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Study of Endemic and Threatened Fish Species Diversity and its Assemblage Structure from Northern Western Ghats, Maharashtra, India

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ABSTRACT

The present investigation undertakes to study endemic and threatened fish species and its assemblage structure from rivers of Kolhapur district for the period July-2012 to December-2014. The study area is situated in the extreme Southern part of Maharashtra state. It contributes much more part of Western Ghats. A total of 23 species belonging to 7 families and 19 genera were reported. In which 9 species are threatened and 20 species are endemic to Western Ghats, we found that 6 species are threatened as well as endemic. *Puntius sahyadriensis*, *Nemacheilus anguilla*, *Pterocryptis wynaadensis* and *Glyptothorax trewavasae* are first time reported from Kolhapur district. High Shannon diversity index shows considerable variation and ranges from 1.34-2.43. Margalef's diversity index and Evenness index for each sampling site were also recorded. The similarity in cluster analysis from nearby sampling site along the river has similar faunal assemblage. The problems related to various threats for aquatic biodiversity and conservation management strategies have been discussed.

Key words: Assemblage structure, conservation, endemism, Northern Western Ghats, threats

INTRODUCTION

The significance of endemism was studied by some workers in plants as well as in animals. Endemic species are of both locally and globally important, because they increase the amount of genetic diversity and offer insight into biogeographical questions, like where certain species originated and how distribution patterns have changed over time (Skarbek, 2008; Muderhwa and Matabaro, 2010). They are related to biogeography that denotes the unique occurrence of a living species in the ecological state of a well defined geographic location that may be a small local area with unique niche characteristics (Venkataraman *et al.*, 2013). The Western Ghats is one of the hotspots of biodiversity in the world and endowed with rare, endemic and threatened species of flora and fauna (Hanson *et al.*, 2009). The freshwater fish fauna are one of the most important threatened and endemic taxonomic group of the Western Ghats that contribute critical ecological role in aquatic ecosystem (Holmlund and Hammer, 1999). Recently 320 freshwater fish species belonging to 11 orders, 35 families and 112 genera were reported from the Western Ghats and out of which 212 are endemic to the Western Ghats (Dahanukar and Raghavan, 2013). Due to the high number of endemic species there is need to study extensively, with the help of biotic and abiotic parameters; that may affects the diversity, community structure and species assemblages in lotic environment (Minns, 1989).

Variation in abiotic factors such as flow, depth, substrate and water quality along with various physicochemical parameters may have significant impact on both, assemblage structure and resource availability (Johnson *et al.*, 2012) of freshwater fishes. In India, some studies have been undertaken for documentation of fish diversity and assemblage structure (Johnson, 1999; Bhat, 2003, 2004; Sreekantha *et al.*, 2007; Shahnawaz *et al.*, 2010). Most of these studies are reported from Central and Southern Western Ghats. From Northern Western Ghats, only one assemblage structure study is reported (Arunachalam, 2000).

From the conservation point of view, various threats and conservation strategies were reported by earlier researchers from Western Ghats. Important threats recorded by earlier researchers includes introduction of alien fish species, industrial and urban pollution, habitat loss, big dam constructions and unmanaged aquarium trade (Paingankar and Dahanukar, 2013; Katwate *et al.*, 2013). In addition, some study also revealed that the global warming is an important major threat of endemic species from biodiversity hotspot (Malcolm *et al.*, 2006). Therefore, there is a need to initiate conservation measures to protect the endemic and threatened species. Minimize human encroachment in aquatic habitat and sustainable utilization of aquatic resources.

The review of literature from study site shows that, Kalawar and Kelkar (1956) studied the fishes of Kolhapur and reported 72 species. After this attempt, Pawar (1988) studied the ichthyofauna from Panchganga river separately and he reported 48 species and concluded the decline in number of fish fauna of Kolhapur. Mohite and Samant (2013) studied the fish and fisheries in Warana river basin, they recorded 42 species. Thus, the main objective of this study is to study assemblage structure, assess abundance, diversity, distribution, richness of endemic and threatened fishes from Northern Western Ghats of Kolhapur district.

MATERIAL AND METHODS

The present study encompassed 14 sampling sites (Fig. 1) in main river basin of Kolhapur district. Namely Kodoli and Khochi on Warana river, Bajar Bhogaon on Kasari river, Kale, Prayag chikhali and Kurundwad (Near Krishna river) on Panchganga river, Rashiwade on Bhogavati river, Kagal karnur on Doodhganga river, Bastwade on Vedganga river, Chandewadi on Hiranyakeshi river, Adkur on Ghatprabha river, Kowad on Tamraparni river, Gavashi on Dhamani river and Saitwade on Kumbhi river. Location of each sampling site was documented by using global positioning system (Table 1). The collection of fish sample was done with the help of local fishermen using gill nets, cast nets of different mesh sizes and type of river basins. Fish sampling protocol followed the method of Johnson and Arunachalam (2009). During the collection, fishes were examined, counted and released back into the basin, while unidentified species were brought to the

Table 1: Details of the sampling sites

Site codes	Sampling sites	Rivers of sampling site	GPS locations
S1	Kodoli	Warana	16°53'37.8"N, 74°11'32.3"E
S2	Khochi	Warana	16°52'11.2"N, 74°23'14.8"E
S3	Kurundwad	Panchaganga	16°41'30.2"N, 74°35'45.9"E
S4	Prayag chikhali	Panchaganga	16°43'01.2"N, 74°11'19.9"E
S5	Bajar bhogaon	Kasari	16°45'24.4"N, 73°58'56.5"E
S6	Kale	Panchaganga	16°42'30.9"N, 74°03'27.8"E
S7	Saitavade	Kumbhi	16°33'12.1"N, 73°52'16.4"E
S8	Gavashi	Dhamani	16°36'16.4"N, 73°59'15.4"E
S9	Rashiwade	Bhogawati	16°32'18.0"N, 74°06'48.0"E
S10	Karnur (kagal)	Dudhganga	16°33'33.3"N, 74°18'19.3"E
S11	Bastawade	Vedganga	16°26'36.7"N, 74°16'27.7"E
S12	Chandewadi	Hiranyakeshi	16°07'43.6"N, 74°13'35.0"E
S13	Adkur	Ghatprabha	16°00'45.7"N, 74°16'32.8"E
S14	Kowad	Tamraparni	15°58'48.1"N, 74°22'02.4"E

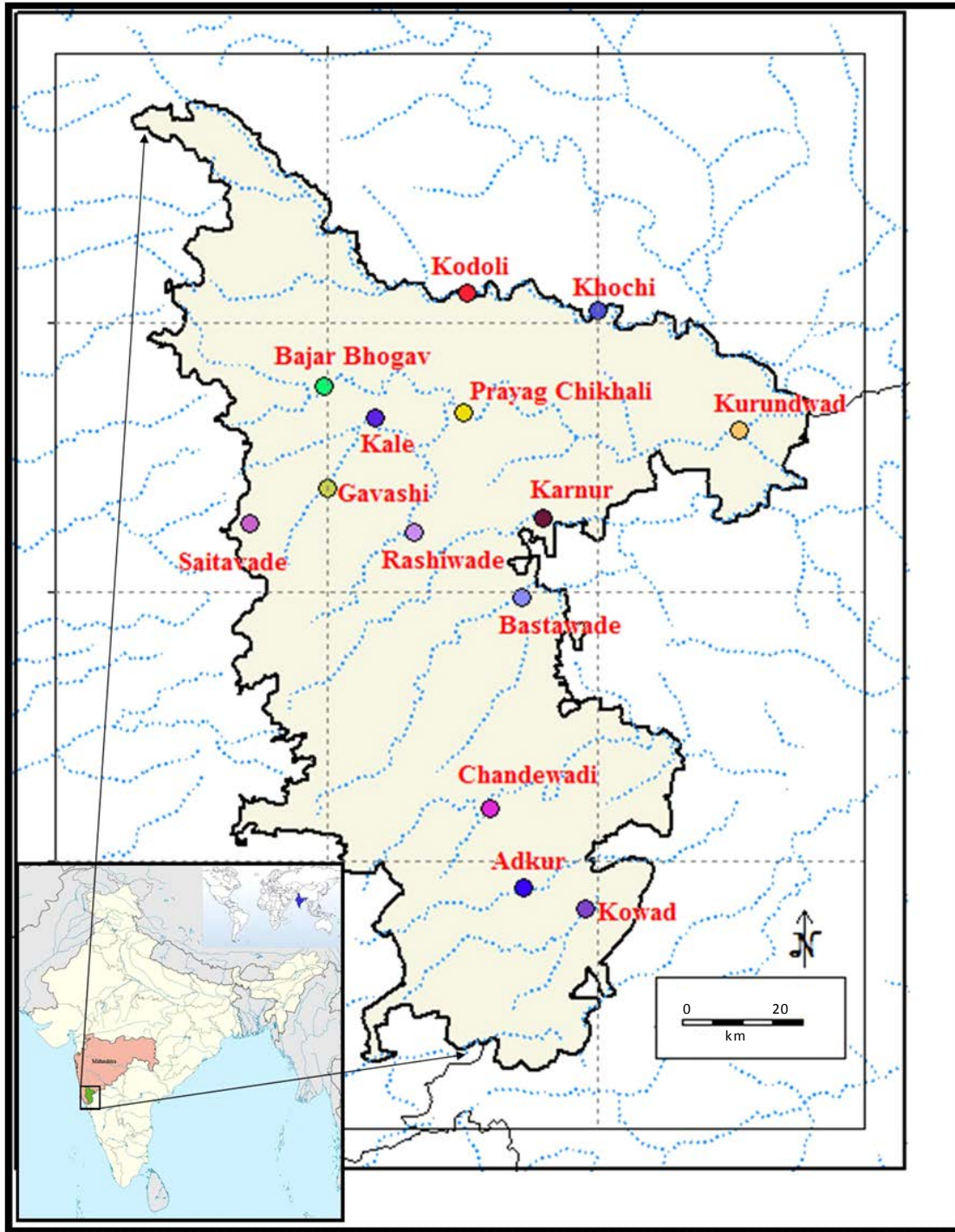


Fig. 1: Study map showing different sampling sites on river

laboratory, properly preserved in 10% buffered formalin and transported to lab for confirmation. Identification of collected fish was done on the basis of morphological features with the help of standard keys (Jayaram, 1999, 2009, 2010). After catching, photographs of fishes were taken immediately as well as in the laboratory using DSLR Camera (EOS 60D, Canon inc, Japan). The

confirmatory identification of species was done at Zoological Survey of India, Western Regional Centre, Pune. All identified specimens are deposited in Department of Zoology, Shivaji University, Kolhapur.

Statistical analysis: For statistical analysis different diversity indices were calculated, namely Shannon diversity index, Margalef's index, Buzas and Gibson's evenness and Simpson's dominance index.

Shannon index (Shannon and Weaver, 1949): A diversity index, taking into account the number of individuals as well as number of taxa, varies from 0 for communities with only a single taxon to high values for communities with many taxa, each with few individuals:

$$H = - \sum_i \frac{n_i}{n} \ln \frac{n_i}{n}$$

where, n_i is number of individuals of 'i' taxon and n is total number of individuals.

Margalef's index (Margalef, 1958):

$$R = (S-1)/\ln N$$

where, S is number of species and N total number of individuals.

Buzas and Gibson's evenness index (Buzas and Gibson, 1969):

$$E = \frac{eH}{S}$$

where, H refers to Shannon weaver index and S is species number.

Simpson dominance index (Simpson, 1949): Ranges from 0 (all taxa are equally present) to 1 (one taxon dominates the community completely):

$$D = \sum_i \left(\frac{n_i}{n} \right)^2$$

where, n_i is number of individuals of 'i' taxon.

Clustering analysis: Dendrogram were constructed to assess the resemblance of fish assemblage structure among the sampling sites by using the Bray-Curtis similarity index using non-transformed species abundance data (Anderson, 2001) using PAST Version 2.17 programme (Hammer *et al.*, 2001).

RESULTS

A total of 23 species belonging to 7 families and 19 genera were recorded (Table 2). In which 6 species are endangered (26%), 3 species are vulnerable (13%), 2 species are near threatened (9%), 11 species are least concern (48%) and 1 species has data deficient (4%) as per IUCN red list

Table 2: Check list of fish species collected from different rivers of Kolhapur district with IUCN redlist category

Family and species	English name	Remarks*	IUCN redlist category**
Cyprinidae			
<i>Puntius sahyadriensis</i> (Silas, 1953)	Khavli barb	E	LC
Cyprinidae			
<i>Salmostoma boopis</i> (Day, 1874)	Boopis razorbelly minnow	E	LC
Cyprinidae			
<i>Hypselobarbus curmuca</i> (Sykes, 1839)	Curmuca barb	NE	EN
Cyprinidae			
<i>Garra bicornuta</i> (Narayan Rao, 1920)	Tunga garra	E	NT
Cyprinidae			
<i>Tor khudree</i> (Sykes, 1839)	Mahseer	NE	EN
Cyprinidae			
<i>Cyprinus carpio</i> (Linnaeus, 1758)	Scale carp	I	VU
Cyprinidae			
<i>Labeo potail</i> (Sykes, 1839)	Deccan labeo	E	EN
Cyprinidae			
<i>Labeo porcellus</i> (Heckel, 1844)	Bombay labeo	E	LC
Cyprinidae			
<i>Schismatorhynchus nukta</i> (Sykes, 1839)	Nukta	E	EN
Bagridae			
<i>Mystus seengtee</i> (Sykes, 1839)	-	E	LC
Bagridae			
<i>Mystus malabaricus</i> (Jerdon, 1849)	Jerdon's mystus	E	NT
Bagridae			
<i>Rita kuturnee</i> (Sykes, 1839)	Deccan rita	E	LC
Bagridae			
<i>Rita gogra</i> (Sykes, 1839)	Gogra rita	E	LC
Nemacheilidae			
<i>Acanthocobitis mooreh</i> (Sykes, 1839)	Loach	E	LC
Nemacheilidae			
<i>Nemacheilus anguilla</i> (Annandale, 1919)	Loach	E	LC
Nemacheilidae			
<i>Nemachilichthys ruppelli</i> (Sykes, 1839)	Loach	E	LC
Nemacheilidae			
<i>Indoreonectes evezardi</i> (Day, 1872)	Loach	E	LC
Schilbidae			
<i>Neotropius khavalchor</i> (Kulkarni, 1952)	Khavalchor catfish	E	DD
Schilbidae			
<i>Proeutropiichthys taakree</i> (Sykes, 1839)	Indian taakree	E	LC
Sisoridae			
<i>Glyptothorax trewavasae</i> (Hora, 1938)	-	E	VU
Sisoridae			
<i>Gagata itchkeea</i> (Sykes, 1839)	Deccan nangra	E	VU
Cobitidae			
<i>Botia striata</i> (Rao, 1920)	Tiger loach	E	EN
Siluridae			
<i>Pterocryptis wynaadensis</i> (Day, 1873)	Malabar silurus	E	EN

*E: Endemic to Western Ghats, NE: Not endemic to Western Ghats, I: Introduced. **LC: Least concern, NT: Near threatened, VU: Vulnerable, EN: Endangered, DD: Data deficient

of threatened species (Fig. 2). Out of 23 fish species, 20 species are endemic to Western Ghats (Dahanukar and Raghavan, 2013). In the present study, cyprinids were the most dominant group represented by 9 species belonging to 8 genera followed by Bagridae (4 species from 2 genera), Nemacheilidae (4 species from 4 genera), Schilbidae (2 species from 2 genera), Sisoridae (2 species from 2 genera), Cobitidae (1 species) and Siluridae (1 species) (Fig. 3). From study sites, *Puntius sahyadriensis*, *Nemacheilus anguilla*, *Pterocryptis wynaadensis* and *Glyptothorax trewavasae* are first time recorded from rivers of Kolhapur district (Table 3). *Pterocryptis wynaadensis* from the Hiranyakeshi river at Chandewadi, *Glyptothorax trewavasae* were recorded from Panchganga river

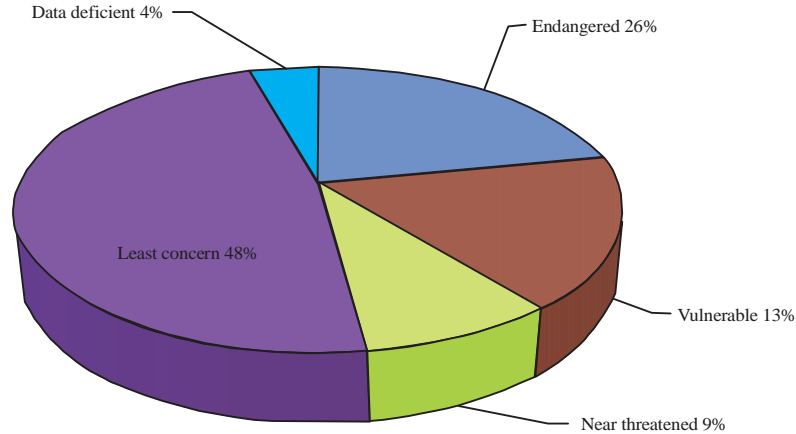


Fig. 2: Percentage composition of conservation status (IUCN) of fish fauna

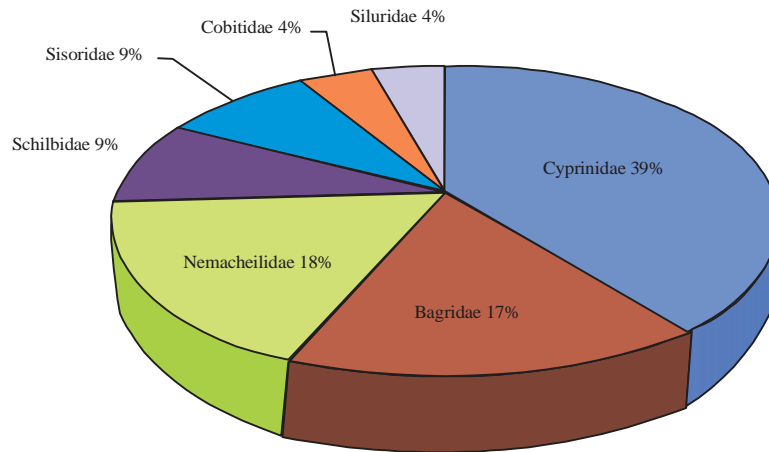


Fig. 3: Percentage composition of families

at Prayag Chikhali sampling site. Three species namely *Nemacheilus anguilla*, *Glyptothorax trewavasae* and *Puntius sahyadriensis* were reported by Jadhav *et al.* (2011) from Koyna river at Wai. As per reviews and literature available, the *Pterocryptis wynaadensis* are presently reported from few localities namely Kabini, Kuttiyadi, Chandragiri, Tungabhadra, Bedti, Bhavani, Moyar, Tamraparni and Neerar River Systems (Raghavan *et al.*, 2007). The highest number of individuals is observed from family Bagridae. A total of 161 individuals of *Mystus malabaricus* 25.63% were recorded followed by *Mystus seengtee* 15.60% (98) and *Hypselobarbus curmuca* 10.19% (64). The remaining species wise percent composition is also calculated (Fig. 4).

High Shannon diversity index showed considerable variation and ranged from 1.34-2.43 indicates a strong relationship with overall species richness. The maximum fish diversity index was observed in middle stretch as compared to lower and upper stretch. The highest fish diversity was recorded from Panchganga river on Prayag Chikhali sampling site i.e. 26.43%. The lowest diversity was recorded from Ghatprabha and Tamraparni river on Adkur and Kowad sampling site (3.50 and 3.18%), respectively. Margalef's diversity index, Simpson dominance index and Evenness index for

Table 3: List of fish species recorded at each sampling site

Species name	Sampling sites													
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
<i>Puntius sahyadriensis</i>	-	-	-	-	-	2	4	5	6	-	-	-	-	-
<i>Salmostoma boopis</i>	-	-	6	4	-	-	-	-	-	-	-	-	-	-
<i>Hypseobarbus curmuca</i>	7	8	7	18	-	6	1	2	-	2	5	2	3	3
<i>Garra bicornuta</i>	2	-	-	2	1	-	-	-	-	-	-	-	-	-
<i>Tor khudree</i>	-	-	-	3	-	-	-	-	1	-	-	-	-	-
<i>Cyprinus carpio</i>	8	3	6	7	3	2	1	1	5	3	3	2	4	-
<i>Labeo potail</i>	-	-	-	4	-	-	-	-	-	-	1	-	-	-
<i>Labeo porcellus</i>	-	2	-	2	-	-	-	-	-	1	-	-	-	-
<i>Schismatorhynchus nukta</i>	4	3	-	8	-	-	-	-	-	-	-	-	-	-
<i>Mystus seengtee</i>	0	0	16	26	3	3	4	-	7	9	6	11	6	7
<i>Mystus malabaricus</i>	7	14	22	45	2	22	5	-	12	11	11	7	3	-
<i>Rita kuturnee</i>	-	-	13	16	11	4	2	1	-	2	-	-	3	5
<i>Rita gogra</i>	-	2	7	5	-	-	-	-	-	-	-	-	-	-
<i>Acanthocobitis mooreh</i>	-	-	-	-	6	-	3	2	-	-	-	3	-	-
<i>Nemacheilus anguilla</i>	-	-	-	4	3	-	-	-	-	-	-	-	-	-
<i>Nemacheilus ruppelli</i>	-	-	-	2	-	-	-	1	-	-	-	-	-	-
<i>Indoreonectes evezardi</i>	3	-	-	3	-	3	2	9	-	11	11	9	3	5
<i>Neotropiichthys khav alchor</i>	-	-	6	8	1	5	-	-	-	-	-	-	-	-
<i>Proeutropiichthys taakree</i>	-	2	5	-	-	-	-	-	-	-	-	-	-	-
<i>Glyptothorax trewavasae</i>	-	-	-	4	-	-	-	-	-	-	-	-	-	-
<i>Gagata itchkeea</i>	-	-	-	2	-	-	-	-	-	-	-	-	-	-
<i>Botia striata</i>	-	-	2	3	-	-	-	-	-	-	-	-	-	-
<i>Pterocryptis wynaadensis</i>	-	-	-	-	-	-	-	-	-	-	-	2	-	-

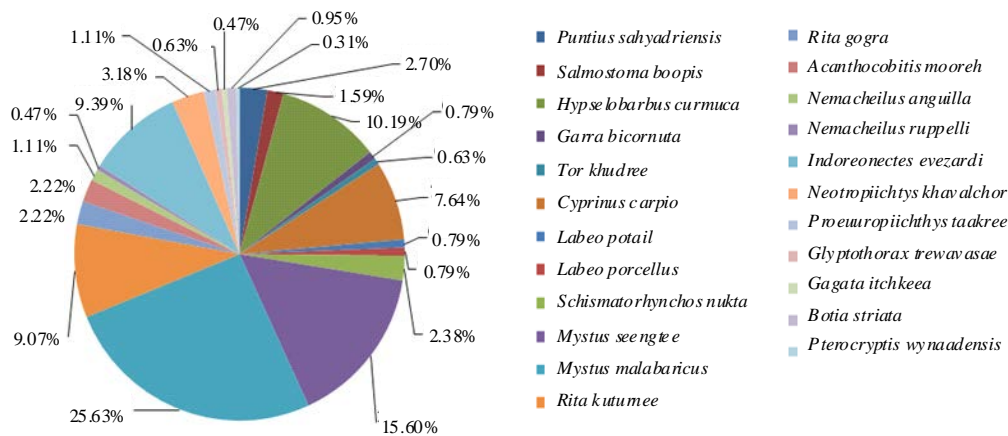


Fig. 4: Percentage composition of species

each sampling site was also recorded (Table 4). The similarities in species composition among the sites were analyzed by using the Bray-Curtis similarity index. A positive relationship were observed from nearby sampling site along the river have similar faunal assemblage. The similarity in species composition across all sampling sites is shown in dendrogram (Fig. 5).

Notes on new records

***Puntius sahyadriensis* (Fig. 6a):** Body short, compressed, head is more or less blunt, eyes large situated more towards the anterior half of the head. The barbels are absent. Body with seven vertical black bands. Pelvic fin shows black and white colouration.

Table 4: Summary of variation in species abundance, richness index, Shannon index, evenness index and dominance

Study sites	Sampling sites													
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
Species	7	7	10	19	7	8	8	7	5	7	6	7	6	4
Individuals	33	37	90	166	27	47	22	21	31	39	37	36	22	20
Shannon index	1.76	1.67	2.11	2.43	1.62	1.68	1.94	1.58	1.42	1.64	1.58	1.71	1.75	1.34
Margalef's index	1.71	1.66	2	3.52	1.82	1.81	2.26	1.97	1.16	1.63	1.38	1.67	1.61	1.00
Evenness index	0.83	0.75	0.82	0.59	0.72	0.67	0.87	0.69	0.83	0.74	0.81	0.79	0.96	0.95
Dominance index	0.19	0.23	0.14	0.13	0.24	0.26	0.15	0.26	0.26	0.22	0.22	0.20	0.18	0.27

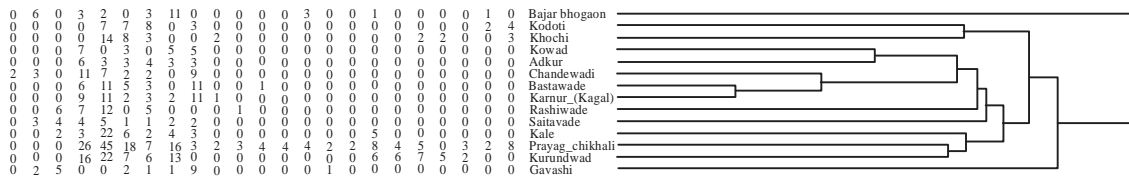


Fig. 5: Dendrogram resulting from Bray-Curtis similarities of species abundance data of study sites



Fig. 6(a-d): (a) *Puntius sahyadriensis*, (b) *Glyptothorax trewavasae*, (c) *Nemacheilus anguilla* and (d) *Pterocryptis wynaadensis*

***Glyptothorax trewavasae* (Fig. 6b):** Head small, depressed and covered with thick skin. Mouth conical but not pointed. Lips thick, fleshy, papillated. Four pairs of barbels; one pair of maxillary, one pair of nasal and two pairs of mandibular. Adhesive apparatus well developed extending forward to a point between union of gill membranes with isthmus.

***Nemacheilus anguilla* (Fig. 6c):** Body loach like, dorsal fin with eight branched rays, body with a row of black blotches running along midlateral line and extending up to the caudal fin. Small spots also present on dorsal and caudal fins.

***Pterocryptis wynaadensis* (Fig. 6d):** Body laterally compressed, head somewhat flattened and broader than body. Eyes small situated just above the angle of the mouth. Snout with rounded anterior profile. Two pairs of mandibular barbels. Caudal fin rounded.

DISCUSSION

The present study revealed that the rivers of Kolhapur district have a diverse ichthyofauna of high conservation importance. In present study, 23 species were observed when we compare this data to previous available literature, the number of species are going to decline. As expected, the cyprinids dominate the assemblage structure as they occupy all possible habitats and due to their high adaptive property. We pointed that, number of endemic species like *Tor khudree*, *Botia striata*, *Gagata itchkeea*, *Schismatorhynchos nukta* and *Pachypterus khavalchor* become very rare. From Kolhapur district including Warana river, Kalwar and Kelkar (1956) got 71 species in which most of the species are abundant, after this attempt Mohite and Samant (2013) reported 42 species in which 19.04% species are become very rare when they compare the data to earlier. In our finding, *Tor khudree*, *Botia striata*, *Gagata itchkeea*, *Schismatorhynchos nukta*, *Pachypterus khavalchor* and *Rita gogra* become rare. Similar results were obtained from Panchganga river but the species namely *Gagata itchkeea*, *Rita kuturnee*, *Rita gogra*, *Proeutropiichthys taakree*, *Garra bicornuta* and *Nemachilichthys ruppelli* are very rare. Due to lack of fish diversity data from Dudhganga, Vedganga, Hiranyakeshi, Ghatprabha and Tamraparni rivers, it is not possible to assess the rate of decline in endemic and threatened fish species from Kolhapur district. Another important finding is first report of *Puntius sahyadriensis*, *Nemacheilus anguilla*, *Pterocryptis wynaadensis* and *Glyptothorax trewavasae* from study sites.

The earlier researchers concluded that, the species richness, diversity and its abundance is increased from upstream to downstream (Welcomme, 1985; Bayley and Li, 1994; Lorencio, 2000). But the present results revealed that the middle stretch sampling site (Prayag chikhali) of Panchganga river has higher species richness, diversity and its abundance. Numbers of threats were recorded from tributaries of Panchganga that affects the assemblage structure of Kasari, Kumbhi, Dhamani and Bhogawati rivers. The main threats recorded includes drying of upper stretch during summer month and at the same time use of dynamites for fishing purpose, fragmentation due to construction of dams and weirs, sand mining, agriculture expansions and over fishing. All these factors collectively contributes the destruction of natural habitat of aquatic fauna. Due to all such factors, the species richness was high in middle stretch of Panchganga river at Prayag Chikhali sampling site as compared to lower and upper stretches sampling sites. Whereas, at remaining sampling sites namely Kagal karnur on Doodhganga river, Bastwade on Vedganga river, Chandewadi on Hiranyakeshi river, Adkur on Ghatprabha river and Kowad on Tamraparni river same threats were recorded that affects the assemblage structure.

The present attempt provides data concerning the assemblage structure and diversity of endemic and threatened fish species from Northern Western Ghats of Kolhapur district. From this small attempt it is concluded that, the number of threats to fish fauna from rivers of Kolhapur district is very high. There is an urgent need to take a concrete decision towards the conservation of ichthyofauna. If the present trend continues, the adverse conditions might lead to the loss of the ichthyofauna from Northern Western Ghats of Kolhapur district.

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