



An overview of fish fauna of Raigad District, northern Western Ghats, India

Unmesh Katwate ¹, Rupesh Raut ² & Sahir Advani ³

¹ Bombay Natural History Society Hornbill House, Opp. Lion Gate, Shaheed Bhagat Singh Road, Mumbai, Maharashtra 400001, India

² Department of Zoology, Elphinstone College, Mumbai, Maharashtra 400032, India

³ Department of Zoology, The Institute Of Science, Mumbai, Maharashtra 400032, India

Email: ¹ theunmesh@gmail.com, ² rupesh.raut@gmail.com (corresponding author), ³ advani.sahir@gmail.com

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Abstract: We studied the fish fauna of Raigad District for two years from August 2008 to August 2010. Sixty six freshwater and secondary freshwater fish species belonging to 31 families and 53 genera were collected from various sampling sites and local markets along the banks of Patalganga, Bhogawati, Amba, Kundalika, Mandad and Savitri river systems present in Raigad District, Maharashtra, northern Western Ghats. Cyprinids were the most dominant group represented by 22 fish species belonging to 13 genera followed by the loaches, croakers and gobies belonging to the family Balitoridae, Sciaenidae and Gobiidae respectively (three species from each family). Of the 66 fish species, five belong to the Vulnerable (VU), four to Near Threatened (NT), 37 to the Least Concern (LC) category and 20 were found to be not evaluated for IUCN Red List criteria. Raigad District is under severe threat of rapid industrialization and urbanization. Further, introduced exotic fish species are becoming a major threat to the indigenous fish fauna of Raigad District. Implementation of ecosystem based adaptation plans and conservation measures are necessary to protect the diverse, endemic and threatened fish fauna of Raigad District.

Keywords: Fish fauna, Raigad District, species composition, species diversity, threat status, Western Ghats.

The Western Ghats of India harbor rich biodiversity and are aptly classified as one of the 34 Biodiversity Hotspots of the world owing to the concentration of endemism (Mittermeier et al. 2005). The biodiversity of the Western Ghats is under severe threat of deforestation (Myers 1990). Holding only 12,450km² (i.e. 6.8%) primary vegetation out of an original extent of 182,500km² primary vegetation, Western Ghats awaits major conservation priorities (Myers et al. 2000). The most important impact is the massive degradation of habitat and extinction of species taking place in a catastrophically short time scale (Novacek 2001), resulting in the modification of both the identities and numbers of species in ecosystems (Tilman 1997).

The literature till date records 288 freshwater fish species from the Western Ghats with 41% fish species endemic to this region (Dahanukar et al. 2004). The fish fauna of northern Western Ghats have been well studied but most of the studies are limited to the east flowing rivers of the Western Ghats while the west flowing rivers have had limited attention (Dahanukar et al. 2011). These west flowing rivers of the northern Western Ghats flow in the Konkan region of Maharashtra, a narrow coastal plain between the Western Ghats and the Arabian Sea. Raigad District forms the middle part of Konkan in the northern Western Ghats. While very few studies are available on fishes of the Konkan region (Annandale 1919; Kulkarni 1947; Bal & Mohmed, 1957; Singh & Yazdani 1988), the Raigad District is even less explored with only three studies (Singh

& Yazdani 1993; Arunachalam 2000, 2002) to our knowledge. In our present study we have carried out a more extensive survey to document the diversity of fish fauna of Raigad District and associated threats to the fish fauna.

Raigad District (Image 1) ($17^{\circ}51' - 19^{\circ}80'N$ & $72^{\circ}51' - 73^{\circ}40'E$) forms a major part of northern Konkan and has the Western Ghats on its eastern and southern border (Singh & Yazdani 1993); the eastern and southern part of the district lies in the high rain shadow of the Sahyadri mountains; the altitude ranges from 500 to 1000 m. The annual rainfall ranges from 3000 to 5500 mm in high altitude regions like Matheran. Rainfall decreases in the range of 2000 to 2500 mm as we go from south to north (Chaudhari 1993). Six major west flowing rivers, namely Patalganga, Bhogawati, Amba, Kundalika, Mandad and Savitri with their tributaries, originate from the eastern boundaries of Raigad District and drain into the Arabian Sea (Image 1). These six major rivers with undulating terrains

have tropical semi deciduous, semievergreen and some evergreen forest patches in their catchments. In the last few decades, urbanization, industrialization and increasing organic waste load in Raigad District threaten the ichthyofauna of these rivers.

During the present survey six sampling sites (Image 1) namely Kharpada ($18^{\circ}50'42''N$ & $73^{\circ}07'20''E$), Pen ($18^{\circ}44'03''N$ & $73^{\circ}06'49''E$), Wadkhal ($18^{\circ}35'41''N$ & $73^{\circ}06'10''E$), Roha ($18^{\circ}26'03''N$ & $73^{\circ}10'36''E$), Mandad ($18^{\circ}20'37''N$ & $73^{\circ}07'52''E$) and Mahad ($18^{\circ}05'20''N$ & $73^{\circ}26'46''E$) situated on the course of Patalganga, Bhogawati, Amba, Kundalika, Mandad and Savitri rivers respectively were selected for experimental fishing. Samples were also collected from local markets and landing centers. For the present study samplings were carried out at all six sampling sites on a monthly basis from August 2008 to July 2011. Experimental fishing was carried out both by members of the survey team as well as by using the expertise of local fisher folk. Different types of

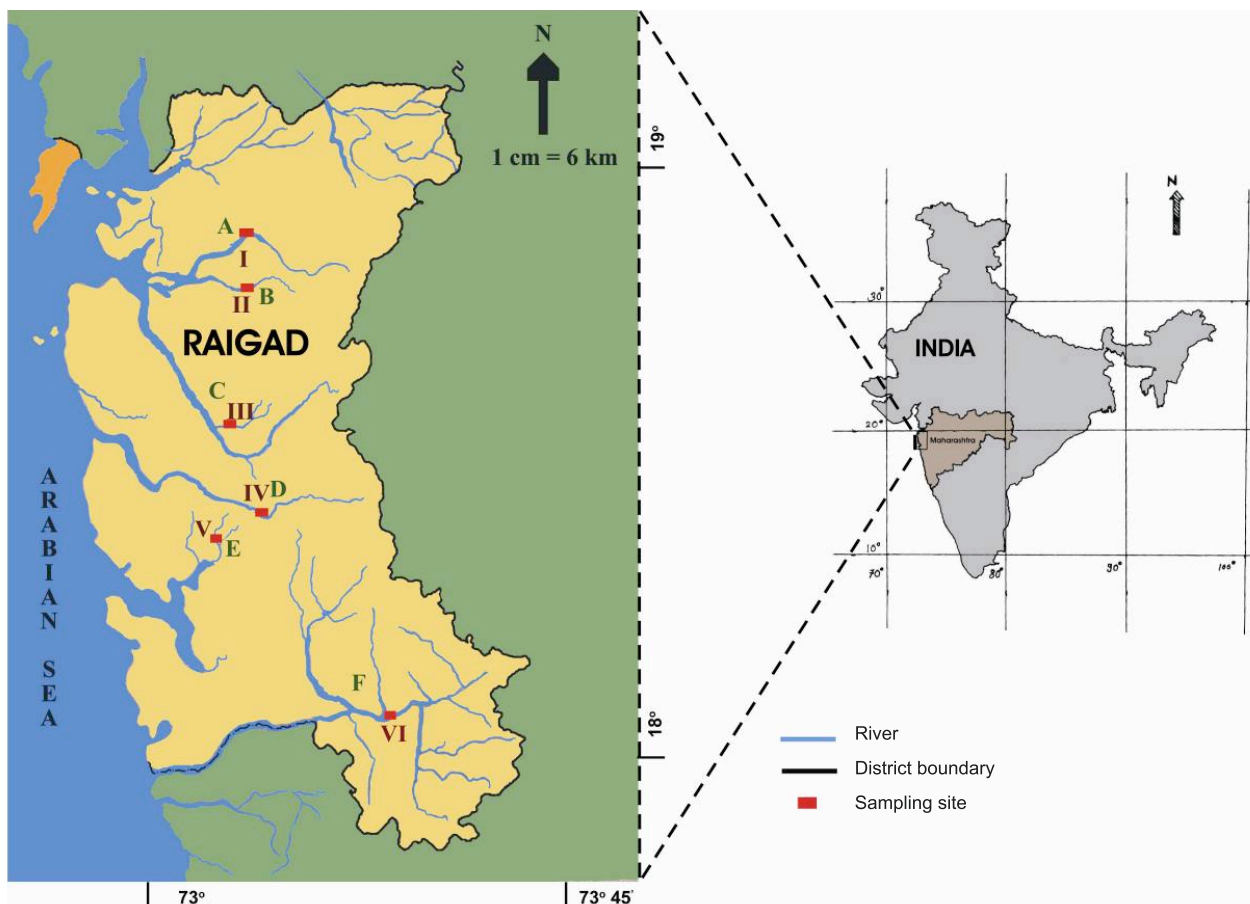


Image 1. Study site showing sampling locations: I - Kharpada; II - Pen; III - Wadkhal; IV - Roha; V - Mandad; VI - Mahad. Rivers: A - Patalganga; B - Bhogawati; C - Amba; D - Kundalika, E - Mandad, F - Savitri

gear including cast nets, gill nets, scoop nets (all with varying mesh sizes), traps and other local contrivances were used for collecting the fishes allowing us to sample a range of fish sizes and minimize the bias due to specific gear. At each sampling site different microhabitats like water pools, riffles, cascade, falls, run and plunge were assessed for sampling.

Representative specimens of all fish species were fixed in 4% formaldehyde and transferred to the laboratory and stored in glass bottles. We also visited local fish markets and landing centers situated nearer to the sampling sites to monitor and look for the presence of any species which were not available during our experimental fishing. Samples were subsequently identified by following standard literature (Jayaram 1991; 1999; 2010; Talwar & Jhingran 1991). The threat status of the fish species is adapted from IUCN Red List of Threatened Species-Version 2011.1 (IUCN 2011). Relative abundance was recorded for each species in each river as rare, common and very common. If a species contributed < 5% or 5% of the total catch in a sample it was considered as rare, if < 50% or 50% it was considered as common and if the species contributed > 50% it was considered as very common.

A total number of 66 fish species belonging to 31 families and 53 genera (Table 1) were collected from the six sampling sites located along the course of monitored rivers. Some of the fishes collected from various rivers are shown in Image 2. Cyprinids were the most dominant group represented by 22 species belonging to 13 genera, followed by the loaches, croakers and gobies of the family Balitoridae, Sciaenidae and Gobiidae respectively (3 species from each family). Kundalika River showed the maximum species number (66 species) followed by Savitri River (64 species) and Amba (61 species). Patalganga River showed the least number of species (45 species) (Fig. 1).

Singh & Yazdani (1993) have reported 106 freshwater and marine fish species in the entire Konkan region of northern Western Ghats of which 41 fish species were recorded from Raigad District. Arunachalam (2000) and Arunachalam et al. (2002) studied Kundalika, Savitri River and Kal River a major tributary of Savitri River as well as Phansad Wildlife Sanctuary area. Arunachalam (2000) recorded 20 fish species, while Arunachalam et al. (2002) reported

a total of 22 fish species. Even though we could not record five species recorded by the earlier workers we recorded 18 species for the first time from this area. A cumulative number of species based on previous studies and the current study suggest that there could be at least 71 species of freshwater and secondary freshwater fishes in this region.

In our present study we recorded two bagrids *Mystus bleekeri* and *M. malabaricus*. There are earlier records of occurrence of *M. seenghala* (now *Sperata seenghala*), *M. vittatus* and *M. keletius* in Raigad District (Singh & Yazdani 1993) but during the present study these species were not recorded. Arunachalam (2002) has reported the occurrence of juveniles of *Tor khudree* from Khandala Falls, an origin of Patalganga River. During the field study, issues of occurrence of *Tor khudree* with local fishermen were discussed. As per their knowledge this species is very rarely seen in the wild in this area but is known to be cultivated in farms in some areas of Raigad District. We could not record the presence of *Tor khudree* in our study. Nevertheless, even in the absence of species like *M. seenghala*, *M. vittatus*, *M. keletius*, *Gonoproktopterus curmuca* and *Tor khudree* recorded earlier (Singh & Yazdani 1993; Arunachalam 2002), we have reported 18 new records of fish species to Raigad District, namely *Anguilla bengalensis*, *Cirrhinus cirrhosus*, *Crossocheilus latius*, *Esomus danrica*, *Garra gotyla stenorhynchus*, *Labeo calbasu*, *Puntius chola*, *Parapsilorhynchus discophorus*, *Ompok bimaculatus*, *Heteropneustes fossilis*, *Xenentodon cancila*, *Monopterus indicus*, *Etroplus maculatus*, *Eleotris fusca*, *Channa punctata*, *C. gachua*, *Chanda nama* and *Mastacembalus armatus*. Our study also reported eight new records of introduced fish species to this region like *Catla catla*, *Cirrhinus mrigala*, *Ctenopharyngodon idella*, *Cyprinus carpio*, *Labeo rohita*, *Clarias gariepinus*, *Gambusia affinis* and *Poecilia reticulata*. *Puntius* cf. *amphibius* collection reported in the present study has ambiguous taxonomic status. Pethiyagoda & Kottelat (2005, p.151) considered *Puntius amphibius* from its lectotype which was preserved some two centuries ago from Bombay Presidency, a rather ill defined type locality as it points to a very large region. Our *Puntius* cf. *amphibius* specimens do not match with the lectotype of *Puntius amphibius* sensu stricto because of the presence of a dark oval blotch on caudal peduncle, which is absent in lectotype studied by Pethiyagoda

Table 1. Fish species recorded from Raigad District.

Family/species ^a	Abundance in study area ^b						Global status ^d	Remarks ^e
	A ^c	B	C	D	E	F		
Notopteridae								
<i>Notopterus notopterus</i> (Pallas, 1769)	-	-	-	+	-	+	LC	
Anguillidae								
<i>Anguilla bengalensis</i> (Gray, 1831) ^f	-	+	+	+	-	+	LC	S
Clupeidae								
<i>Tenuulosa ilisha</i> (Hamilton, 1822)	++	+++	+++	+++	++	+++		S
Cyprinidae								
<i>Catla catla</i> (Hamilton, 1822) ^f	++	++	++	+++	-	+++		I
<i>Cirrhinus cirrhosus</i> (Bloch, 1795) ^f	-	++	+	++	-	++	VU	
<i>Cirrhinus mrigala</i> (Hamilton, 1822) ^f	-	-	+	+	-	+		I
<i>Crossocheilus latius</i> (Hamilton, 1822) ^f	+	++	++	+++	+	+++	LC	
<i>Ctenopharyngodon idella</i> (Valenciennes, 1844) ^f	-	-	++	++	-	++		I
<i>Cyprinus carpio</i> (Linnaeus, 1758) ^f	-	-	++	++	-	++		I
<i>Devario aequipinnatus</i> (McClelland, 1839)	++	+++	+++	+++	++	+++	LC	
<i>Devario fraseri</i> (Hora, 1935)	-	+	+	+	-	+	VU	E
<i>Esomus danrica</i> (Hamilton, 1822) ^f	+	+	++	+	+	++	LC	
<i>Garra gotyla stenorhynchus</i> (Jerdon, 1849) ^f	+	+	++	+++	+	+++	LC	E
<i>Garra mullya</i> (Sykes, 1839)	+++	+++	+++	+++	+++	+++	LC	
<i>Labeo calbasu</i> (Hamilton, 1822) ^f	-	+	+	++	+	++	LC	
<i>Labeo rohita</i> (Hamilton, 1822) ^f	++	++	+++	+++	++	+++		I
<i>Laubuca laubuca</i> (Hamilton, 1822)	++	++	++	++	++	++	LC	
<i>Puntius cf. amphibius</i> (Valenciennes, 1842)	++	+++	+++	+++	+	+++	DD	
<i>Puntius bimaculatus</i> (Bleeker, 1863)	+	+	+	+	+	+	LC	
<i>Puntius chola</i> (Hamilton, 1822) ^f	+	++	++	+++	-	+++	LC	
<i>Puntius sarana subnasutus</i> (Valenciennes, 1842)	+++	+++	+++	+++	++	+++	LC	E
<i>Puntius sophore</i> (Hamilton, 1822)	+++	+++	+++	+++	+++	+++	LC	
<i>Puntius ticto</i> (Hamilton, 1822)	+	+	++	+++	+	+++	LC	
<i>Rasbora daniconius</i> (Hamilton, 1822)	+++	+++	+++	+++	+++	+++	LC	
<i>Salmophasia ballokee</i> (sykes, 1839)	-	-	+	+	-	+	LC	
Parapsilorhynchidae								
<i>Parapsilorhynchus discophorus</i> (Hora, 1921) ^f	-	-	-	+	-	+	VU	E
<i>Parapsilorhynchus tentaculatus</i> (Annandale, 1919)	-	-	-	+	-	+	LC	
Balitoridae								
<i>Indoreonectes evezardi</i> (Day, 1872)	+++	+++	+++	+++	+++	+++	LC	
<i>Nemachilichthys rueppelli</i> (Sykes, 1839)	-	-	++	++	-	++	LC	E
<i>Schistura denisoni</i> (Day, 1867)	-	-	+	+	-	+	LC	
Cobitidae								
<i>Lepidocephalichthys thermalis</i> (Valenciennes, 1846)	+++	+++	+++	+++	+++	+++	LC	
Bagridae								
<i>Mystus bleekeri</i> (Day, 1877)	+	+	++	+	+	+++	LC	
<i>Mystus malabaricus</i> (Jerdon, 1849)	+	+	+	+	+	+	NT	E
Siluridae								
<i>Ompok bimaculatus</i> (Bloch, 1794) ^f	-	+	+	+	-	+	NT	

Family/species ^a	Abundance in study area ^b						Global status ^d	Remarks ^e
	A ^c	B	C	D	E	F		
<i>Wallago attu</i> (Bloch & Schneider, 1801)	-	-	+	+	-	+	NT	
Ariidae								
<i>Arius sona</i> (Hamilton, 1822)	+++	+++	+++	+++	+++	+++		S
<i>Hexanematchthys sagor</i> (Hamilton, 1822)	+++	+++	+++	+++	+++	+++		S
Clariidae								
<i>Clarias gariepinus</i> (Burchell, 1822) ^f	+++	+++	+++	+++	+++	+++		I
Heteropneustidae								
<i>Heteropneustes fossilis</i> (Bloch, 1794) ^f	-	-	-	+	-	-	LC	
Hemiramphidae								
<i>Hyporhamphus limbatus</i> (Valenciennes, 1847)	-	-	+	+	-	+	LC	S
Belonidae								
<i>Xenentodon cancila</i> (Hamilton, 1822) ^f	-	-	-	+	-	-	LC	
Horaichthyidae								
<i>Horaichthys setnai</i> Kulkarni, 1940	++	++	++	+++	++	+++	LC	
Aplocheilidae								
<i>Aplocheilus lineatus</i> (Valenciennes, 1846)	+	++	++	++	+	++	LC	S
Poecillidae								
<i>Gambusia affinis</i> (Baird & Girard, 1853) ^f	+++	+++	+++	+++	+++	+++		I
<i>Poecilia reticulata</i> (Peters, 1859) ^f	+++	+++	+++	+++	+++	+++		I
Synbranchidae								
<i>Monopterus indicus</i> (Silas & Dawson, 1961) ^f	-	+	+	+	-	+	VU	E
Lutjanidae								
<i>Lutjanus johni</i> (Bloch, 1792)	+++	+++	+++	+++	+++	+++		S
Polynemidae								
<i>Eleutheronema tetradactylum</i> (Shaw, 1804)	+++	+++	+++	+++	+++	+++		S
<i>Leptomelanosoma indicum</i> (Shaw, 1804)	+++	+++	+++	+++	+++	+++		S
Sciaenidae								
<i>Dendrophysa russelli</i> (Cuvier, 1829)	+++	+++	+++	+++	+++	+++		S
<i>Johnius belangerii</i> (Cuvier, 1830)	+++	+++	+++	+++	+++	+++		S
<i>Otolithoides biauritus</i> (Cantor, 1849)	+++	+++	+++	+++	+++	+++		S
Scatophagidae								
<i>Scatophagus argus</i> (Linnaeus, 1766)	+++	+++	+++	+++	+++	+++		S
Cichlidae								
<i>Etroplus maculatus</i> (Bloch, 1795) ^f	+	+	+++	+++	+	+++	LC	S
<i>Oreochromis mossambicus</i> (Peters, 1852)	+++	+++	+++	+++	+++	+++		I
Mugilidae								
<i>Mugil cephalus</i> Linnaeus, 1758	+++	+++	+++	+++	+++	+++	LC	S
Gobiidae								
<i>Boleophthalmus boddarti</i> (Pallas, 1770)	+++	+++	+++	+++	+++	+++		S
<i>Boleophthalmus dussumieri</i> (Valenciennes, 1837)	+++	+++	+++	+++	+++	+++		S
<i>Glossogobius giurus</i> (Hamilton, 1822)	+++	+++	+++	+++	+++	+++		S
Eleotridae								
<i>Eleotris fusca</i> (Forster, 1801) ^f	+	+	++	++	+	++	LC	S

Family/species ^a	Abundance in study area ^b						Global status ^d	Remarks ^e
	A ^c	B	C	D	E	F		
Channidae								
<i>Channa punctata</i> (Bloch, 1793) ^f	+++	+++	+++	+++	+++	+++	LC	
<i>Channa gachua</i> (Hamilton, 1822) ^f	++	++	++	+++	++	+++	LC	
Centropomidae								
<i>Lates calcarifer</i> (Bloch, 1790)	+	++	+++	+++	+++	+++		S
Anabantidae								
<i>Anabas testudineus</i> (Bloch, 1792)	-	+	+	++	++	++	DD	S
Ambassidae								
<i>Chanda nama</i> (Hamilton, 1822) ^f	-	+	+	+	+	+	LC	
Mastacembelidae								
<i>Mastacembelus armatus</i> (Lacepède, 1800) ^f	+	+	++	++	+	++	LC	S

a - Taxonomic status adapted from Jayaram 1991, 1999, 2010; Talwar & Jhingran 1991.

b - Abundance categories: - not found, + rare, ++ common, +++ very common.

c - Collection sites: A: Patalganga River; B: Bhogawati River; C: Amba River; D: Kundalika River; E: Mandad River; F: Savitri River.

d - Global Status adapted IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 09 August 2011. LC Least Concern, DD - Data Deficient, NT - Near Threatened, VU - Vulnerable. IUCN Status of introduced species and unassessed species are not provided.

e - Remarks: E - endemic to Western Ghats; S - secondary freshwater; I - introduced to this region.

f - New record to Raigad District based on previous literature surveys.

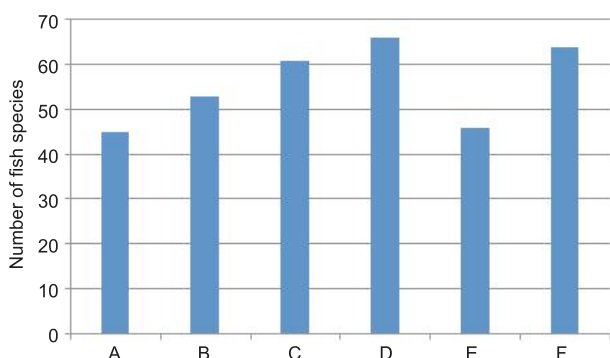


Figure 1. Species richness of rivers in Raigad District. Rivers abbreviations as per Image 1.

& Kottelat (2005, p.150). Pethiyagoda & Kottelat (2005, p.150) distinguished *Puntius amphibius* from *Puntius mahecola* by having a smaller eye diameter (61.6% of snout length, vs. 68.4–100.0 %). Eye diameter of our *Puntius* cf. *amphibius* collection ranges between 71–98 % of snout length, which falls closer to *P. mahecola*, a species restricted to southern Western Ghats (Pethiyagoda & Kottelat 2005). Such variations between our *Puntius* cf. *amphibius* collection and lectotype of *Puntius amphibius* studied by Pethiyagoda & Kottelat (2005) suggest that there is a need to reinvestigate *Puntius amphibius* from its type locality with a fresh collection.

Out of the recorded 66 fish species, five species are categorized as vulnerable globally. These species are *Cirrhinus cirrhosus*, *Cyprinus carpio*, *Devario fraseri*, *Parapsilorhynchus discophorus* and *Monopterus indicus* (IUCN 2011). Western Ghats endemics like *Devario fraseri*, *Garra gotyla stenorhynchus*, *Puntius sarana subnasutus*, *Parapsilorhynchus discophorus*, *Nemachilichthys rueppelli*, *Mystus malabaricus* and *Monopterus indicus* constitute 10% to the total fish species of the study area. The global threat status of the studied fish species shows that 7.5% belong to Vulnerable (VU), 6% to Near Threatened (NT), 56% to Least Concern (LC) while 3% has Data Deficient (DD). The status of around 26% species was not available (Fig. 2). Kundalika, Savitri and Amba show maximum contribution (6–7.5 %) of globally vulnerable species in their species assemblages (Table 2).

Raigad District is showing rapid industrialization. The fish fauna of Raigad District is threatened mainly due to pollution, industrial sewage disposal in river systems, habitat alteration due to construction of dams, indiscriminate deforestation on a large scale, and over-exploitation of present fish stock and introduction of exotic fish species. Nine introduced fish species like *Catla catla*, *Cirrhinus mrigala*, *Ctenopharyngodon*

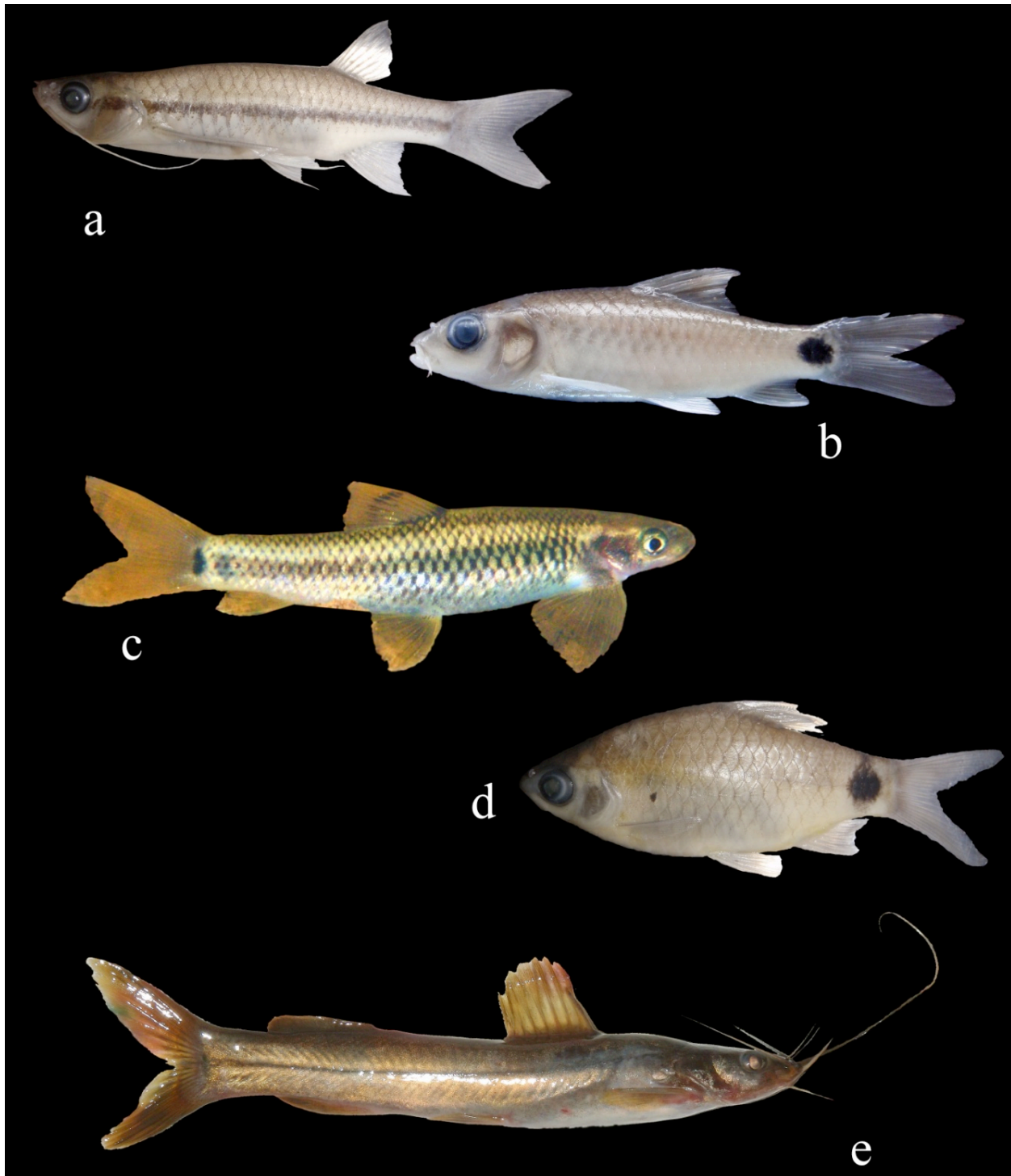


Image 1. Some fishes of Raigad District.

a - *Esomus danrica*; b - *Puntius cf. amphibiis*; c - *Parapsilorhynchus discophorus*; d - *Puntius ticto*; e - *Mystus malabaricus*.

idella, *Cyprinus carpio*, *Labeo rohita*, *Clarias gariepinus*, *Gambusia affinis*, *Poecilia reticulata* and *Oreochromis mossambicus* were collected from the different sampling sites which constituted about 13% of the total fish fauna. Fishes like *Catla catla*,

Cirrhinus mrigala and *Labeo rohita* were native to the Ganges River systems and introduced in greater numbers for mass aquaculture practices. Studies suggest that native fish fauna of the Western Ghats are severely threatened by the introduction of alien fish

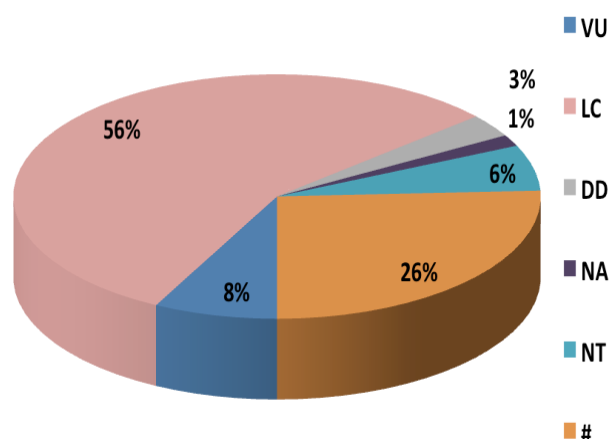


Figure 2. Threat status of fishes collected from Raigad District.

LC - Least Concern; DD - Data Deficient; NT - Near Threatened; VU - Vulnerable; NA - Not Available; # - Status of these species was not available.

species with regard to predation, competition for food and other resources, and also with the introduction of new pathogens (Daniels 2006; Raghavan et al. 2008; Krishnakumar et al. 2009; Knight 2010). These exotic populations have the status of potential pests and hence pose a serious threat to the fish fauna of Raigad District, especially to the endemic and threatened species having a low population size.

It is recommended that further long term intensive monitoring studies are needed to trace the impact of anthropogenic activities on the freshwater fish fauna of Raigad District. Implementation of conservation measures are also necessary to protect the locally, as well as globally threatened freshwater fish species from this area.

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Table 2. Percentage composition of threatened species in each river system of Raigad District.

	A	B	C	D	E	F
LC	25	28	33	37	25	35
DD	1	2	2	2	2	2
NA	0	0	2	2	0	2
NT	2	3	4	4	2	4
VU	0	3	4	5	0	5
#	17	17	17	17	17	17

Rivers: A - Patalganga; B - Bhogawati; C - Amba; D - Kundalika; E - Mandad; F - Savitri.

Global Status adapted IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>. Downloaded on 09 August 2011. LC - Least Concern; DD - Data Deficient; NT - Near Threatened; VU - Vulnerable; NA - Not Available. # Status of these species was not available.

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Author Details: UNMESH KATWATE is a zoology postgraduate currently working as Research Scientist in Bombay Natural History Society (BNHS). He is studying ecology and conservation aspects of freshwater fishes and amphibians in northern Western Ghats. Currently he is working on coastal plateaus of Konkan in Western Ghats.

RUPESH RAUT is a head of Department of Zoology, Elphinstone College. He works on ecology, systematic biology and molecular phylogeny of freshwater fishes, amphibians and bats of Western Ghats.

SAHIR ADVANI is currently a Research Associate at Dakshin Foundation, Bangalore, a marine conservation NGO. His research interests lie in the field of marine protected areas and coral reef associated fisheries. He is presently working on a project profiling the fisheries of the Andaman Islands in order to establish critical areas for research and conservation.

Author contribution: UK, RR and SA all have contributed their efforts in extensive field work. RR systematically designed this study. UK, RR and SA performed systematic taxonomic identification, morphometric data analysis of different fish species and manuscript preparation.