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RECENT ICHTHYOFAUNAL COLLECTIONS FROM THE WAYANAD PART OF WESTERN GHATS, KERALA, INDIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Both the authors have equally taken part in the various aspects of the work and manuscript preparation. Both authors read and approved the final manuscript.

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ABSTRACT

The objective of the study was to prepare a catalogue of freshwater fish species from the Wayanad part of Western Ghats, Kerala, India. The freshwater fish fauna of the region was studied for a period from June 2017 to August 2021 with a sampling frequency of once in pre-monsoon, once in post monsoon and once in summer (three times a year). The fishes were collected using various fishing gears from 12 sampling stations. A total of 60 species of freshwater fishes belonging to 37 genera, 20 families and nine orders were collected during the current study. Cypriniformes (58.33%) was the most species rich order with 35 species followed by Anabantiformes (11.66%) with 7 species; Order Siluriformes (10%) was represented by 6 species; Cyprinodontiformes (6.66%) by 4 species; Cichliformes (5%) by 3 species and Synbranchiformes (3.33%) by 2 species. Order Gobiiformes, Beloniformes and Anguilliformes were represented by each of one species (1.66%). The family Cyprinidae was dominated among the collected fishes (S=18). One species was Critically Endangered (CR), one species was Endangered (EN), one was Vulnerable (VU), five were Near Threatened (NT), 30 Least Concern (LC), five Not Evaluated (NE) and one was Data Deficient (DD) as per the IUCN Red List criteria.

Keywords: Wayanad; freshwater fishes; Kabini River; conservation.

1. INTRODUCTION

The Western Ghats of India is a UNESCO World Heritage Site and is also known as the "Great Escarpment of India" [1]. "Being one of the biodiversity hotspots in the world, India is endowed with a rich biodiversity of freshwater fishes in the Western Ghats and the North Eastern Hills" [2]. "The freshwater fish fauna is one of the important, threatened and endemic taxonomic groups of the Western Ghats that contribute critical ecological services in aquatic ecosystems" [3,4]. Fishes in the

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Western Ghats are under threat due to several anthropogenic stressors [5] "such as industrial and urban pollutants, habitat loss, dam constructions, unmanaged aquarium trade, introduction of alien fish species and global warming" [6,7,8].

The history of Indian freshwater fish faunal studies in the Western Ghats region goes back to Hamilton [9], who studied the fish fauna found in the state of Mysore, Canara and Wayanad. A comprehensive and authoritative account on the freshwater fish fauna of the Wayanad region has been provided by Jerdon [10,11] and Day [12]. "Since then, there have been several investigations on the freshwater fish fauna of the Western Ghats region and many new fish species have been discovered and their taxonomic and systematic studies are an active area of research. Some of the newly described freshwater fishes from the Western Ghats region includes, *Dario urops"* [13], *Pethia longicauda* [14], *Dario huli* [15], *Pethia striata* [16], *Dario neela* [17], *Channa rara* [18], *Aenigmachanna gollum* [18], *A. mahabali* [19], *Pangio bhujia* [20] and three species of filament barbs *Dawkinsia crassa*, *D. apsara* and *D. Austellus* [21]. The record of new fish species in the Western Ghats region indicates the importance of further extensive scientific studies on freshwater fishes of this region.

Wayanad is a hill district in Kerala with an area of 2131 sq.kms (km^2) and is mainly drained by Kabani and its three main tributaries viz. Panamaram, Mananthawady and Tirunelli. Other tributaries include Bavelipuzha and Noolpuzha. Kabani River is one of the three east flowing rivers in Kerala and is an important tributary of the Cauvery River. Though freshwater fish diversity studies are going on in Kerala, most of the region sampled in the present study have not been systematically sampled and recorded (as per the available literature). The present study will provide baseline data for preparing conservation management plans targeting the fishes and will be useful to design fisheries policy related to the Wayanad region.

2. MATERIALS AND METHODS

2.1 Survey and Sample Collection

Fish sampling was carried out from June 2017 to August 2021with a frequency of once in pre-monsoon, once in post monsoon and once in summer (three times a year). Twelve sampling stations were randomly selected (Image 1 and Table 1). Fishing operations and sample collections were made using various fishing gears like cast nets, scoop nets, and gill nets of varying mesh size. Traditional fishing techniques like bamboo cage traps and sieving by cloth were also used in suitable areas. Only a minimum number of fish were collected for identification and the rest were released back into the stream, immediately after capture. Fish specimens obtained were fixed in 10% formaldehyde. For DNA barcoding, fin clips of every species were preserved in 100% ethanol.

2.2 Species Identification and Taxonomy

Taxonomic keys with illustrations made by Nelson et al. [22], Tan & Armbruster [23] were followed "for the family status while overall taxonomy" and nomenclature follows Fricke et al. [24]. Conservation status of fishes were obtained from IUCN [25]. Specimens with taxonomic ambiguity were preserved for future DNA barcoding studies. Voucher specimens were made for each species and were deposited at the Biodiversity and Molecular biology Lab, Dept. of Zoology, Kannur University Campus, Wayanad, Kerala. Specimens which could not be identified up to species level have not been deposited as further studies on them are in progress.

Table 1. Details of sampling sites in Wayanad district

No	Site (S)	Latitude N	Longitude E
1	Manathavady (S1)	11°47'07.3"N	76°00'31.9"E
2	Karapuzha (S2)	11°36'57.8"N	76°10'45.0"E
3	Thirunelli (S3)	11°54'13.8"N	75°59'44.2"E
4	Panamaram (S4)	11°44'43.0"N	76°04'49.2"E
5	Ellumantham (S5)	11°47'16.9"N	75°57'41.1"E
6	Kambamala (S6)	11°50'28.9"N	75°59'55.6"E
7	Tavinjal (S7)	11°50'36.6"N	75°56'33.2"E
8	Suganthagiri (S8)	11°34'02.2"N	75°59'42.1"E
9	Vythiri (S9)	11°33'14.6"N	76°02'23.1"E
10	Periya (S10)	11°50'10.2"N	75°51'27.7"E
11	Padinjarathara(S11)	11°40'33.4"N	75°58'05.0"E
12	Mullenkolly (S12)	11°49'05.8"N	76°10'35.5"E

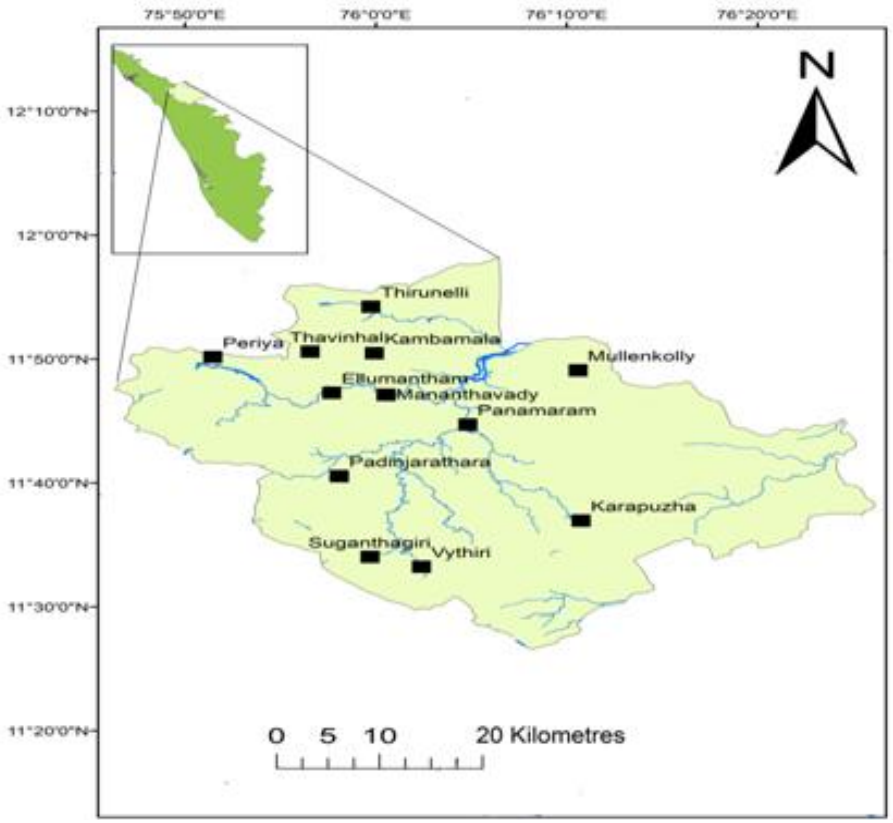

Image 1. Map of study area with sampling stations

3. RESULTS

A total of 60 species belonging to 37 genera, 20 families, and nine orders were obtained during the current study. Cypriniformes were the most species rich order (S=35, 58.33 %) followed by Anabantiformes (S=7, 11.66 %), (Table 3). Among the families, Cyprinidae dominated with 18 species followed by Danionidae with nine species, Nemacheilidae with six species, Aplocheilidae, Cichlidae, and Channidae with three species each, Osphronemidae, Siluridae, Bagridae and Badidae with two species and the remaining 10 families with one species each. Of these, 20 species were endemic to the Western Ghats (Fig. 1). Two species *Oreochromis mossambicus* and *Poecilia reticulata* were exotic to the country. Karapuzha (S2) had the highest species richness (n= 15), followed by Manathavady (S1) (n= 13). Species level identification was not possible in nine instances as the specimens showed substantial differences in morphology from that of their congeners reported earlier from the region. The conservation status of the species collected in the present study revealed that one species was Critically Endangered (CR), one species was of endangered category, one species was Vulnerable, five species were Near Threatened, 30 of Least Concern, one Data Deficient and five were of Not Evaluated category (Fig. 2). A detailed list of the fishes collected with their order, family, subfamily, species, location, red list status, and endemicity is provided in the following (Table 2) and the images of some of the fishes are provided in Plates 1-4.

3.1 Morphological Variants Encountered during the Study

Several distinct *Aplocheilus* species were collected during the course of the study. Of the collected specimens, most of them were *Aplocheilus lineatus* (Valenciennes, 1846). In some cases, the colour pattern of the specimens do not match with that of the *A. lineatus* described earlier. *Haludaria* cf. *melampyx*, Garra cf. mullya, *Garra* cf. *mcclellandi*, *Amblypharyngodon* cf. *microlepis*, *Amblypharyngodon* cf *melittinus*, *Schistura* cf. *nilgiriensis*, *Mesonoemacheilus* cf. *Pambarensis*, *Pseudosphromenus* cf *cupanus* are the other morphological variants encountered in the study. Careful examination of the specimens and their molecular genetic characterization could reveal whether the specimens comprise of cryptic species.

Plate 1.

4. DISCUSSION

"The current study is an attempt to prepare a comprehensive list of freshwater fishes of Wayanad part of Western Ghats, Kerala. A total of 60 species belonging to nine orders, 20 families and 37 genera are described. Of these, 20 species were endemic to the Western Ghats. As per the available literature most of the region sampled in the present study have not been systematically sampled and recorded. Until now documentation of freshwater fishes from the Wayanad region was done in 1900s" [26]. Currently the data of their study is not available in the public domain. Later, in the year 1997 the same authors [27] documented "the fresh water fishes from the selected region of Wayanad, as a part of their study of freshwater fish diversity in Kerala part of the Nilgiri Biosphere Reserve. They obtained a total of 92 species where 37 species were endemic to Western Ghats. Similarly, 45 species of fresh water fishes were documented from Aralam wild life sanctuary in the Kannur region of Western Ghats where 26 species were Western Ghats endemics" [28]. Species like *Pethia pookodensis* (Mercy & Jacob 2007), *Pethia nigripinnis* (Knight, Rema Devi, Indra & Arunachalam 2012), and *Dario neela* (Britz et al. 2018), were subsequently described from the study area. However, the collections are of conservation significance that one critically endangered, one endangered, one Vulnerable and five Near Threatened species were recorded from the streams adjacent to human-inhabited areas. Proper management plans should be choked out like setting

quotas for fishing or imposing localized bans for fishing during the breeding season of these fishes to conserve them. Moreover, the water pollution due to soil mining, sand mining, rock mining, agricultural run-offs, industrial effluents and invasive species noticed in study the area should be strictly controlled.

"In the present study, species level identification was not possible in nine cases as the specimens showed substantial differences in their morphology with that of their congeners reported from the region by previous workers. Two species of invasive fishes (*Oreochromis mossambicus* and *Poecilia reticulata*) were collected during the study are now well established, and widely distributed in the study area. *The introduction and establishment of non-native species can have adverse effects on individuals, populations, and communities of native species, and those have already been introduced have contributed to the decline or extinction of native species throughout the world"* [29,30]. Managing the aquaculture of non-native species through legislation and enforcing strict licensing for aquarium or pet shops should be given top priority. Otherwise, these practices could destroy the rich freshwater fish biodiversity of the region.

Plate 2.

Plate 3.

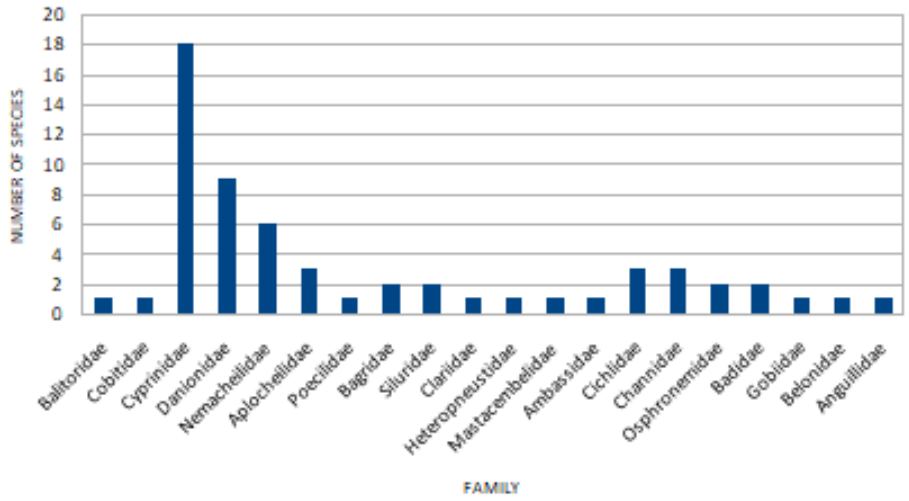

Fig. 1. Family wise diversity of freshwater fishes of Wayanad region

Plate 4.

Table 2. Systematic list of freshwater fishes of Wayanad with their distribution, conservation status and endemism

Sl No	Order/ Family/ Species	Locations	Red List status	Endemicity
	Order: Cypriniformes			
	Family: Balitoridae			
1	*Bhavania australis* (Jerdon, 1849)	S8	LC	WG
	Family: Cobitidae			
2	*Lepidocephalichthys thermalis* (Valenciennes 1846)	S4	LC	
	Family: Cyprinidae			
3	*Dawkinsia filamentosa* (Valenciennes 1844)	S4	LC	WG
4	*Haludaria fasciata* (Jerdon, 1849)	S3, S6, S7	LC	WG
5	*Haludaria* cf *melampyx*	S8		
6	*Pethia punctata* (Day, 1865)	S4	LC	WG
7	*Pethia conchonius (*Hamilton, 1822)	S1	LC	
8	*Pethia pookodensis* (Mercy & Jacob, 2007)	S3, S6, S7	CR	WG
9	*Pethia nigripinnis* (Knight, Rema Devi, Indra & Arunachalam, 2012)	S2	NE	WG
10	*Puntius machecola* (Valenciennes,1844)	S1	DD	WG
11	*Puntius vittatus* Day, 1865	S10	LC	
12	*Puntius bimaculatus* (Bleeker 1863).	S3	LC	
13	*Puntius melanostigma* (Day 1878).	S2	NE	
14	*Osteochilichthys nashii* (Day, 1869)	S11	LC	WG
15	*Cirrhinus mrigala* (Hamilton, 1822	S2		
16	*Labeo rohita* (Hamilton, 1822)	S2		
17	*Cyprinus carpio* Linnaeus, 1758	S2		
18	*Labeo catla* (Hamilton 1822)	S2		
19	*Garra* cf. *mullya*	S6, S8		
20	*Garra cf. mcclellandi*	S8		

Sl No	Order/ Family/ Species	Locations	Red List status	Endemicity
	Family: Danionidae			
21	*Danio rerio* (Hamilton, 1822)	S5, S7	LC	
22	*Devario neilgherriensis* (Day, 1867)	S1, S8	EN	WG
23	*Opsarius malabaricus* Jerdon, 1849	S2	NE	WG
24	Salmostoma balookee (Sykes, 1839)	S6	LC	WG
25	*Amblypharyngodon* cf *melittinus*	S5		
26	*Amblypharyngodon microlepis* (Bleeker 1853)	S2	LC	
27	*Amblypharyngodon* cf. *microlepis*	S2		
28	*Rasbora dandia* (Valenciennes, 1844)	S1, S2	LC	
29	*Rasbora caverii* (Jerdon 1849)	S6	LC	
	Family: Nemacheilidae			
30	*Schistura semiarmata* (Day 1867).	S9	LC	WG
31	*Schistura* cf. *nilgiriensis*	S7		
32	*Schistura nilgiriensis* (Menon 1987)	S7, S8	LC	WG
33	*Mesonoemacheilus pambarensis* (Rema Devi & Indra, 1994)	S1	VU	WG
34	Mesonoemacheilus cf. pambarensis	S3		
35	Mesonoemacheilus guentheri (Day, 1867)	S1	LC	WG
	Order: Cyprinodontiformes			
	Family: Aplocheilidae			
36	*Aplocheilus lineatus* (Valenciennes, 1846)	S3, S6	LC	
37	*Aplochelius* cf.*lineatus*	S6, S8		
38	*Aplochelius* sp.	S3		
	Family: Poecilidae			
39	*Poecilia reticulata* Peters, 1859	S5		
	Order: Siluriformes			
	Family: Bagridae			
40	*Mystus malabaricus* (Jerdon, 1849)	S1	NT	WG
41	*Mystus montanus* (Jerdon, 1849)	S1, S11	LC	WG
	Family: Siluridae			
42	*Ompok bimaculatus* (Bloch, 1794)	S12	NT	
43	Wallago attu (Bloch & Schneider, 1801)	S1	NT	
	Family: Clariidae			
44	*Clarias dussumieri* Valenciennes, 1840	S1, S2	NT	
	Family:Heteropneustidae			
45	*Heteropneustes fossilis* (Bloch, 1794)	S1	LC	
	Order: Synbranchiformes			
	Family: Mastacembelidae			
46	*Mastacembelus armatus* (Lacepède, 1800)	S2	LC	
	Family: Ambassidae			
47	*Parambassis thomassi* (Day, 1870)	S4	LC	WG
	Order: Cichliformes			
	Family: Cichlidae			
48	*Oreochromis mossambicus* (Peters, 1852)	S7, S3		
49	*Pseudetroplus maculatus* (Bloch, 1795)	S4	LC	
50	Etroplus suratensis (Bloch, 1790)	S2, S11	LC	
	Order: Anabantiformes			
	Family: Channidae			
51	*Channa gachua* (Hamilton, 1822)	S3, S5	LC	
52	*Channa marulius (*Hamilton, 1822)	S2	LC	
53	*Channa striata* (Bloch, 1793)	S2, S11	LC	
	Family: Osphronemidae			
54	Pseudosphromenus cupanus (Cuvier, *1831)*	S1, S3	LC	
55	*Pseudosphromenus* cf *cupanus*	S5, S7		

Sl No	Order/ Family/ Species	Locations	Red List status	Endemicity
	Family:Badidae			
56	*Dario neela Britz*, Anoop & Dahanukar, 2018	S8	NE	WG
57	*Dario huli* Britz & Ali 2015	S8	NE	WG
	Order: Gobiiformes			
	Family: Gobiidae			
58	*Glossogobius giuris* (Hamilton, 1822)	S9, S12	LC	
	Order: Anguilliformes			
	Family: Anguillidae			
59	*Anguilla bengalensis* (Gray, 1831)	S1, S11	NT	
	Order: Beloniformes			
	Family: Belonidae			
60	*Xenentodon cancila* (Hamilton, 1822)	S4, S12	LC	

a. IUCN categories: CR-Critically Endangered: EN-Endangered; LC - Least Concern; NT - Near Threatened, VU - Vulnerable; DD data deficient: NE - Not Evaluated.
b. Endemicity: WG - Western Ghats; I - Introduced
S1-12; Sampling stations 1-12

Table 3. Composition of genera and species under different orders

S. No	Order	Genera	% of genera in order	Species	% of species in order
1	Cypriniformes	19	51.35	35	58.33
2	Cyprinodontiformes	2	5.40	4	6.66
3	Siluriformes	5	13.51	6	10
4	Synbranchiformes	2	5.40	2	3.33
5	Cichliformes	3	8.11	3	5
6	Anabantiformes	3	8.11	7	11.66
7	Gobiiformes	1	2.70	1	1.66
8	*Anguilliformes*	1	2.70	1	1.66
9	*Beloniformes*	1	2.70	1	1.66

Fig. 2. Conservation status of freshwater fishes of Wayanad region

5. CONSERVATION MEASURES

Unscientific methods of fishing and indiscriminate harvest of fishes in the study area should be completely prohibited. Streams and marshes close to the main river systems should be protected, since they are the spawning grounds of several native fish species. Farming and cultivation of non-native species in the regions adjacent to river channels should not be encouraged. Activities like soil mining, sand mining and rock mining close to the water bodies should be legally banned. Create public awareness about the importance of conservation of native fish species.

6. CONCLUSION

Though we studied several streams in the region during the survey, records of more species are expected and further taxonomic studies are essential for calculating the true diversity of fishes in this

region. The present study would give a base line information to formulate the necessary conservation strategies to protect the faunal diversity in the Wayanad region. Moreover, the study area experienced two consecutive floods in the years 2018 and 2019 and the present work may also help to set a foundation for detailed studies on the impacts of flood on the freshwater fish diversity and distribution.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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