59 : *Wallago attu* (5.0 kg) in Dharamsala Bazar.

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