ISSN 0375-1511

Rec. zool. Surv. India : **113**(Part-3):79-92, 2013

INVENTORY OF ENDEMIC FRESHWATER FISH FAUNA OF MAHARASHTRA STATE: INDIA

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INTRODUCTION

Freshwater systems are amongst the most vulnerable natural systems on the earth spread over 0.8% of Earth's surface, cover 0.01% of world's water resource. It provide sole habitat for extremely rich, endemic, and sensitive biota, estimated to harbour around 6% of all described species (Dudgeon *et. al.*, 2005; Strayer & Dudgeon, 2010). In recent times anthropogenic activities and climatological changes are driving its biodiversity under severe crises and thus making it the most endangered natural system in the world (Suski and Cooke, 2007, Sarkar *et. al.*, 2008, Woodward, 2010). In view of this, freshwater systems and its biodiversity have to be conserved and managed properly, as it incorporates an invaluable resource, in economic, cultural, aesthetic, scientific and educational terms, necessary for human health and well being (Dudgeon *et. al.*, 2005).

Maharashtra state has been blessed with rich ichtyofaunal diversity by virtue of congregation of different types of topographical, agroclimatic and hydrodynamical conditions within the state boundaries, however only one effort was made to document the fish diversity of Maharashtra state as a whole by Kulkarni and Ranade,1975 (Acharya & Iftekhar, 2000). A through estimate of the freshwater fish fauna of Maharashtra itself is not published and this information deficiency on the diversity and distribution of freshwater fishes, (Acharya & Iftekhar, 2000; Molur *et. al.* 2011; Jadhav *et. al.* 2011) obscure the understanding of the true patterns in fish diversity (Molur *et. al.* 2011) and becomes a hurdle in designing and implementing conservation strategies (Jadhav *et. al.*, 2011). Likewise there was no attempt to document the endemic freshwater fish fauna of Maharashtra state and the available information on endemic freshwater fishes of Maharashtra is scattered in published literature and not so far documented at one place.

The endemic fish diversity with restricted distribution need particular attention due to consequent susceptibility to endangerment, if their habitats are altered it will lead to their decline and disappearance. In the view of present background an endeavour was made to document endemic fish species found in Maharashtra state, based on the available published literature and samples collected at Zoological Survey of India Western Regional Station, Pune. To fill the information gap on endemic freshwater fish species by providing relevant data at one place suitable for use within development and conservation planning processes. The scientific literature describing the

Table 1 : Number of endemic freshwater fishes reported in India and in Western Ghats

Year	India	Source	Western Ghats	Source
1998			100	Molur and Walker
2003			116	Daniels,
			112	Rema Devi & Indra respectively
2004			118	**Dahanurkar *et al.*,**
2005	225	**Karmarkar and Das,**		
2007	191	**De Silva *et al.***	119	**Sreekantha *et al.*,**
2009	192	**Goyal and Arora**	116	**Goyal and Arora**
2011	196	**Fishbase**	138	**Molur *et al.*,**

endemic freshwater fishes of the India and Maharashtra state was reviewed and distribution was confirmed, along with threat status.

In the Asian region the knowledge of the fish faunal biodiversity and its conservation aspects are relatively less documented (Nguyen and De Silva, 2006) as it is still in exploration and discovery phase (Lundberg *et. al.*, 2000; Pinna, 2006). Similarly Indian fish fauna remains in need of in-depth systematic study (Lundberg *et. al.*, 2000) as many species are still to be described or to be discovered (Le´ve^que *et. al.*, 2008; Goyal and Arora 2009), and the available information is from a few well-studied locations only (Molur and Walker, 1998; Bhat, 2003).

India stands ninth among the mega biodiversity countries rich in freshwater ecosystems (Kar *et. al.*, 2006) and estimated to harbour 930 freshwater fishes (Jayram, 2010). Among the East, and South and South-East Asian countries, India possesses maximum number of endemic freshwater fishes (De Silva *et. al.*, 2007); comprising 225 species (Karmarkar and Das, 2005). The freshwater resources are currently experiencing an alarming rate of decline in fish diversity (Sarkar *et. al.*, 2008), with 17 species Critically endangered, 69 species under endangered and 81 species under vulnerable status in the Eastern Himalayas and Western Ghats itself (Allen *et. al.*, 2010; Molur *et. al.*, 2011). Further the endemic freshwater fishes in the Western Ghats region assessed by Molur *et. al.*, (2011) are far more threatened than the non-endemics.

Endemic Fishes in India:

A living organism restricted to a particular geographic area is recognized as endemic species, which need attention owing to limited distribution along with consequent susceptibility to endangerment, if their habitats are altered it will lead to their decline and disappearance (Young, 2007). The proper understanding of endemism facilitates precise prediction of future of biodiversity (Pimm *et. al.*, 1995) and aids in recommending conservation priorities (Myers *et. al.*, 2000). This calls attention for detailed evaluation of endemic fish fauna, which will be more relevant and crucial for developing suitable conservation strategies and management policies to ensure preservation of biodiversity (De Silva *et. al.*, 2007).

As already mentioned among the East, and South and South-East Asian countries, India possesses maximum number of endemic freshwater fishes (De Silva *et. al.*, 2007); comprising 225 species (Karmarkar and Das, 2005). Within India Peninsular India holds maximum number of endemic freshwater fishes, comprising 135 species (Karmarkar and Das, 2005) and Western Ghats in Peninsular India harbour 138 endemic fishes (Molur *et. al.*, 2011). Significant variation in the number of endemic freshwater species of India and Western Ghats is reported in different sources (Table 1).

Molur *et. al.*, (2011), reported 189 endemic freshwater fish species from Western Ghats assessment region (including Western Ghats and associated river basins; Narmada, Tapi,

Godavari, Krishna, Cauvery and all other river systems in southern India), justifying the incomplete survey work in the country as mentioned above and demands a more efficient detailed state or water-shed wise study of Indian freshwater fish fauna.

STUDY AREA

The present study focuses on the state of Maharashtra ($15^0$35'-$22^0$02'N and $72^0$36'-$80^0$54'E) located in the North Western part of peninsular India. The state encompass three distinct physiographical regions, viz., (1) approximately 80 km wide strip of land between the Western Ghats and coastal line (Konkan), (2) 720 km of Western Ghats hill region, running parallel to the coastline and (3) the eastern plateau drained by the rivers and dotted with thousands of small reservoirs. Maharashtra (with 9.36% of the total geographic area of the country) is the third largest State in terms of area (307,713 Km^2), blessed with vast freshwater resources; comprising 3.39 lakh ha of inland water bodies (SoER, 2007) and 380 rivers draining 19,269 km. Stretch (GoM, 2005).

The review of literature reveals that the five interacting freshwater biodiversity threat categories, viz: overexploitation; water pollution; flow modification; destruction or degradation of habitat; and invasion by exotic species (Dudgeon *et. al.*, 2005), with more or less varying severity are observed in the freshwaters systems of the Maharashtra state (Molur *et. al.*, 2011). This emphasizes the need of proper conservation and management strategies to restore the natural resources for conserving the endemic fish fauna in Maharashtra state.

Anthropogenic development and aquatic habitat loss:

Maharashtra, the second largest state in terms of population size (115.2 million), the third most urbanised state with an urban population of 45.23% (GOI Census, 2011), is one of the most industrialised state in the country (SOER, 2007), where anthropogenic activities (predominantly, industrialisation and urbanisation) have been major factor to affect the water quality of major rivers in the state (Environment monitor, 2006). Of the 30 river basins in world prioritised for the protection of aquatic biodiversity by Groombridge and Jenkins (1998), Rivers Godavari and Krishna originate in Maharashtra and Rivers Narmada & Tapti flow from the northern border of the state. Maharashtra also has the leading number of polluted river water stretches in the country (MPCB, 2009), highest number of large dam (1693) constructed during last century (NRLD, 2009) and low forest cover compared to that at national level (SOER, 2007). These factors with added decline in Western Ghats forest area (Panigrahy *et. al.*, 2010) have become responsible for natural freshwater habitat loss in the state.

Introduction of Exotic species:

Reservoir fisheries in Maharashtra use mostly transplanted Indian major carps (*Catla catla, Labeo rohita* and *Cirrhinus mrigala*) (Sugunan 1995) and exotic species (*Hypopthalmichtys molitrix, Ctenopharyngodon idella* and *Cyprinus carpio*) (Acharya & Iftekhar, 2000) as stocking material. Some of the reported exotic species in Maharashtra are *Oreochromis mossambica* (Kharat *et. al.*, 2003), *Clarias gariepinus* (Sugunan, 2002; Singh & Lakra 2008), *Pangasianodon hypophthalamus* (Krishna *et. al.*, 2011), *Pygocentrus nattereri* (Singh & Lakra 2011), *Gambusia affinis, Hypophthalmichthys nobilis* and *Pangasianodon hypophthalmus* (pers. obs.). These exotic fishes are affecting the native and endemic freshwater fishes in Maharashtra (Kharat *et. al.*, 2003; Dahanukar *et al.*, 2011).

Studies on fish fauna:

Some of the notable works carried out at few localities by different workers on freshwater fishes in Maharashtra state are given in appendix 1. The review of literature suggests that the Northern parts of western Ghats situated at the western border of Maharashtra and tributaries of the west flowing rivers Godavari and Krishna have not been surveyed extensively or in some cases have not been explored at all and checklists for individual rivers are not available (Jadhav *et. al.*, 2011; Molur *et. al.*, 2011).

Table 2: Conservation status of endemic freshwater fish fauna in the state of Maharashtra according to IUCN Red List Category

Sr. No.	Red List Category	Number of species	Percentage
1	Extinct (EX)	0	
2	Extinct in the Wild (EW)	0	
3	Critically Endangered (CR)	2	2.74%
4	Endangered (EN)	13	17.81%
5	Vulnerable (VU)	8	10.96%
6	Near Threatened (NT)	2	2.74%
7	Least Concern (LC)	37	50.68%\
8	Data Deficient (DD)	6	8.22%
9	Not Evaluated (NE)	5	6.85

METHODOLOGY

The fish species endemic to India, having distributional range in the state of Maharashtra are considered endemic species for this study. The scientific literature describing the endemic freshwater fishes of the India and Maharashtra state was reviewed (Molur and Walker, 1998; Ponniah & Gopalakrishnan 2000; Dahanurkar *et. al.* 2004; Karmarkar and Das, 2005; FishBase (http://www.fishbase.org); Molur *et. al.* 2011and Jadhav *et. al*, 2011) and list of endemic freshwater fish species was extracted. The extracted list of endemic species was checked for distribution with the available base literature (Talwar & Jhingran, 1991; Jayram, 2010, Ponnaiah & Gopalakrishnan 2000) and other published works (Kulkarni and Ranade, 1975; Yazdani and Singh, 1990; Acharya & Iftekhar, 2000; Dutta Munshi & Shrivastava, 1988; Arunachalam *et. al.*, 2000; Arunachalam *et. al.*, 2002; Daniels, 2002; Wagh & Ghate, 2003; Ghate *et. al.*,2002; Kharat *et. al.*,2003; Chandanshive *et. al.*,2007; Heda 2009a; Jadhav & Yadav, 2009; Rathod, 2011; Jadhav, *et. al.*, 2011) to come up with a list of endemic fish species of Maharashtra State. The list was then checked with the available samples and locality records at Zoological survey of India, Western Regional Station, Pune. The threat status follows as per IUCN (2011).

RESULTS

The endemic freshwater fish fauna in the state of Maharashtra is reputed to consist of 73 fish species belonging to five orders and 13 families. The family Cyprinidae has the highest number of endemic species (36) followed by Balitoridae (7), Bagridae (7), Sisoridae (6), Schilbeidae (5), Parapsilorhynchidae (4), Cobitidae (2), 6 other families with one endemic species each. Of the 73 species assessed as endemic to the Maharashtra state, fifteen species have uncertain distribution according to IUCN database, but still they are incorporated in the list as need confirmation by further studies. Further two species with taxonomic ambiguities are also listed. The inventory of endemic fish species of Maharashtra state is given in Appendix 2.

The conservation status of endemic freshwater fish fauna in the state of Maharashtra according to IUCN Red List Category is given in table 2.

DISCUSSION

The present findings are based on the available published literature and samples at Zoological survey of India, Pune suggesting that there are 73 endemic freshwater fish in the state of Maharashtra. The family Cyprinidae 62.80% and Balitoridae & Bagridae account for 9.59% of the total number of endemic species respectively. Among the species endemic to the study area ten species are not distributed beyond the boundaries of Maharashtra state. Of these ten species six species are threatened (assessed Critically Endangered, Endangered or Vulnerable) two species *Puntius deccanensis* and *Parapsilorhynchus*

Appendix 1: Some of the notable work carried on Freshwater fishes of Maharashtra

Sr. No.	Year	Author	Area of work
1	1841	Sykes	Deccan
2	1876	Day	Deccan
3	1919	Annandale	Satara and Pune districts
4	1937 & 1939	Hora and Misra	Deolali
5	1942 a. & b.	Fraser	Pune
6	1942	Hora & Misra	Pune
7	1944	Suter	Pune
8	1947	Kulkarni	Bombay
9	1953	Silas	Mahabaleshwar and Wai
10	1955	Kalawar & Kelekar	Kolhapur
11	1963	David A	Godavari and krishna Rivers
12	1963	Tonapi & Mulherkar	Pune
13	1975	Kulkarni and Ranade	Compilation of fishes of Maharashtra
14	1976	Tilak & Tiwari	Pune district
15	1976	Yazdani & Mahabal	Indrayani River
16	1987	Singh & Kamble	Jalgaon district
17	1988	Singh & Yazdani	Sanjay Gandhi National Park
18	1990	Singh	Dhulia district
19	1990	Yazdani & Singh	Ujni wetland, Solapur
20	1992	Ghate & Pawar	Neera river, Pune
21	1992	Singh	Nashik
22	1992	Singh & Pradhan	Tansa Wildlife Sanctuary
23	1993	Yazdani & Singh	Konkan Region of Maharashtra
24	1997	Pradhan	Wardha River basin
25	2000	Acharya & Iftekhar,	Note on Some of the freshwater fishes of Maharashtra
26	2002	Arunachalam *et. al.*	Konkan region
27	2002	Yazdani & Singh	Ujani Wetland
28	2003	Wagh & Ghate	Mula and Mutha Rivers Pune
29	2003	Yadav	Northern parts of Western Ghats
30	2004	Dahanurkar *et al.*	Western Ghats including Northern parts
31	2004	Yadav	Pench National Park
32	2005	Yadava.	a. Melghat Tiger Reserve
			b. Nathsagar wetland Jaikwadi
34	2005	Khedkar	Nathsagar Reservoir Paithan
35	2005	Khedkar & Gynanath	Issapur Reservoir Yeotmal
36	2006	Yadav	Tadoba Andhari Tiger Reserve
37	2007	Hirware	Four districts of Marathwada region
38	2008	Tijare & Thosar	Lakes of Gadchiroli district
39	2009	Jadhav & Yadav	Solapur district
40	2009	Yadav	Bhimashankar Wildlife Sanctuary
41	2009	Heda	Adan River, and, Kathani River of Godavari basin
42	2011	Molur *et al.*	Western Ghats ecoregion, including Maharashtra
43	2011	Jadhav *et al.*	Koyna River
44	2011	Dahanurkar *et al.*	Indrayani River
45	2012	Katwate	Raigad District
46	2012	Kharat	Krishna River at Wai

Appendix 2: Inventory of endemic fishes of Maharashtra state

Sr. No.	Scientific Name	IUCN Categories	EN-IS
A.	**Order Cypriniformes**	**I.**	**Family Cyprinidae**
1	*Salmophasia acinaces* (Valenciennes, 1844)	LC	EN-I
2	*Salmophasia boopis* (Day, 1874)	LC	EN-I
3	*Salmophasia horai* (Silas 1951)	VU	EN-I
4	*Salmophasia novacula* (Valenciennes, 1840)	LC	EN-I
5	*Barilius evezardi* Day, 1872	DD	EN-WGM
6	*Barilius gatensis* (Valenciennes, 1844)	LC	EN-WG
#7	*Chela dadiburjori* (Menon)	LC	EN-I
8	*Devario fraseri* (Hora, 1935)	VU	EN-WG
9	*Rasbora labiosa* Mukerji, 1935	LC	EN-WG
10	*Thynnichthys sandkhol* (Sykes, 1839)	EN	EN-I
11	*Tor kulkarnii* Menon, 1992	EN	EN-WGM
12	*Osteobrama cotio peninsularis* Silas, 1952	DD	EN-I
13	*Osteobrama neilli* (Day, 1873)	LC	EN-WG
14	*Osteobrama vigorsii* (Sykes, 1839)	LC	EN-I
15	*Rohtee ogilbii* Sykes, 1839	LC	EN-WG
16	*Puntius deccanensis* Yazdani & Babu Rao,1976	CR	EN-WGM
17	*Puntius fasciatus* (Jerdon, 1849)	LC	EN-I
18	*Puntius fraseri* (Hora & Misra, 1938)	EN	EN-WGM
19	*Puntius jerdoni* (Day, 1870)	LC	EN-WG
20	*Puntius mahecola* (Valenciennes, 1844)	DD	EN-WG
21	*Puntius narayani* (Hora, 1937)	LC	EN-WG
22	*Puntius parrah* Day, 1865	LC	EN-WG
23	*Puntius sahyadriensis* Silas, 1953	LC	EN-WG
24	*Puntius sarana subnasutus* (Valenciennes, 1842)	LC	EN-WG
25	*Hypselobarbus kolus* (Sykes, 1839)	VU	EN-I
26	*Hypselobarbus mussullah (Sykes, 1839)*	EN	EN-I
*27	*Osteochilichthys godavariensis* Rao	NE	EN-WGM
28	*Osteochilus nashii* (Day, 1869)	LC	EN-WG
29	*Cirrhinus cirrhosus* (Bloch, 1795)	VU	EN-I
30	*Cirrhinus fulungee* (Sykes, 1839)	LC	EN-I
31	*Labeo kawrus* (Sykes, 1839)	LC	EN-I
32	*Labeo potail* (Sykes, 1839)	EN	EN-I
33	*Schismatorhynchos nukta* (Sykes, 1839)	EN	EN-I
34	*Garra bicornuta* Narayan Rao, 1920	NT	EN-WG
35	*Garra gotyla stenorhynchus* Jerdon, 1849	NE	EN-WG
#36	*Garra mcclellandi* (Jerdon)	LC	EN-WG
II.	**Family Parapsilorhynchidae**		
37	*Parapsilorhynchus discophorus* Hora, 1921	VU	EN-WGM

Sr. No.	Scientific Name	IUCN Categories	EN-IS
38	*Parapsilorhynchus prateri* Hora & Misra, 1938	CR	EN-WGM
39	*Parapsilorhynchus elongatus* Singh, 1994	EN	EN-WGM
40	*Parapsilorhynchus tentaculatus* (Annandale, 1919)	LC	EN-I
III.	**Family Balitoridae**		
41	*Balitora laticauda* Bhoite, Jadhav, Rahul Kumar & Dahanukar, 2012	NE	EN-WGM
42	*Acanthocobitis mooreh* (Sykes, 1839)	LC	EN-I
43	*Nemacheilus anguilla* Annandale, 1919	LC	EN-WG
44	*Schistura denisoni* (Day, 1867)	LC	EN-I
45	*Longischistura striatus* (Day, 1867)	EN	EN-WG
46	*Nemacheilus rueppelli* (Sykes, 1839)	LC	EN-WGM
47	*Indoreonectes evezardi* (Day, 1872)	LC	EN-I
IV.	**Family Cobitidae**		
*48	*Botia macrolineata* Teugels, De Vos & Snoeks, 1986	NE	EN-I
49	*Botia striata* Narayan Rao, 1920	EN	EN-WG
B.	**Order Siluriformes**	**I.**	**Family Bagridae**
50	*Rita gogra* (Sykes, 1839)	LC	EN-I
51	*Rita kuturnee* (Sykes, 1839)	LC	EN-I
52	*Mystus malabaricus* (Jerdon, 1849)	NT	EN-WG
53	*Mystus montanus* (Jerdon, 1849)	LC	EN-I
54	*Mystus seengtee* (Sykes, 1839)	LC	EN-I
#55	*Mystus oculatus* (Val.)	LC	EN-WG
56	*Hemibagrus maydelli* (Rössel, 1964)	LC	EN-WG
II.	**Family Siluridae**		
57	*Ompok malabaricus* (Val.)	LC	EN-WG
III.	**Family Schilbidae**		
58	*Clupisoma bastari* Datta & Karmakar, 1980	DD	EN-I
#59	*Eutropiichthys goongwaree* (Sykes, 1839)	DD	EN-I
60	*Neotropius khavalchor* Kulkarni, 1952	DD	EN-WG
61	*Proeutropiichthys taakree* (Sykes, 1839)	LC	EN-WG
62	*Silonia childreni* (Sykes, 1839)	EN	EN-I
IV.	**Family Sisoridae**		
63	*Gagata itchkeea* (Sykes, 1839)	VU	EN-I
#64	*Glyptothorax housei* Herre	EN	EN-WG
65	*Glyptothorax lonah* (Sykes, 1839)	LC	EN-I
66	*Glyptothorax madraspatanum* (Day, 1873)	EN	EN-WG
67	*Glyptothorax poonaensis* Hora, 1938	EN	EN-WG
68	*Glyptothorax trewavasae* Hora, 1938	VU	EN-WG

Sr. No.	Scientific Name	IUCN Categories	EN-IS
C.	**Order Belonifirmes**		
I.	**Family Adrianichthyidae**		
69	*Oryzias setnai* (Kulkarni, 1940)	LC	EN-I
D.	**Order Synbranchiformes**		
I.	**Family Synbranchidae**		
70	*Monopterus indicus* (Silas & Dawson, 1961)	VU	EN-WG
II.	**Family Mastacembelidae**		
71	*Macrognathus guentheri* (Day)	LC	EN-WG
E.	**ORDER PERCIFORMES**		
I.	**Family Pristolepididae**		
72	*Pristolepis marginata* Jerdon, 1849	LC	EN-WG
II.	**Family Channidae**		
**73	*Channa leucopunctatus* Sykes	NE	EN-I

Abbreviations: EN-I: Endemic to India, EN-WG: Endemic to Western Ghats, EN-WGM: Endemic to Western Ghats of Maharashtra

** Synonymy doubtful hence treated as separate species following Jayaram (2010)*

*** This species treated as synonym of Channa marulius* (Ham)*, but our study indicates that C. leucopunctatus is a distinct species. The detailed study will be published separately.*

 # Occurrence doubtful needs confirmation.

prateri are under Critically Endangered category. One of the authors (SJ) conducted a survey of Deolali & surrounding areas repeatedly during last three years, for the collection of *P. prateri*. Finally, the collection was made in stream, near Trimbakeshwar, Nasik district after a long gap. The detailed study of this species will published separately. Urgent need is felt to take up proper steps for conservation of these species.

Among the total endemic species in Maharashtra state 31.51% species are under threatened category (two species are Critically Endangered, thirteen species are Endangered and eight species are Vulnerable). Two species are under near threatened category and 6 species are under Data Deficient category. Hence almost 49% of endemic fish fauna falls under Threatened, Near Threatened, and Data Deficient and Not Evaluated category.

CONCLUSION

The present work essentially consists of distillations of the text and illustrations of earlier works as mentioned by Kottelat and Whitten, (1996). Even then, the generated information on endemic freshwater fish biodiversity of Maharashtra will help the student, researchers, planners and policy makers to frame conservation and management strategies. The present work will form a basis for further studies. Probable additions and / or deletions in the number of species are possible after detailed field surveys and after resolving taxonomic ambiguities. The authors are of the opinion that stream wise detailed surveys are necessary for documenting the diversity and understanding of resource for proper planning, sustainable utilisation and conservation.

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Manuscript received : 17-06-2013; *Accepted* : 19-09-2013