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Review Paper

Review of the Research on the Fish Diversity in the River Mahanadi and Identifying the Probable Potential Ornamental Fishes among them with reference to Threats and Conservation Measures

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Abstract

In the era of globalisation, global warming and climate change are matter of concern to all, whether they are animals, plants or even micro-organisms. Conservation is the only way that presently exists to save the biodiversity. The fish diversity in the Mahanadi River is in no way exceptional from the current impact of global warming and climate change. Although substantial study on fish diversity of the Mahanadi has been undertaken, classifying the existing diversity of fish species in the Mahanadi River into ornamental fishes is an untouched area. It is observed from the information and earlier works done on the fish diversity in the Mahanadi River that a significant number of fish species having potential ornamental properties are there amongst them.

Keywords: Mahanadi, Hirakud, MPEDA, the Suktel, the Jeera, the Jonk, the Ibb, the Ong, and the Tel.

Introduction

The Indian National Biological Diversity Act, 2002 defines biological diversity as 'the variability among living organisms from all sources and the ecological complexes of which they are part and includes diversity with species or between species and of eco system'[1].

Biodiversity is the short form of biological diversity. It is considered as an umbrella term referring to organisms found within the living world, i.e. the number, variety, and variability of living organisms. It may thus be assumed to be a synonym for 'Life on Earth', variety of life and its process, 'condition of being different' or what Darwin exclaimed as 'Life's endless forms'. In the words of Frankel, biodiversity is indeed 'the essence of life'. In reality however, biodiversity is a very vast and complex concept and its ramifications extend deep into all spheres of human life and activity. Biodiversity is normally treated in terms of genes, species and ecosystems in correspondence with the three fundamental hierarchical levels of biological organisation; these three diversities are respectively referred to as Genetic, Species and Ecosystem diversities. According to di Castri and Younes, biodiversity should not be construed as a 'simple umbrella covering a mosaic of heterogeneous activities', but should represent a composite entity 'shaped by the interactions'[2].

Studies of freshwater fishes in the Indian subcontinent have been limited to scattered works on commercial fisheries and even these have been largely restricted to some of major river systems like Ganges and the Yamuna. Out of the 2500 species of fishes that have been recognised in the Indian subcontinent, 930 are categorised as freshwater species. Looking at the history of freshwater fish studies in India, the interest of the British officers working in India in natural history of the region was significant move in this direction. Some early contributions were those of Hamilton-Buchanan in the 'Fishes of the Ganges' (1822) and by others like McClelland, Sykes and Jerdon. Besides, the work of Francis Day in his publication 'Fishes of India' (1875-1878) is a quite significant contribution in this area. Quite a good amount of literature is currently available on Indian fishes especially on identification and systematics of freshwater fishes of India which starts from Hora's contribution during 1920-1950s to very recent texts by Talwar and Jhingran and Jayaram[3-6].

Qualitative works on the fish diversity of the Mahanadi River have been undertaken specifically classifying them into respective families, but categorising them as ornamental fishes has not been done so far. Studies on the biodiversity of ornamental fishes in the Mahanadi River along with their economic importance are yet to be undertaken. Categorising the ornamental fishes from the so far reported fish diversity of the Mahanadi River is a step forwarded in this direction.

About the Mahanadi

The name 'Mahanadi' is derived from Sanskrit words "*Maha*" (great) and "*Nadi*" (river). Among the rivers of India, the Mahanadi River is the third largest in the peninsular region of

India. It has a spread of drainage area more than 132,000 km^2 starting from the Bastar Hills of Chhattisgarh passing through different geological formations of Eastern Ghats and the adjacent areas and finally joins the Bay of Bengal by different branches passing along the coastal line of Cuttack and Puri districts of Odisha. The length of the river is about 860 km. Its drainage basin ($80^0$30'- $86^0$50'E and $19^0$20'- 23^0 35' N) is shared by the States of Maharashtra, Chhattisgarh, Jharkhand and Odisha. The basin lies in the States of Chhattisgarh (75136 km^2), Odisha (65580 km^2), Jharkhand (635 km^2) and Maharashtra (238 km^2). It has an annual runoff of 50×10^9 m^3 with a peak discharge of 44740 m^3 s^{-1}. Near the city of Sambalpur, a large dam known as the Hirakud Dam was built on the river in 1957. Hirakud is a big reservoir for fishes, located at 80^0 E longitudes and 21^0 30'N latitude. The catchments area of the reservoir is 83395 km^2 with a shore line of 643.6 km. The Mahanadi and the Brahmani rivers together form a large delta where they meet the Bay of Bengal. The Cuttack city lies at the head of this delta. The delta extends over an area of 141589 km^2 which is nearly 4.3 % of the total geographical area of the country. The main branches of the Mahanadi River meet Bay of Bengal at Paradeep and Nuagarh (Devi estuary). An average annual surface water potential of 63.9 km^3 has been assessed in this basin, out of which 50 km^3 is utilizable water and about 80000 km^2 is culturable area. Presently use of surface water in the basin is 17 km^3. The main tributaries of River Mahanadi are the Suktel, the Jeera, the Jonk, the Ibb, the Ong, and the Tel. Besides, there are a number of seasonal rainfed streams which are locally called as nallahs[7-10].

Review of Research on Fish Diversity of the Mahanadi River

Substantial studies on the fish diversity of the Mahanadi River have been undertaken by many researchers. The first study on the fish diversity of the Mahanadi River was carried out by Day who reported 146 species mostly collected from Cuttack region. Hora reported 43 species; Chouhan listed 54 fish species from the Tel River, a tributary of river Mahanadi. In the year 1955, Job *et al*., reported more than 103 species after a comprehensive study in a stretch of the Mahanadi. Out of these 103 species, 24 were of economic importance like *Notopterus chitala*, *Puntius sarana*, *Catla catla*, *Labeo boggut*, *Labeo fimbriatus*, *Labeo calbasu*, *Mystus aor*, etc. Further, they reported that *L. fimbriatus* and *L. calbasu* were the most common representatives of the catch. Jayaram and Majumdar reported 42 fish species. Then in 2004, Desai and Shrivastava reported 48 fish species from the Mahanadi River basin. Om Prakash *et al.,* reported 65 fish species. Subsequently, Tamboli and Jha reported 58 fish species in the Mahanadi River in Janjgir-Champa district of Chhattisgarh[4-15].

Hirakud Reservoir and its Fishery: At a Glance

In the year 1957, Odisha got the first major irrigation reservoir commissioned in the Hirakud, which situated in Sambalpur, Jharsuguda and Bargarh districts of Odisha. It stands largest man made reservoir in Asia with the longest dam in the world. It was formed damming the confluence of rivers the Mahanadi and the Ib at Hirakud with location of 21^0 30' N Latitude and 80^0 E Longitude. The reservoir has a water spread area of 463 km^2. The catchment area of the reservoir is 83,395 km^2 with shore line of 643.6 km. The objective of constructing the dam was for controlling flood, irrigation and hydroelectricity production as well as fish production[16].

The commercial fishery of Hirakud Reservoir comprises nearly 40 species, a few important ones *are Catla catla, Labeo rohita, L. gonius, L. fimbriatus, L. calbasu, L. bata, Cirrhinus mrigala, C. reba, Notopterus notopterus, N. chitala, Channa gachua, Channa punctatus, Channa striatus, Clarias batrachus, Heteropneustes fossilis, Wallago attu, Tor mosal, Ompok bimaculatus, Mystus tengara, Silonia silonia* etc.[10] After commissioning of the reservoir in the year 1957, the fish fauna of the Mahanadi River system underwent a significant change. A large number of fish and prawn species have been already affected. These include fishes like Tor mosal, Hilsa ilisha, and prawns like Macrobrachium malcolmsonii etc.[13] Exotic fish like silver carp (*Hypophthalmichthys molitrix*) is also found in the Mahanadi River. The Mahseer fish (*Tor mosal*) which is also called as Kudo, occupies a significant position in terms of its availability in the reservoir[9].

Status of Ornamental Fishes in India

Ornamental fish farming is an important commercial component of aquaculture providing aesthetic requirements and up-keeping of environment. Aquarium keeping of fishes began in 1805. The first public aquarium display opened at Regent's Park in England in 1853. Profit from the genetic manipulation of fish to breed in captivity has landed only in the hands of the ornamental fish breeders. National University of Singapore created transgenic green and red fluorescent versions of the black and white Zebra fish by permanently embedding a green fluorescent gene from the jellyfish and red colour from Sea anemone. We may loose our indigenous stocks for which many organizations in the world are now spending millions towards conservation of such endangered stocks as germplasm conservation[17].

India has very rich freshwater fishery resources, comprising 2.3 million ha ponds and tanks, 1.3 million ha of beels, jheels and derelict waters and 3.0 million ha of reservoirs. Indian rivers are richer with qualitative ornamental fishes in respect of their docile nature, characters suitable for domestication with, fascinating, attractive and brilliant colouration and potentiality for developing techniques for captive breeding. However, no attempt has so far been made to introduce most of these species in the international trade and securing positions in the national as well as international markets for which they deserve[18].

Table-1
Fish diversity recorded by various workers in the Mahanadi River Basin

Sl. No.	Name of the species	Hora (1940)	Jayaram and Majumdar (1976)	Desai and Shrivastava (2004)	Om Prakash, Singh, Vardia, Chari (2004)	Tamboli and Jha (2010)
	Family-Clupeidae					
1	*Gonialossa manmina* (Ham.)	-	+	-	-	-
2	*Gudusia chapra* (Ham.)	-	-	+	+	+
	Family –Notopteridae					
3	*Chitala chitala* (Ham.)	+	-	-	+	+
4	*Notopterus notopterus* (Pallas)	-	+	+	+	+
	Family-Cyprinidae					
5	*Amblypharyngodon mola* (Ham.)	+	+	+	+	+
6	*Aspidoparia morar* (Ham.)	-	+	+	-	-
7	*Barilius bendelisis* (Ham.)	+	+	+	+	+
8	*Barilius barna* (Ham.)	+	+	-	-	-
9	*Barilius barila* (Ham.-Buch.)	-	-	+	-	-
10	*Barilius vagra* (Ham.)	-	+	-	-	-
11	*Catla catla* (Hum.)	-	+	+	+	+
12	*Chela (Laubuca) lubuca* (Hum.)	+	-	+	-	-
13	*Cirrhinus mrigala* (Ham.)	-	-	+	+	+
14	*Cirrhinus reba* (Ham.)	-	-	+	+	+
15	*Ctenophryngodon idella* (Val.)	-	-	-	+	-
16	*Cyprinus carpio* (Linn.)	-	-	-	+	+
17	*Danio aequipinnatus*	+	-	-	-	-
18	*Danio devario* (Ham-Buch.)	-	-	+	+	-
19	*Danio (Brachydenio) rerio* (Ham.)	+	+	-	-	-
20	*Esomos danricus* (Ham.)	+	+	+	-	-
21	*Garra annandalei* (Hora)	-	-	-	+	+
22	*Garra gotyla gotyla* (Gray)	-	-	+	-	-
23	*Garra mullya* (Sykes)	+	-	-	-	-
24	*Gonoproktoptreus kolus* (Sykes)	-	-	-	+	-
25	*Hypophthalmichthys molitrix* (Val.)	-	-	-	+	-
26	*Hypophthalmichthys molitrix* (Rich.)	-	-	-	+	-
27	*Labeo angra* (Ham.)	-	-	-	+	-
28	*Labeo bata* (Ham.)	-	+	+	+	+
29	*Labeo boga* (Bloch)	-	-	-	+	-
30	*Labeo boggut* (Sykes)	+	-	-	+	+
31	*Labeo calbasu* (Ham.)	-	-	+	+	+
32	*Labeo fimbriatus* (Bloch)	-	-	+	-	-
33	*Labeo gonius* (Ham.)	-	-	+	+	+
34	*Labeo rohita* (Ham.)	-	+	+	+	+
35	*Orichthys cosuatus* (Ham.)	+	-	-	-	-
36	*Osteobrama cotio* (Ham.)	-	+	+	+	+
37	*Osteobrama vigorsii* (Sykes)	-	-	+	-	-
38	*Parluciosoma daniconius* (Ham.-Buch.)	+	+	+	+	+
39	*Puntius chola* (Ham.)	-	-	-	+	+
40	*Puntius dorsalis* (Jerdon)	+	-	-	+	-
41	*Puntius gelius* (Ham.)	+	+	-	-	-
42	*Puntius guganio* (Ham-Buch.)	+	-	+	-	-
43	*Puntius phutunio* (Ham-Buch)	-	-	+	-	-
44	*Puntius sarana* (Ham- Buch)	+	+	+	+	+
45	*Puntius sophore* (Ham.)	+	+	+	+	+
46	*Puntius tetraripagus* (Macclelland)	+	-	-	-	-
47	*Puntius ticto* (ham.)	+	+	+	+	+
48	*Salmostoma bacaila* (Ham.)	+	+	+	+	+
49	*Salmostoma phulo* (Ham-Buch.)	-	-	+	-	-
	Family- Amblycepidae					

Sl. No.	Name of the species	Hora (1940)	Jayaram and Majumdar (1976)	Desai and Shrivastava (2004)	Om Prakash, Singh, Vardia, Chari (2004)	Tamboli and Jha (2010)
50	*Amblyceps mangois* (Ham.)	+	-	-	-	-
	Family- Cobitidae					
51	*Lepidocephalichthys guntea* (Ham.)	+	+	+	+	+
52	*Noemacheilus botia* (Ham.)	+	-	-	+	+
53	*Noemacheilus denisonii* (Day)	+	-	+	-	-
	Family- Siluridae					
54	*Ompok bimaculatus* (Bloch)	-	+	+	+	+
55	*Ompok pabda* (Ham.)	-	-	-	-	+
56	*Ompok pabo* (Ham.)	-	-	-	-	+
57	*Wallago attu* (Bl. & Schn.)	-	+	+	+	+
	Family Bagridae					
58	*Mystus (Aorichthys) aor* (Ham.)	+	-	+	+	+
59	*Mystus (Aorichthys) seenghala* (Sykes)	-	+	+	+	+
60	*Mystus bleekeri* (Day)	-	-	+	+	+
61	*Mystus cavassius* (Ham.)	+	+	+	+	+
62	*Mystus tengara* (Ham.)	+	+	-	+	+
63	*Mystus vitatus* (Bloch)	+	+	+	+	+
64	*Rita rita* (Ham)	-	-	-	+	+
65	*Rita chrysea* (Day)	-	+	-	-	-
	Family-Sisoridae					
66	*Bagarius bagarius* (Ham.)	+	-	-	-	+
67	*Eriethistes hara* (Ham.)	+	-	-	-	-
68	*Gagata cenia* (Ham.)	-	+	-	-	-
	Family-Schilbeidae					
69	*Ailia coila* (Ham.)	-	+	-	-	+
70	*Clupisoma bastari* (Dutta & Karmakar)	-	-	+	-	-
71	*Clupisoma garua* (Ham.)	-	+	-	-	-
72	*Eutropiichthys vacha* (Ham.)	-	-	-	+	+
73	*Pseudeotropuis atherinoides* (Bloch)	+	-	-	+	-
	Family- Pangasiidae					
74	*Pangasius pangasius* (Ham.)	-	-	-	+	-
	Family-Saccobranchidae					
75	*Heteropneustes fossilis* (Bloch)	+	-	-	+	+
	Family-Claridae					
76	*Clarias batrachus* (Linn.)	+	+	-	+	+
77	*Clarias gariepinus* (Linn.)	-	-	-	+	+
	Family-Belonidae					
78	*Xenentodon cancila* (Ham.)	+	+	+	+	+
	Family- Mugilidae					
79	*Rhinomugil corsula* (Ham.)	-	+	+	+	+
	Family-Channidae					
80	*Channa gachua* (Ham.)	+	-	-	+	+
81	*Channa marulius* (Ham.)	-	-	-	+	-
82	*Channa orientalis* (Bl. & Schn.)	-	-	+	-	-
83	*Channa punctatus* (Bloch)	+	+	-	+	+
84	*Channa striatus* (Bloch)	-	+	+	+	+
	Family-Centropomidae					
85	*Chanda nama* (Ham.)	-	+	+	+	+
86	*Chanda ranga* (Ham.)	+	+	+	+	+
	Family-Sciaenidae					
87	*Sciaena coitor* (Ham.)	-	-	-	-	+
	Family- Nandidae					
88	*Badis badis* (Ham)	+	+	-	-	-
89	*Nandus nandus* (Ham.)	+	-	+	+	+
	Family- Cichlidae					
90	*Oreochromis mossambicus* (Peters)	-	-	-	+	+

Sl. No.	Name of the species	Hora (1940)	Jayaram and Majumdar (1976)	Desai and Shrivastava (2004)	Om Prakash, Singh, Vardia, Chari (2004)	Tamboli and Jha (2010)
91	*Oreochromis niloticus* (Linn.)	-	-	-	+	-
	Family- Anabantidae					
92	*Anabas oligolepis* (Bleeker)	-	-	-	+	-
93	*Anabas testudineus* (Bloch)	-	-	-	+	+
94	*Colisa fasciatus* (Bl.& Schn.)	-	-	-	+	+
	Family- Gobiidae					
95	*Glossogobius giuris* (Ham.)	+	+	+	+	+
	Family-Mastacembelidae					
96	*Macrognathus aculeatus (Bloch)*	+	+	-	+	+
97	*Mastacembelus armatus* (Lacepede)	+	+	+	+	+
98	*Mastacembelus puncalus* (Ham.)	+	+	+	+	+
	Family- Tetrodontidae					
99	*Tetraodon cutcutia*	-	-	-	-	+
Total		**43**	**42**	**48**	**65**	**58**

(+) = Reported, (-) = Not Reported, Source: Tamboli and Jha

The hobby of ornamental fish keeping in India is nearly seventy years old. As the days passed, the ornamental fish keeping and its propagation became an interesting activity of many by providing financial openings. Out of the 800 ornamental fish species from various aquatic environments seen in the world, it is estimated that more than 100 varieties of indigenous ornamental fishes are available in our freshwater ecosystem in addition to an equal number of exotic species that are bred in captivity [17, 18].

Some of the Indian freshwater ornamental fishes are *Labeo dyocheilus* (McClelland), *Danio devario* (Hamilton-Buchanan), *Brachydenio rerio* (Hamilton-Buchanan), *Nemacheilus corsica* (Hamilton-Buchanan), *Nemacheilus savona* (Hamilton-Buchanan), *Botia rostrata* (Gunther), *Mystus vitatus* (Bloch), *Ompok pabda* (Hamilton-Buchanan), *Wallago attu* (Schneider), *Glyptothorax saisii* (Jenkins), *Xenentodon cancila* (Hamilton-Buchanan) etc.[17-19].

Export Potential and World Trade of Ornamental Fishes

The trade in ornamental fish has been increasing globally since 1985. The value of international trade has increased steadily, touching US$ 350 million in 2007. Developing nations contributed two third of the total export value[20]. The wholesale value of the global ornamental fish trade is estimated to be US$ 1 billion while the retail value is US$ 6 billion. The entire industry, including accessories and fish feed, is estimated to be worth around US $ 18-20 billion. More than 2,500 species are traded and some 30-35 species of fresh water fish dominate the market. While more than 90 percent of freshwater fish are captive bred, only 25 out of nearly 8,000 marine ornamentals fishes are bred in captivity. The trade of ornamental fish with an annual growth rate of 8 percent offers a lot of scope for development of the sector[17].

About 120 countries import ornamental fishes. The major importer is the EU, followed by North America and Japan. UK with 19% and Germany with 18% of the trade share are the major markets in EU. France, the Netherlands, Belgium, Spain and Italy are also among the major importers of ornamental fishes. USA is the largest player in North America with over 85% of the import share. Singapore is the largest exporter for many years and exports more than double that of the top five exporters for the last 2-3 decades. Singapore is regarded as a major trade hub in the region[17,20].

As per the statistics of the Marine Product Export Development Authority (MPEDA) of India (2000-2001), India exports ornamental fishes worth about Rs. 22.8 million, to Japan (24.1%), Singapore (20.2%), the USA (19.7%), China (10.5%), Germany (6.1 %), UK (4.4%), Taiwan (6.4%), Thailand (2.6%), Hong Kong (2.6%), Sri Lanka (1.3%), the Netherland (1.2%),France (0.8%), Bangladesh (0.8%), Belgium (0.7%), Malaysia (0.7%), Nepal (0.6%), Switzerland (0.2%), Finland (0.2%) and Maldives (0.1%). In the year 2009, the Indian exported ornamental fishes valued at more than Rs. 50 million [17, 18].

Status of Ornamental Fishes in the Mahanadi River

Although a variety of potential ornamental fishes are found in the River Mahanadi, no study has been undertaken on the status of ornamental fish diversity of the Mahanadi River. The present investigation is a first step towards identifying the ornamental fish species from amongst the fish diversity of the Mahanadi River reported so far.

Identification of the Ornamental Fish Diversity from the Review of Research

The identification presented in table-2 is based on the reference to different published work related to this as well as the website of IUCN Red List of Threatened Species, Version-3, 2012-2 and the website of Fish Base[17,18-24].

Table-2
Identifying ornamental fishes from the reported fish diversity by various workers in the Mahanadi River

Sl. No.	Name of the species	Ornamental/ Food Fish	IUCN Status
1	*Ailia coila* (Ham.)	Food Fish	NT
2	*Amblypharyngodon mola* (Ham.)	Ornamental	LRlc
3	*Amblyceps mangois* (Ham.)	Ornamental/ Food Fish	LRnt
4	*Anabas oligolepis* (Bleeker)	Ornamental	DD
5	*Anabas testudineus* (Bloch)	Ornamental	VU
6	*Aspidoparia morar* (Ham.)	Ornamental/ Food Fish	LRlc
7	*Badis badis* (Ham)	Ornamental	LRlc
8	*Bagarius bagarius* (Ham.)	Ornamental/ Food Fish	LRnt
9	*Barilius bendelisis* (Ham.)	Ornamental	LRnt
10	*Barilius barna* (Ham.)	Ornamental	LRnt
11	*Barilius barila* (Ham.-Buch.)	Ornamental	LRlc
12	*Barilius vagra* (Ham.)	Ornamental	LRlc
13	*Catla catla* (Hum.)	Food	VU
14	*Chanda nama* (Ham.)	Ornamental	LRlc
15	*Chanda ranga* (Ham.)	Ornamental	LRlc
16	*Channa gachua* (Ham.)	Food Fish	VU
17	*Channa marulius* (Ham.)	Food Fish	LRnt
18	*Channa orientalis* (Bl. & Schn.)	Food Fish	VU
19	*Channa punctatus* (Bloch)	Food Fish	LRnt
20	*Channa striatus* (Bloch)	Food Fish	LRlc
21	*Chela (Laubuca) lubuca* (Hum.)	Ornamental	LRlc
22	*Cirrhinus mrigala* (Ham.)	Food Fish	LRlc
23	*Cirrhinus reba* (Ham.)	Food Fish	VU
24	*Clarias batrachus* (Linn.)	Ornamental/Food Fish	VU
25	*Clarias gariepinus* (Linn.)	Food Fish	Introduced
26	*Clupisoma bastari* (Dutta & Karmakar)	Food Fish	EN
27	*Clupisoma garua* (Ham.)	Food Fish	VU
28	*Colisa fasciatus*** (Bl.& Schn.)	Ornamental	LRnt
29	*Ctenophryngodon idella* (Val.)	Food Fish	Introduced
30	*Cyprinus carpio* (Linn.)	Ornamental/Food Fish	VU
31	*Danio aequipinnatus*	Ornamental	LRlc
32	*Danio devario* (Ham-Buch.)	Ornamental	LRlc
33	*Danio (Brachydenio) rerio* (Ham.)	Ornamental	LRlc
34	*Eriethistes hara* (Ham.)	Ornamental	DD
35	*Esomos danricus* (Ham.)	Ornamental	LRlc
36	*Eutropiichthys vacha* (Ham.)	Food Fish	LRlc
37	*Gagata cenia* (Ham.)	Food Fish	LRlc
38	*Garra annandalei* (Hora)	Ornamental	LRlc
39	*Garra mullya* (Sykes)	Ornamental	LRlc
40	*Garra gotyla gotyla* (Gray)	Ornamental	VU
41	*Glossogobius giuris* (Ham.)	Ornamental/Food Fish	LRlc
42	*Gonoproktoptreus kolus* (Sykes)	Food Fish	EN
43	*Gonialossa manmina* (Ham.)	DD	DD
44	*Gudusia chapra* (Ham.)	Food Fish	LRlc
45	*Heteropneustes fossilis* (Bloch)	Ornamental/Food Fish	VU
46	*Hypophthalmichthys molitrix* (Rich.)	Food Fish	Introduced
47	*Hypophthalmichthys molitrix* (Val.)	Food Fish	Introduced
48	*Labeo angra* (Ham.)	Food Fish	LRlc
49	*Labeo bata* (Ham.)	Food Fish	LRlc
50	*Labeo boga* (Bloch)	Food Fish	LRlc

Sl. No.	Name of the species	Ornamental/ Food Fish	IUCN Status
51	*Labeo boggut* (Sykes)	Food Fish	LRlc
52	*Labeo calbasu* (Ham.)	Food Fish	LRnt
53	*Labeo fimbriatus* (Bloch)	Food Fish	LRlc
54	*Labeo gonius* (Ham.)	Food Fish	LRlc
55	*Labeo rohita* (Ham.)	Food Fish	LRlc
56	*Lepidocephalichthys guntea* (Ham.)	Ornamental	LRlc
57	*Macrognathus aculeatus (Bloch)*	Ornamental/Food Fish*	NE
58	*Mastacembelus armatus* (Lacepede)	Ornamental/Food Fish	LRlc
59	*Mastacembelus puncalus* (Ham.)	Food Fish	LRlc
60	*Mystus (Aorichthys) aor* (Ham.)	Food Fish	DD
61	*Mystus (Aorichthys) seenghala* (Sykes)	Food Fish	LRlc
62	*Mystus bleekeri* (Day)	Ornamental	LRlc
63	*Mystus cavassius* (Ham.)	Food Fish	LRnt
64	*Mystus tengara* (Ham.)	Food Fish	LRlc
65	*Mystus vitatus* (Bloch)	Ornamental	LRlc
66	*Nandus nandus* (Ham.)	Ornamental	LRnt
67	*Noemacheilus botia* (Ham.)	Ornamental	LRnt
68	*Noemacheilus denisonii* (Day)	Ornamental	VU
69	*Notopterus chitala* (Ham.)	Ornamental/Food Fish	LRnt
70	*Notopterus notopterus* (Pallas)	Ornamental/Food Fish	LRnt
71	*Ompok bimaculatus* (Bloch)	Ornamental/Food Fish	VU
72	*Ompok pabda* (Ham.)	Food Fish	LRnt
73	*Ompok pabo* (Ham.)	Food Fish	LRnt
74	*Oreochromis mossambicus* (Peters)	Food Fish	Introduced
75	*Oreochromis niloticus* (Linn.)	Food Fish	Introduced
76	*Orichthys cosuatus* (Ham.)	Ornamental	DD
77	*Osteobrama cotio* (Ham.)	Ornamental	VU
78	*Osteobrama vigorsii* (Sykes)	Food Fish	LRlc
79	*Pangasius pangasius* (Ham.)	Ornamental/Food Fish	CR
80	*Parluciosoma daniconius* (Ham.-Buch.)	Ornamental	LRlc
81	*Pseudeotropuis atherinoides* (Bloch)	Ornamental	LRlc
82	*Puntius chola* (Ham.)	Ornamental	VU
83	*Puntius dorsalis* (Jerdon)	Ornamental	VU
84	*Puntius gelius* (Ham.)	Ornamental	LRlc
85	*Puntius guganio* (Ham-Buch.)	Food Fish*	LRlc
86	*Puntius phutunio* (Ham-Buch)	Ornamental	LRlc
87	*Puntius sarana sarana* (Ham- Buch)	Food Fish	VU
88	*Puntius sophore* (Ham.)	Ornamental	LRnt
89	*Puntius tetraripagus* (Macclelland)	DD	DD
90	*Puntius ticto* (ham.)	Ornamental	LRlc
91	*Rhinomugil corsula* (Ham.)	Food Fish	LRlc
92	*Rita rita* (Ham)	Food Fish	LRlc
93	*Rita chrysea* (Day)	Food Fish	LRlc
94	*Salmostoma bacaila* (Ham.)	Food Fish	LRlc
95	*Salmostoma phulo* (Ham-Buch.)	Food Fish	LRlc
96	*Sciaena coitor* (Ham.)	Food Fish	LRlc
97	*Tetraodon cutcutia*	Ornamental	LRlc
98	*Tor mosal*	Food Fish	VU
99	*Wallago attu* (Bl. & Schn.)	Food Fish	LRnt
100	*Xenentodon cancila* (Ham.)	Ornamental	LRlc

CR-Critically Endangered**, EN-**Endangered, **VU**-Vulnerable, **LRnt**- Low Risk, near threatened, **LRlc-** Low Risk, least concern, **DD**-Data Deficient, ***** Less important

Conservation of the Fish Diversity of Mahanadi

According to Mahapatra the fish catch in the Hirakud Reservoir has declined substantially in 1981-2001. This decline in catch has been attributed to indiscriminate fishing irrespective of species, fishing by using nets with small mesh size, lack of recruitment, lack of closed fishing season during monsoon etc. The catch assessment of the reservoir reveals that nearly all varieties of major carps and economically important cat fishes are facing threat of extinction[9,22,24].

Besides the above, fishing using chemicals as poisons, insecticides, poisons of plant origin, using dynamiting and electro fishing are major threats to the fish diversity. Introduction of alien fish species also possess threats to the endemism of the fish diversity [25].

Considering the above facts, need of the hour is to adopt rational methods and new technology in the fishing as first step towards conservation of fish diversity of the river Mahanadi. Mahapatra (2003) has suggested a few effective measures, some of which are: i. Complete ban on the operation of fine meshed shore-seines, ii. Dragnets with permissible mesh size may be permitted, iii. Operation of gill nets of less than 4" mesh size may be banned throughout the year. iv. Operation specific gear may be encouraged to catch catfish so as to facilitate development of Indian major carp fisheries. v. Know how should be developed for captive breeding and broodstock development of economically important fishes so that these species can be conserved from endangered. Management measures aimed at conserving freshwater fishes should be part of fishery policies of Governments. The broodstock maintenance centre and hatcheries should be established exclusively for endangered and critically endangered indigenous fishes for their *in-situ* conservation. Besides, investigation of the invasive nature of exotic species in the natural habitats should be carried out with a view to establish the nature of their natural breeding populations and the extent to which their feed habits overlap with the endemic population[23-30].

Conclusion

The present review of literature/ published work on fish diversity of the Mahanadi River indicates that the Mahanadi River is endowed with a wide variety of endemic fish species. A significant number of these fishes are considered ornamental species. The economic potential of these ornamental fishes may be used for the domestic market in the first place for aquarium purpose. A study on the potential ornamental fishes in the Mahanadi River alongwith their habit and habitat would be required for making assessment of their export potential for aquarium purpose besides looking at demand in the international market. Further, in order to increase their demand in the international market, indigenous methods of rearing should be developed alongwith breeding possibility. This would not only lead to restricted imports of exotic ornamental fishes but also reduce the risk of ingress of diseases in aquatic sector which may linked to such imports.

References

1. Ministry of Environment and Forest, Government of India, 2013, Available at http://envfor.nic.in/modules/rules-and-regulations/bio-diversity **(2013)**

2. Krishnamurthy K.V., Text Book of Biodiversity, Science Publishers, Inc., Enfield, New Hampshire- 03784, United States of America (**2003)**

3. Jayaram K.C., The freshwater fishes of the Indian Region, Narendra Publishing House, New Delhi (**1999**)

4. Tamboli R.K. and Jha Y.N., Status of piscine diversity of river Mahanadi in Janjgir-Champa District, *Int. Res. J. Lab to Land*, **2(6)**, 139-143 **(2010)**

5. Day F., Fauna of British India, Including Ceylon and Burma, *Fishes*, **1 and 2**, Taylor and Francis, London **(1889)**

6. Tamboli R.K. and Jha Y.N., Status of cat fish diversity of river Kelo and Mand in Raigarh District, CG, India, *ISCA Journal of Biological Sciences*, **1(1),** 71-73 **(2012)**

7. Radhakrishna, Saline Freshwater Interface Structure in Mahanadi Delta Region, Orissa, India, *Environmental Geology* **40(3)**, 369-380 **(2001**)

8. Badapanda H.S., The Fishery and Biology of Mahanadi Mahseer Tor mosal mahanadicus (David), *Indian J. Fish*., **43(4**), 325-331 **(1996)**

9. Mahapatra D.K., Present Status of Fisheries of Hirakud Reservoir, Orissa, *The Fishing Chimes*, **22(10&11)**, 76-79 **(2003)**

10. Sugunan V.V., Reservoir fisheries of India, Fisheries Aquaculture Department, FAO Corporate Documentary Repository, FAO, Rome (**1995)**

11. Hora S.L. and Law N.C., The freshwater fishes of Travancore, *Rec. Ind. Mus*., **43**, 233-256 **(1941)**

12. Talwar P.K. and Jhingran K.C., Inland fishes of India and adjacent countries, 3(1 and 2), Oxford and IBH Co. Pvt. Ltd., New Delhi **(1991**)

13. Rasid A. and Tripathy P.K., On Mahseer of Hirakud, *The Fishing Chimes*, **25(5)**, **(2005)**

14. Desai V.R. and Shrivastava N.P., Ecology of Fisheries of Ravishankar Sagar, Reservoirs, Central Inland Fisheries Research Institute (CFRI), Kolkata, Bull No.126, 1-37 **(2005)**

15. David A., On some new records of fish from the Damodar and the Mahanadi river systems, *J. Zool. Soc. India*, **5(2) (1953)**

16. Pati B. and Biswal M., Hirakud Dam: Fifty Mournful Years, *Dams Rivers & People*, June-August, 7-11 **(2009)**

17. The Marine Products Development Authority (MPEDA) of India, Available at http://www.mpeda.com **(2013)**

18. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India, Available at: http://www.dahd.nic.in **(2013)**

19. Kurup B.M. and Radhakrishnan K.V., Indigenous ornamental fish resources of Western Ghats with special reference to Kerala, Souvenir of Ornamentals Kerala, *International Seminar on Ornamental Fish Breeding, Farming and Trade*, Department of Fisheries, Government of Kerala, Cochin, India (**2006)**

20. Food and Agriculture Organisation, Available at: http://www.fao.org **(2013)**

21. Fish Base, Available at: http://www.fishbase.org/search.php **(2013)**

22. Radhakrishnan K.V. and Kurup B.M., Distribution and stock size of freshwater ornamental fishes of Kerala (S India) with special reference to sustainability issue, Sustain Fish - International Symposium on Improved Sustainability of fish production systems and appropriate technologies for utilization, 589-605 **(2006)**

23. IUCN, IUCN Red List of Threatened Species (ver.3 2012.2), Available at: http://www.iucnredlist.org **(2013)**

24. Sarkar U.K. and Ponniah A.G., Fish biodiversity of north east of India, NBFGR's NATP special publication No. 2, National Bureau of Fish Genetic Resources, 1- 228 **(2000)**

25. Kurup B.M., Radhakrishnan K.V., and Manojkumar T.G., Biodiversity status of fishes inhabiting rivers of Kerala (S. India) with special reference to endemism, threats and conservation, *Proceedings of the Second International Symposium on the Management of Large Rivers for fisheries* (Vol.II), FAO Corporate Documentary Repository, Produced by Regional Office for Asia and the Pacific, 164-182 **(2004)**

26. Bhat A., Diversity and composition of freshwater fishes in river systems of Central Western Ghats, India, *Environmental Biology of Fishes,* **68**, 25-38 **(2003)**

27. Chandanshive N.E., The Seasonal Fluctuation of Physico-Chemical parameters of River Mula-Mutha at Pune, India and their Impact on Fish Biodiversity, *ISCA Research Journal of Animal, Veterinary and Fisheries Sciences,* **1(1**), 11-16, **(2013)**

28. Gadhavi M.K., Kardani H.K., Pathak R., Prajapati P.C. and Vachhrajani K.D., Impact of Trawl Fish Ban on Artisanal Brachuran Crab Fishery in and Around Sikka, Gulf of Kutch, Gujarat, India*, ISCA Research Journal of Animal, Veterinary and Fisheries Sciences,* **1(1)**, 22-27 **(2013)**

29. Khatri P.C., The Distribution and Status of Cinereous Vulture (*Aegypius monachus*), at Jorbeer, Bikaneer, Rajasthan, India: A study of Near Threatened Monk Vulture*, ISCA Research Journal of Animal, Veterinary and Fisheries Sciences,* **1(1),** 17-21 (**2013**)

30. Theurkar S.V., Takalakar D.L., Jadhav S.S. and Pawar R.M., Diversity and Composition of Fisheries of Chaskaman Dam, Rajgurunagar, part of Northern Western Ghats, Pune, MS, India, *ISCA Res. J. Animal, Veterinary & Fisheries Science,* **1(1),** 7-10 **(2013)**