



The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication

Journal of Threatened Taxa

Building evidence for conservation globally

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

ARTICLE

FISH DIVERSITY IN STREAMS/RIVERS OF KALAKAD-MUNDANTHURAI TIGER RESERVE, TAMIL NADU, INDIA

K. Kannan & J.A. Johnson

26 November 2020 | Vol. 12 | No. 15 | Pages: 17077–17092

DOI: 10.11609/jott.6249.12.15.17077-17092



For Focus, Scope, Aims, Policies, and Guidelines visit <http://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-0>

For Article Submission Guidelines, visit <http://threatenedtaxa.org/index.php/JoTT/about/submissions#onlineSubmissions>

For Policies against Scientific Misconduct, visit <http://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-2>

For reprints, contact ravi@threatenedtaxa.org

The opinions expressed by the authors do not reflect the views of the Journal of Threatened Taxa, Wildlife Information Liaison Development Society, Zoo Outreach Organization, or any of the partners. The journal, the publisher, the host, and the partners are not responsible for the accuracy of the political boundaries shown in the maps by the authors.

Member



Publisher & Host





Fish diversity in streams/rivers of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu, India

K. Kannan¹ & J.A. Johnson²

^{1,2}Wildlife Institute of India, #18, Chandrabani, Dehradun, Uttarakhand 248001, India.

¹Present address: Department of Animal Health and Management, Alagappa University, Karaikudi, Tamil Nadu 630003, India.

¹kanna.k84@gmail.com, ²jaj@wii.gov.in (corresponding author)

Abstract: This article describes fish diversity in streams and rivers of Kalakad-Mundanthurai Tiger Reserve (KMTR), Tamil Nadu. Fifty species of fishes belonging to 10 orders, 15 families, and 32 genera are recorded. Seven species, *Garra joshuai*, *G. kalakadensis*, *Haludaria kannikattiensis*, *Hypseobarbus tamiraparniei*, *Mesonemachilus tambraparniensis*, *Neolissochilus tamiraparniensis*, and *Dawkinsia tambraparniei* are strictly endemic to this protected area. The minnows, *Devocio aequipinnatus*, *Garra mulya*, and *G. kalakadensis* are widely distributed in KMTR streams. High species diversity ($H' = 2.81$) was recorded in Gadana River, whereas low species diversity ($H' = 0.61$) was registered in Poonkulam area. Bray-Curtis similarity analysis showed that sites along the headwater streams have similar faunal assemblage. Result of regression analysis revealed that there is a significant pattern explained between stream order and species richness ($r^2 = 0.86$; $p < 0.05$). Among 50 species, four (*Garra kalakadensis*, *G. joshuai*, *Dawkinsia tambraparniei*, and *Tor malabaricus*) are listed in threatened categories of IUCN Red List. Important threats faced by endemic species and their management strategies are discussed.

Keywords: Agasthyamalai, Pisces, Poonkulam, Tamiraparni, Western Ghats.

Editor: Rajeev Raghavan, Kerala University of Fisheries and Ocean Studies (KUFOS), Kochi, India.

Date of publication: 26 November 2020 (online & print)

Citation: Kannan, K. & J.A. Johnson (2020). Fish diversity in streams/rivers of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu, India. *Journal of Threatened Taxa* 12(15): 17077–17092. <https://doi.org/10.11609/jota.6249.12.15.17077-17092>

Copyright: © Kannan & Johnson 2020. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use, reproduction, and distribution of this article in any medium by providing adequate credit to the author(s) and the source of publication

Funding: Department of Science and Technology, New Delhi (Grant No:SR/FT/LS-094/2007 dt. July 23, 2009).

Competing interests: The authors declare no competing interests.

Author details: K. Kannan is a fish biologist, working on ecology and biology of freshwater and marine fishes. Presently, he is working as UGC Dr. D. S. Kothari Post-Doctoral Fellow in Alagappa University, Karaikudi, India. His research interests include fish taxonomy, ecology, molecular systematics and fish stock assessment. J.A. Johnson has been working on taxonomy, ecology and biology of Indian fishes. His research included species distribution patterns, community structure, spatio-temporal changes in resource (food and space) partitioning among co-existing species, conservation of rare and threatened species, e-fl w assessment and effects of human disturbance on aquatic resources. Currently he is co-ordinating the freshwater fish monitoring project under MoEFCC's Long-term Ecological Observation (LTEO) programme.

Author contribution: K. Kannan—involved in field sampling, data collection and data analysis; J.A. Johnson—involved in field sampling, Supervision, data analysis, image preparation and manuscript drafting

Acknowledgements: The principal investigator (PI) is thankful to the Principal Chief Conservator of Forests and Chief Wildlife Warden, Tamil Nadu and the Field Director, Kalakad-Mundanthurai Tiger Reserve, Tirunelveli for providing necessary permission to carry out this work (No.WL5/23465/2010 dated 28.08.2010). The PI extends his gratitude to the forest range officers of KMTR and his supporting staff for their assistance in field sampling. We also thank Shri K. Krishna Prasad from Osmania University, Hyderabad for providing an image of *Puntius bimaculatus*. The PI would like to thank the Director, Dean and Research Coordinator, Wildlife Institute of India (WII) for their support and encouragement. The financial support from the Department of Science and Technology, New Delhi under Fast Track Young Scientist scheme is sincerely acknowledged.



INTRODUCTION

Kalakad-Mundanthurai Tiger Reserve (KMTR) is one of the important biodiversity rich areas in southern Western Ghats forming an important watershed for the perennial east flowing Tamiraparani River. Since this reserve has many perennial streams and rivers, this protected area is popularly known as River Sanctuary (Johnsingh & Viickram 1987). The watershed area has very rich fish fauna with notable endemic and globally threatened species. Information on fishes of this region emerged in 1950s with the description of two new species *Garra joshuai* and *Dawkinsia tambraparniei* (Silas 1953). Later, Johnsingh & Viickram (1987) provided the first comprehensive list of fishes (33 species) of the Mundanthurai Sanctuary with illustrations. This checklist covered the fishes from dams and associated rivers in Mundanthurai Sanctuary, and gave an insight into the ichthyological diversity of this region. Subsequently, four new species *Garra kalakadensis* (Remadevi 1992), and *Haludaria kannikattiensis* Arunachalam & Johnson 2002, *Hypselobarbus tamiraparaniei* Arunachalam et al. 2014 and *Neolissochilus tamiraparaniensis* Arunachalam et al. 2017 were described from this region. In addition to taxonomy, ecology and biology of fishes of this region have also been studied in recent years (Johnson & Arunachalam 2010, 2012; Kannan et al. 2013, 2014). Despite this, the diversity of fishes in KMTR is probably underestimated, because many streams/ rivers of KMTR had not been explored in the past. Further, comprehensive information on fish in KMTR is still in an emerging stage. Hence, the present paper is an attempt to provide an updated status of the fish diversity and assemblage structure associated with different streams/ rivers of KMTR.

MATERIALS AND METHODS

Study Area

Kalakad-Mundanthurai Tiger Reserve is located in the southern end of Western Ghats in Tirunelveli District, Tamil Nadu. This reserve comprises of four wildlife sanctuaries, namely, Kalakad, Mundanthurai, Nellai, and Kanyakumari, covering a total area of about 1,601 km². It lies between 8.4166–8.8833 °N & 77.1666–77.9166 °E with altitude ranging from 50m to 1,868 m at the highest point, Agasthyamalai Peak. This area represents diverse vegetation types and the core zone of the reserve is considered as one of the important rainforest areas in the country (Johnson & Kannan 2012).

The rich and dense forest types are important watershed areas for many streams and rivers. The major perennial river, Tamiraparani originates from Poonkulam at the base of Agasthyamalai (Image 1) and flows through the core zone of the tiger reserve. Along its course, several major tributaries such as Servalar, Manimuthar, Pachiyar, Gowthalaiair, Gadana, and Ramanadhi rivers join the river Tamiraparani. In the present study, 25 streams covering different streams/ rivers within the KMTR were sampled for species diversity and the survey was carried out between January 2011 and March 2012. The location of sampling sites in KMTR is presented in Figure 1.

Fish sampling

Fish sampling was performed in different habitats such as pools, riffles runs, and cascades within 100m reach based on the methods of Angermeier & Schlosser (1989) and Johnson & Arunachalam (2009). These reaches were selected based on regular pattern of morphology such as pools and riffle and also special scales covering different stream orders. Fishes were collected using monofilamentous gill nets of different mesh sizes (8 to 32 mm), drag and scoop nets. Sampled fishes were examined, counted, photographed and released back to the system. Gill nets were also set during night along the habitat to obtain nocturnal catfishes. In addition to netting, hooks and lines were also used for collecting Anguillid and Mastacembelid fishes. Few specimens of unidentified taxa were preserved in 10% formalin and the species were confirmed using standard taxonomic literature (Jayaram 2010). Current valid species names follow the Catalogue of Fishes (Fricke et al. 2020) and conservation status follow the IUCN Red



Image 1. Poonkulam – the origin of River Tamiraparani in Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu.

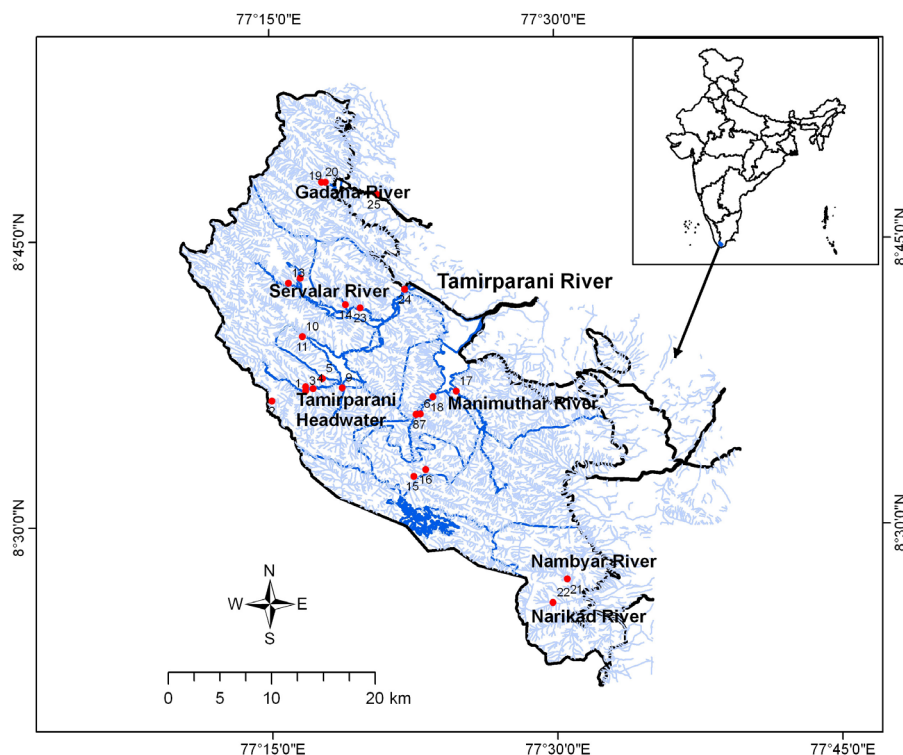


Figure 1. Sampling sites in Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu.

List of Threatened Species (2020). At each sampling location, altitude and GPS coordinates were recorded. In addition, stream order classification was obtained for all sampling reach based on Strahler's method (Strahler 1957).

Data Analysis

Information on fish diversity and their distribution patterns were extracted by adopting different univariate indices, Shannon diversity index and evenness index. Calculation of these indices followed the methods of Padhye et al. (2006). The indices were used to compare species distribution, richness, diversity, and equitability across the study streams. Quantitative data of species along with their abundance were used for construction of dendrogram to understand the similarity of fish assemblage structure between the streams. This was done using Bray-Curtis similarity index based on non-transformed species abundance data (Anderson 2001; Padhye et al. 2006) in PAST program. Further, the patterns of species distribution in KMTR streams was examined using simple linear regression model, where stream order and altitude were used as independent variables and species richness as dependant variable.

RESULTS

Diversity and assemblage structure

A total of 50 species of primary freshwater fishes belonging to 10 orders, 15 families, and 32 genera were recorded from the study area (Table 1 & Images 2–6). Among the species, *Devario aequipinnatus*, *Garra mulya*, *Garra kalakadensis*, *Garra joshuai*, and *Rasbora dandia* were commonly present across the study streams. The Malabar Mahseer *Tor malabaricus* was recorded from Myeelar, Pambanar, Gowthalyar, Vaalayar streams, and also in Ingikuli river. Of 50 species, seven species namely, *Garra kalakadensis*, *G. joshuai*, *Haludaria kannikattiensis*, *Hypselobarbus tamiraparaniei*, *Mesonemachilus tambraparniensis*, *Neolissochilus tamiraparaniensis*, and *Dawkinsia tambraparniei* are endemic to KMTR and Tamiraparani River basin. Among these endemic species, *Dawkinsia tambraparniei* is the only species with a wide distribution range in middle and lower reaches of Tamiraparani River basin and the rest are restricted to the headwaters of Tamiraparani (i.e., within KMTR). The exotic species *Oreochromis mossambicus* was recorded in the lower reach of Gadana and Tamiraparani rivers at Papanasam region.

Total number of species, Shannon diversity, and evenness index for each stream are given in Table 2.

Table 1. List of fish species recorded from streams/rivers of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu.

Rivers/Streams	Alaiar	Poonkulam	Sophar	Palavarathod	Ullar	Selampandolai	Elumbenodai	Myelalar	Pampanar	Gowthalar	Karayar	Chinappullar	Vaalayar	Thailar	Nalunkkuyar	Kakachidolai	Manimutthar	Thalayani	Kallar	Thoonneyar	Narakkad	Nambiyar	Servalar	Papanasm	Gadana
Cyprinodontiformes																									
Aplocheilidae																									
<i>Aplochelus lineatus</i>																									
Cypriniformes																									
Cyprinidae																									
<i>Bangana dero</i>																									
<i>Cirrhinus reba</i>																									
<i>Dawkinsia filamentosa</i>																									
<i>Dawkinsia tambraparniei</i>																									
<i>Garra mullia</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Garra joshuai</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Garra kalakadensis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Haludaria kannikattensis</i>			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Hypselobarbus tamiraparniei</i>																									
<i>Labeo calbasu</i>																									
<i>Labeo fimbriatus</i>																									
<i>Labeo rohita</i>																									
<i>Labeo pangusia</i>																									
<i>Neolissochilus tamiraparniensis</i>	+					+			+	+	+		+	+			+	+	+	+			+	+	+
<i>Pethia punctata</i>										+	+														
<i>Puntius sophore</i>																									
<i>Puntius amphibius</i>																									
<i>Puntius bimaculatus</i>																									
<i>Puntius chala</i>																									
<i>Puntius dorsalis</i>																									
<i>Puntius vittatus</i>																									
<i>Systomus subnasutus</i>																									
<i>Tor malabaricus</i>											+														
Danionidae																									
<i>Amblypharyngodon microlepis</i>																									

Fish species	Rivers/Streams	Aiellar	Poonkulam	Sophar	Palavarathod	Ullar	Selampandodai	Elumbenodai	Myeelar	Pampanar	Gowthaiyar	Karayar	Chinappullar	Vaaiyar	Thallar	Nalunukkuyar	Kakachiodai	Manimutthar	Thalayani	Kallar	Thoonneyar	Naraiikkad	Nambiyar	Servaiyar	Papanasam	Gadana
<i>Devario aequipinnatus</i>		+			+	+	+	+	+	+	+	+			+	+			+	+	+	+	+	+	+	+
<i>Esomus thermoicos</i>																										
<i>Rasbora dandia</i>		+			+	+	+																			
<i>Rasbora caverii</i>																										
<i>Salmostoma balookee</i>																										
<i>Salmostoma boopis</i>																										
Balitoridae																										
<i>Bhavanla annandalei</i>						+			+																	
Nemacheilidae																										
<i>Mesonoemacheilus tambaraparniensis</i>						+					+															
Cobitidae																										
<i>Lepidocephalichthys thermalis</i>																										
Siluriformes																										
Bagridae		+			+					+	+	+														
<i>Mystus armatus</i>																										
<i>Mystus montanus</i>																										
<i>Mystus seengtee</i>																										
<i>Mystus vittatus</i>																										
Siluridae																										
<i>Ompok binaculatus</i>																										
<i>Ompok malabaricus</i>																										
Anguilliformes																										
Anguillidae																										
<i>Anguilla bengalensis</i>																										
Synbranchiformes																										
Mastacembelidae																										
<i>Mastacembelus armatus</i>																										
Cichliformes																										
Cichlidae																										
<i>Epiplatys surattensis</i>																										
<i>Pseudotropheus maculatus</i>																										
<i>Oreochromis mossambicus</i>																										
Gobiiformes																										
Gobiidae																										
<i>Glossogobius giuris</i>																										

Gadana	+	+	+	+
Papanasam	+	+	+	+
Servalar	+	+	+	+
Nambiyar	+	+	+	+
Naraikkad	+	+	+	+
Thoonayar	+	+	+	+
Kallar	+	+	+	+
Thalayani	+	+	+	+
Manimutthar	+	+	+	+
Kakachiodai	+	+	+	+
Nalumukkuyar	+	+	+	+
Thallar	+	+	+	+
Vaayar	+	+	+	+
Chinnapullar	+	+	+	+
Karayar	+	+	+	+
Gowthayar	+	+	+	+
Pampanar	+	+	+	+
Myealar	+	+	+	+
Elumbenodai	+	+	+	+
Selampandai	+	+	+	+
Ullar	+	+	+	+
Palavarathod	+	+	+	+
Sophar	+	+	+	+
Poonkulam	+	+	+	+
Aielar	+	+	+	+
Rivers/Streams				
Fish species				
Anabantiformes				
Channidae				
Channa gachua				
Channa striata				
Perciforms				
Ambassidae				
Chanda nama				
Belontiiformes				
Belontiidae				
Xenentodon canila				

Maximum number of species were recorded in Gadana River, ($S=30$), followed by Papanasam site ($S=30$), whereas low number of species were recorded in Poonkulam (Tamiraparani origin) in the upstream and Elumbenodai Stream (two species in each). In the entire study area, cyprinids were the dominant members of the assemblage structure, comprising 12 genera and 23 species. High values for the Shannon diversity index were registered in Gadana ($H'=2.81$), Papanasam ($H'=2.78$), and Servalar ($H'=2.62$), whereas low value was registered in Poonkulam ($H'=0.61$). The evenness index of species equitability was high in Nalumukkuyar ($E=0.97$) followed by Palavarathod and Aielar ($E=0.96$ in both) whereas the site Chinnapullar and Vaayar had comparatively uneven distribution of species (0.74 and 0.77, respectively). Cluster analyses of species composition in KMTR showed that two distinct clusters and two separate lines were formed based on the Bray-Curtis similarity (Figure 2). The sites along the headwater streams had more similar faunal assemblage and they were grouped together in cluster 'A'. The sites in the middle reach of the river with rich diversity sites such as Papanasam, Gadana, Servalar, Naraikkad, and Nambiyar had more similar faunal assemblages and they were grouped in cluster 'C'. The streams namely Vaayar and Poonkulam (headwater) had distinct species assemblage and they did not cluster with other sites (line 'B' & 'D' in Figure 2). The result of regression analysis revealed that there is a strong significant pattern explained between stream order and species richness ($r^2=0.86$; $p<0.05$). The study site with higher stream order had more species (Figure 3a). Similarly in the case of regression result on altitude vs. species richness a weak relationship explained between altitude and species richness ($r^2=0.19$; $p<0.05$). Sites located at lower elevation such as Gadana, Papanasam, and Servalar had more number of species than higher elevation sites (Figure 3b).

Threatened species

Current status of KMTR fishes were compared with IUCN Red List data (IUCN 2020) and of 50 species four species are listed under threatened categories (*Garra kalakadensis*, *G. joshuai*, *Dawkinsia tambraparniei*, and *Tor malabaricus*). Apart from those, two species namely *Labeo pangusia* and *Ompok bimaculatus* are listed in the Near Threatened category. Distributions of these threatened species in KMTR are presented in Table 3. These threatened species constitute about 8% of the species inhabiting KMTR region.

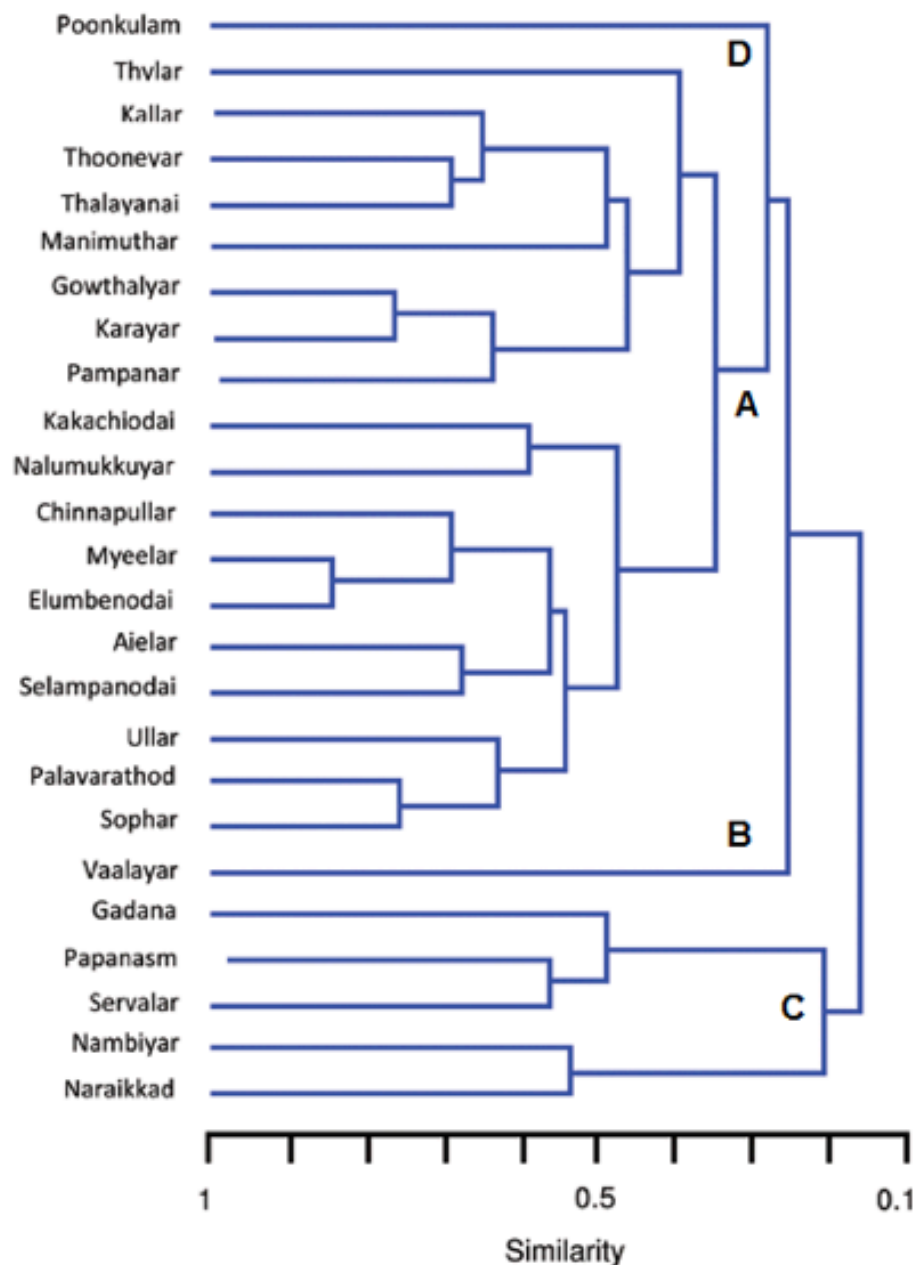


Figure 2. Dendrogram resulting from Bray-Curtis similarities of species abundance data of study streams.

DISCUSSION

Previous studies on ichthyofauna of this region covered different isolated patches. Silas (1953) listed nine species of fishes including two new species *Garra joshuai* and *Dawkinsia tambraparniei* from the headwaters of Tamiraparani. Johnsingh & Viickram (1987) listed 33 species of fishes from Mundanthurai Sanctuary, primarily from Papanasam lower & upper dam and Servalar & Manimuthar dams. Of the 33 species, four species, *Homaloptera brucei* (restricted

to eastern Himalayan), *Garra lissorhynchus* (restricted to eastern Himalaya), *Barbodes carnaticus* (restricted to Cauvery River drainages), and *Nemachilus pulchellus* were misidentifications of *Bhavana annandalei*, *Garra mullya*, *Neolissochilus tamiraparaniensis*, and *Mesonemachilus tambraparniensis*, respectively. Later, Remadevi (1992) also listed 19 species from Kalakad Sanctuary and Arunachalam et al. (2000) listed 14 species from Nambiyar River. Thus, the present list of 50 species represents a complete updated account on fishes of KMTR.

Table 2. Geomorphological features, species richness, Shannon index and evenness index recorded in streams/rivers of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu.

Sites	Stream order	Altitude (m)	Number of Species	Shannon index (H')	Evenness index (E)
Aielar	3	609	7	1.87	0.96
Poonkulam	2	609	2	0.61	0.88
Sophar	3	600	7	1.63	0.84
Palavarathod	3	630	7	1.87	0.96
Ullar	3	637	8	1.77	0.85
Selampanodai	3	258	6	1.71	0.95
Elumbenodai	2	252	4	1.24	0.90
Myeelar	3	248	4	1.28	0.93
Pampanar	3	291	9	1.96	0.89
Gowthalyar	4	300	13	2.42	0.92
Karayar	4	300	15	2.44	0.88
Chinnapullar	3	300	4	1.02	0.74
Vaalayar	3	405	6	1.39	0.77
Thailar	3	400	6	1.53	0.85
Nalumukkuyar	3	1250	4	1.34	0.97
Kakachiodai	3	1230	3	1.05	0.95
Manimuthar	4	300	8	1.95	0.94
Thalayani	4	300	15	2.16	0.82
Kallar	4	150	10	2.01	0.87
Thooneyar	4	165	7	1.81	0.93
Naraikkad	4	350	15	2.49	0.92
Nambiyar	4	350	13	2.37	0.92
Servalar	5	300	22	2.62	0.88
Papanasm	6	250	24	2.78	0.90
Gadana	6	150	30	2.81	0.84

Table 3. List of threatened species and their distribution range within Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu.

	Threatened species	IUCN status	Distribution within KMTR
1.	<i>Garra kalakadensis</i>	Endangered	Aielar, Sophar, Palavarathod, Ullar, Selampanodai, Elumbenodai, Myeelar, Pampanar, Gowthalyar, Karayar, Chinnapullar, Vaalayar, Thailar, Nalumukkuyar, Kakachiodai, Nambiyar
2.	<i>Garra joshuai</i>	Endangered	Aielar, Poonkulam, Sophar, Palavarathod, Ullar, Selampanodai, Elumbenodai, Myeelar, Pampanar, Gowthalyar, Karayar, Chinnapullar, Vaalayar, Thailar, Nalumukkuyar, Kakachiodai, Manimuthar
3.	<i>Dawkinsia tambraparniei</i>	Endangered	Gowthalyar, Karayar, Manimuthar, Thalayani, Kallar, Thooneyar, Servalar, Papanasam, Gadana
4.	<i>Tor malabaricus</i>	Endangered	Pampanar, Gowthalyar, Karayar, Vaalayar

Interestingly, the record of a viable population of Malabar Mahseer in streams such as Pampanar, Gowthalaia, Karayar, and Valayar in KMTR is additional information to this area. This mahseer was described by Jerdon (1849) as *Barbus malabaricus* from the mountain streams of Malabar regions of India. Menon (1992) synonymised this species with *Tor khudree* without any explanation. Indra (1993), however, considered

this species as a valid subspecies as *Tor khudree malabaricus*. Recently, Silas et al. (2005) confirmed the validity of *T. malabaricus* as a separate species using molecular techniques. This species is reported from rivers Balamore in Kanyakumari District, Tamil Nadu and Kallada River in Kerala (Silas et al. 2005). Though, the presence of this species in Tamiraparani River was reported by various workers under different names (as

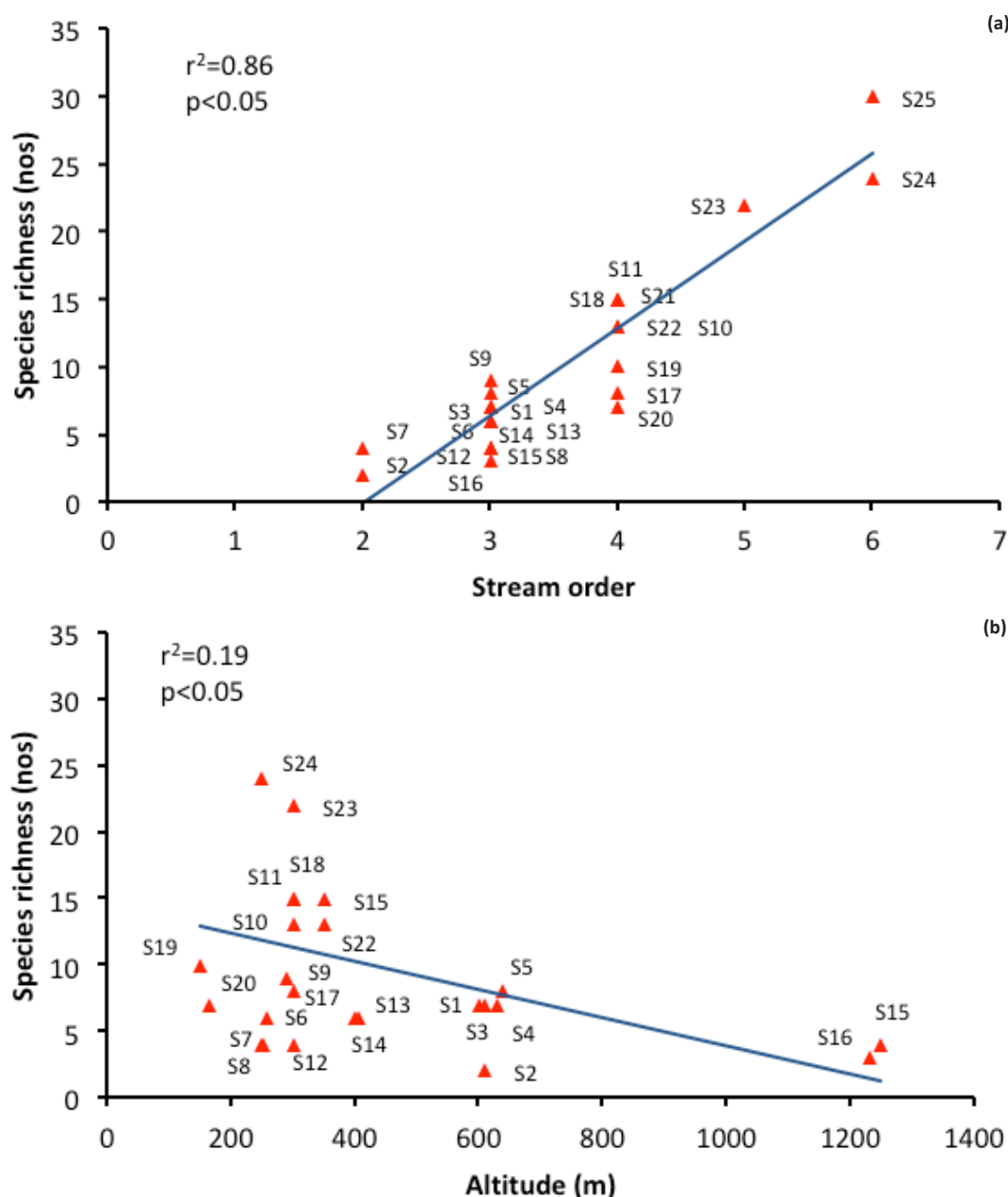


Figure 3. Regression plot of species richness vs stream order (a) and species vs altitude (b)—among sampling streams/ rivers in Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu [S1—Aielar | S2—Poonkulam | S3—Sophar | S4—Palavarathod | S5—Ullar | S6—Selampanodai | S7—Elumbenodai | S8—Myeelar | S9—Pampanar | S10—Gowthalyar | S11—Karayar | S12—Chinnapullar | S13—Vaalaray | S14—Thailar | S15—Nalumukkuyar | S16—Kakachiodai | S17—Manimuthar | S18—Thalayani | S19—Kallar | S20—Thooneyar | S21—Naraikkad | S22—Nambiyar | S23—Servalar | S24—Papanasam | S25—Gadana].

Barbus malabaricus by Johnsingh & Viickram 1987; as *Tor khudree malabaricus* by Johnson 1999; *Tor malabaricus* by Johnson & Arunachalam 2012), the distribution of *Tor malabaricus* in an east fl wing river is questionable. In this context, a separate investi ation on identity of this species using molecular techniques is in progress.

Moreover, recently the genus *Horalabiosa* was synonymised with genus *Garra* by Yang et al. (2012)

based on molecular data without any discussion on *Horalabiosa*'s morphological features. Other workers have also followed the same synonymy (KoÄelat 2013; Bleher 2018). We, however, strongly suspect that the chance of sampling error as juvenile *Garra* are morphologically similar to *Horalabiosa* (KoÄelat 2020). Further, combined molecular and morphological investi ation on the validity of genera *Horalabiosa* and

Garra is necessary.

The patterns of diversity explained in the present study revealed that sites falling in the lower altitude with large stream size had high diversity of fish. The study sites Gadana, Papanasam, and Servalar are large size rivers (6th order streams) and located at the foot-hills of Western Ghats, which had high Shannon diversity index ($H' = 2.81$; $H' = 2.78$; $H' = 2.68$, respectively) compared to study sites located high elevation with small stream channel (2nd order stream). High diversity of fishes found in Gadana, Papanasam, and Servalar rivers are mainly due to the size of the channel and tributary effect (Horwitz 1978; Vannote et al. 1980; Minshall et al. 1985), as these are 6th order river channel with many tributaries in the upstream. In general, main river channel will have high species richness than head waters (Schlosser 1991; Pusey et al. 1993). Similar type of patterns have been reported in east flowing streams of Western Ghats (Johnson 1999; Johnson & Arunachalam 2010). Further, the regression plot fitted with species richness vs altitude suggest that altitude is covariate for temperature, which may be a key environmental variable associated with fish species distribution in the KMTR streams. Similar observations of longitudinal gradient in species diversity and assemblage structure have been reported from other mountainous regions (Horwitz 1978; Oberdorff et al. 1993, 1995; Godinho et al. 2000; Silvano et al. 2000; Ostrand & Wilde 2002; Grenouillet et al. 2004).

An exotic fish *Oreochromis mossambicus* was recorded from Gadana and Tamiraparani rivers at Papanasam. This species was introduced in south Indian reservoirs in 1950s by fishery department (including reservoirs of KMTR) to improve reservoir fishery production (De Silva et al. 2004). Now it is well established in rivers, canals, irrigation tanks and downstream of Tamiraparani River, below the reservoirs. This species is not established in the upper reaches of KMTR (above reservoirs) due to presence of natural obstacles like high water falls and rocky cascades.

Although, the endemic fishes are present inside the protected area, there are few threats to these species. The important threats faced by these endemic species are: habitat degradation due to tea garden operation, entry of household waste from human settlements in some parts of KMTR and entry of chemical contaminations from tea garden. These activities may render the stream habitat not suitable for highly specialized fishes like *Garra joshuai* and *G. kalakadensis*, ultimately leading to reduction in endemic fish population. In order to conserve these threatened fishes, proper waste management mechanism should

be placed in the tea garden areas. Further, the study on population status of endemic species is essential for conserving threatened species.

REFERENCES

- Anderson, M.J. (2001). Permutation tests for univariate or multivariate analysis of variance and regression. *Canadian Journal of Fisheries and Aquatic Sciences* 58: 626–639. <https://doi.org/10.1139/f01-004>
- Angermeier, P.L. & I.J. Schlosser (1989). Species area relationship for stream fishes. *Ecology* 70: 1450–1462. <https://doi.org/10.2307/1938204>
- Arunachalam, M. & J.A. Johnson (2002). A new species of *Puntius* (Hamilton) from Tamiraparani River. *Journal of Bombay Natural History Society* 99(3): 474–480.
- Arunachalam, M., A. Sankaranarayan, J.A. Johnson, A. Manimekalan, R. Soranam, P.N. Shanthi & C. Vijayakumar (2000). Fishes of Nambiyar river, Kalakkad Mundanthurai Tiger Reserve, Tamil Nadu. *Journal of the Bombay Natural History Society* 97(1): 153–154.
- Bleher, H. (2018). *Indian Ornamental Fishes - Volume 1*. Aquapress Publishers, Miradolo Terme, Italy, 850pp.
- De Silva, S.S., W.M.H.K. Wijenayake, A.B.A.K. Gunaratne & U.S. Amarasinghe (2004). Use of GIS tools to develop a scale for the selection of non-perennial reservoirs for culture based fisheries activities pp. 559–572. In: Nishida, T., P.J. Kailola & C.E. Hollingworth (eds.) *GIS Spatial Analysis in Fishery and Aquatic Sciences - Vol. 2*. Fishery and Aquatic GIS Research Group, Japan, 735pp. https://doi.org/10.1007/978-1-4020-8636-6_4
- Godinho, F.N., M.T. Ferreira & J.M. Santos (2000). Variation in fish community composition along an Iberian river basin from low to high discharge: relative contributions of environmental and temporal variables. *Ecology of Freshwater Fish* 9: 22–29.
- Grenouillet, G., D. Pont & C. Herisse (2004). Within-basin fish assemblage structure: the relative influence of habitat versus stream spatial position on local species richness. *Canadian Journal of Fish and Aquatic Science* 61: 93–104.
- Fricke, R., W.N. Eschmeyer & R. van der Laan (eds.) (2020). Eschmeyer's catalog of fishes: genera, species, references. Electronic version. accessed 23 April 2020. http://researcharchive.calacademy.org/research/ichthyology/catalog/fish_atmain.asp
- Horwitz, R.J. (1978). Temporal variability patterns and the distributional patterns of stream fishes. *Ecological Monograph* 48: 307–321.
- Indra, T.J. (1993). Report on the ichthyofauna of Kanyakumari District, Tamil Nadu. *Records of the Zoological Survey of India* 92: 177–192.
- IUCN (2020). IUCN Red List of Threatened Species. Version 2020.2. Available at <http://www.iucnredlist.org>. Downloaded on 08 March 2020.
- Jayaram, K.C. (2010). *The Freshwater Fishes of the Indian Region*. NPH Publishers, New Delhi, 616pp.
- Jerdon, T.C. (1849). On the fresh-water fishes of southern India. (Continued from p. 149). *Madras Journal of Literature and Science* 15(2): 302–346.
- Johsingh, A.J.T. & D. Viickram (1987). Fishes of Mundanthurai Wildlife Sanctuary, Tamil Nadu. *Journal of the Bombay Natural History Society* 84(3): 526–533.
- Johnson, J.A. (1999). Diversity and ecological structure of fishes in selected streams/rivers in Western Ghats. PhD Thesis. Department of Zoology, St. Xavier's College, Manonmaniam Sundaranar University, Tirunelveli, 128pp.
- Johnson, J.A. & K. Kannan (2012). Diversity and conservation of endangered fish genetic resources of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu. DST-Project Completion Report, Wildlife Institute of India, Dehradun, 44pp.
- Johnson, J.A. & M. Arunachalam (2009). Diversity, distribution and assemblage structure of fishes in streams of southern Western

1. *Amblypharyngodon microlepis*2. *Devario aequipinnatus*3. *Rasbora caverii*4. *Rasbora dandia*5. *Esomus thermoicos*6. *Salmostoma balookee*7. *Salmostoma boopis*8. *Garra joshuai*9. *Garra mullya*10. *Garra kalakadensis*

Image 2. Fishes of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu. © J.A. Johnson & K. Kannan

11. *Dawkinsia filamentosa*12. *Dawkinsia tambraparniei*13. *Haludaria kannikattiensis*14. *Pethia punctata*15. *Puntius amphibius*16. *Puntius sophore*17. *Puntius bimaculatus*18. *Puntius chola*19. *Puntius dorsalis*20. *Puntius vittatus*

Image 3. Fishes of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu. © J.A. Johnson, K. Kannan & K. Krishna Prasad

21. *Bangana dero*22. *Cirrhinus reba*23. *Hypselobarbus tamiraparaniei*24. *Neolissochilus tamiraparanensis*25. *Labeo calbasu*26. *Labeo fimbriatus*27. *Labeo rohita*28. *Labeo pangusia*29. *Systomus subnasutus*30. *Tor malabaricus*

Image 4. Fishes of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu. © J.A. Johnson & K. Kannan

31. *Bhavania annandalei*32. *Lepidocephalichthys thermalis*33. *Mesonoemacheilus tambaraparniensis*34. *Glossogobius giuris*35. *Channa gachua*36. *Channa striata*37. *Etroplus suratensis*38. *Pseudetroplus maculatus*39. *Oreochromis mossambicus*40. *Chanda nama*

Image 5. Fishes of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu. © J.A. Johnson & K. Kannan

41. *Mystus armatus*42. *Mystus montanus*43. *Mystus seengtee*44. *Mystus vittatus*45. *Ompok bimaculatus*46. *Ompok malabaricus*47. *Anguilla bengalensis*48. *Mastacembelus armatus*49. *Aplocheilus lineatus*50. *Xenentodon cancila*

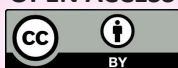
Image 6. Fishes of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu. © J.A. Johnson & K. Kannan

- Ghats, India. *Journal of Threatened Taxa* 1(10): 507–513. <http://doi.org/10.11609/JoTT.o2146.507-13>
- Johnson, J.A. & M. Arunachalam (2010). Habitat use of fishes in streams of Kalakad-Mundanthurai Tiger Reserve, India. *International Journal of Ecology and Development* 17(10): 34–47.
- Johnson, J.A. & M. Arunachalam (2012). Feeding habit and food partition in a stream fish community of Western Ghats, India. *Environmental Biology of Fishes* 93: 51–60. <http://doi.org/10.1007/s10641-011-9889-9>
- Kannan, K., J.A. Johnson & H. Malleshappa (2013). Growth and fitness of an endangered fish *Dawkinsia tambraparniei* (Cypriniformes: Cyprinidae) from southern Western Ghats, India. *Aqua, International Journal of Ichthyology* 19(2): 61–66.
- Kannan, K., J.A. Johnson, A. Kumar & S.K. Gupta (2014). Mitochondrial variation in the endangered fish *Dawkinsia tambraparniei* (Actinopterygii: Cypriniformes: Cyprinidae) from Southern Western Ghats, India. *Acta Ichthyologica Et Piscatoria* 44(1): 3–8. <http://doi.org/10.3750/AIP2014.44.1.01>
- Kottelat, M. (2013). The fishes of the inland waters of southeast Asia: a catalogue and core bibliography of the fishes known to occur in freshwaters, mangroves and estuaries. *Raffles Bulletin of Zoology Supplement* 27: 1–663.
- Kottelat, M. (2020). *Ceratogarra*, a genus name for *Garra cambodgiensis* and *G. fasciata* and comments on the oral and gular soft anatomy in labeonine fishes (Teleostei: Cyprinidae). *Raffles Bulletin of Zoology* 35: 156–178.
- Menon, A.G.K. (1992). Taxonomy of Mahseer fishes of the genus *Tor* Gray with description of a new species from the Deccan. *Journal of the Bombay Natural History Society* 89(2): 210–228.
- Minshall, G.W., K.W. Cummins, R.C. Petersen, C.E. Cushing, D.A. Burns, J.R. Sedell & R.L. Vannote (1985). Development and in stream ecosystem theory. *Canadian Journal of Fisheries and Aquatic Sciences* 42: 1045–1055.
- Oberdorff, T., J.F. Guban & B. Hugueny (1995). Global scale patterns of fish species richness in rivers. *Ecography* 18: 345–352.
- Oberdorff, T., E. Guilbert & J. Lucchetta (1993). Patterns of fish richness in the Seine River basin, France. *Hydrobiologia* 259: 81–91.
- Ostrand, K.G. & G.R. Wilde (2002). Seasonal and spatial variation in a Prairie stream fish assemblage. *Ecology of Freshwater Fish* 11: 137–149.
- Padhye, A.D., N. Dahanukar, M. Panigankar, M. Deshpande & D. Deshpande (2006). Seasonal and landscape wise distribution of butterflies in Tamhini, northern Western Ghats, India. *Zoos' Print Journal* 21: 2175–2181. <http://doi.org/10.11609/JoTT.ZPJ.1142.2175-81>
- Pusey, B.J., A.H. Arthington & M.G. Read (1993). Spatial and temporal variation in fish assemblage structure in the Mary River, south-eastern Queensland: the influence of habitat structure. *Environmental Biology of Fishes* 37: 355–380. <http://doi.org/10.1007/BF00005204>
- Remadevi, K. (1992). Fishes of Kalakad Wildlife Sanctuary, Tirunelveli District, Tamil Nadu, India. *Records of Indian Museum* 92(1-4): 193–209.
- Schlosser, I.J. (1991). Stream fish ecology a landscape perspective. *Bioscience* 41: 704–712. <http://doi.org/10.2307/1311765>
- Silas, E.G. (1953). New fishes from the Western Ghats, with notes on *Puntius arulius* (Jerdon). *Records of Indian Museum* 51: 27–38.
- Silas, E.G., A. Gopalakrishnan, L. John & C.P. Shaji (2005). Genetic identity of *Tor malabaricus* (Jerdon) (Teleostei: Cyprinidae) as revealed by RAPD markers. *Indian Journal of Fisheries* 52(2): 125–140.
- Silvano, R.A.M., B.D. do Amaral & O.T. Oyakawa (2000). Spatial and temporal patterns of diversity and distribution of the Upper Juruá River fish community (Brazilian Amazon). *Environmental Biology of Fishes* 57: 25–35.
- Strahler, A.N. (1957). Quantitative Analysis of Watershed Geomorphology. *American Geophysical Union Transactions* 38: 912–920.
- Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sebell & C.E. Cushing (1980). The river continuum concept. *Canadian Journal of Fisheries and Aquatic Sciences* 37: 130–133. <http://doi.org/10.1139/f80-017>
- Yang, L., M. Arunachalam, T. Sado, B.A. Levin, A.S. Golubtsov, J. Freyhof, J.P. Friel, W. Chen, M.V. Hirti, R. Manickam, M.K. Agnew, A.M. Simons, K. Saitoh, M. Miya, R.L. Mayden & S. He (2012). Molecular phylogeny of the cyprinid tribe Labeonini (Teleostei: Cypriniformes). *Molecular Phylogenetics and Evolution* 65(2): 362–375. <http://doi.org/10.1016/j.ympev.2012.06.007>



www.threatenedtaxa.org

PLATINUM
OPEN ACCESS



The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) unless otherwise mentioned. JoTT allows unrestricted use, reproduction and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

November 2020 | Vol. 12 | No. 15 | Pages: 17063–17170

Date of Publication: 26 November 2020 (Online & Print)

DOI: 10.11609/jott.2020.12.15.17063-17170

Articles

Status of Nahan's Partridge *Ptilopachus nahani* (Dubois, 1905) (Aves: Galliformes: Odontophoridae) in Uganda

– Eric Sande, Sisiria Akoth, Ubaldo Rutazaana & William Olupot, Pp. 17063–17076

Fish diversity in streams/rivers of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu, India

– K. Kannan & J.A. Johnson, Pp. 17077–17092

Gastrointestinal helminth and protozoan infections of wild mammals in four major national parks in Sri Lanka

– Chandima Sarani Sepalage & Rupika Subashini Rajakaruna, Pp. 17093–17104

Review

Appraising carnivore (Mammalia: Carnivora) studies in Bangladesh from 1971 to 2019 bibliographic retrieves: trends, biases, and opportunities

– Muntasir Akash & Tania Zakir, Pp. 17105–17120

Communications

Diversity of scorpions (Arachnida: Scorpiones) in Polonnaruwa Archaeological Reserve, Sri Lanka

– Kumudu B. Wijesooriya, Lakshani S. Weerasekara & Kithsiri B. Ranawana, Pp. 17121–17128

A faunistic survey of tiger beetles (Coleoptera: Carabidae: Cicindelinae) in Chakrashila Wildlife Sanctuary and adjoining riverine ecosystem in Assam, India

– Kushal Choudhury, Chandan Das & Amar Deep Soren, Pp. 17129–17137

Occurrence of the *Aporrectodea caliginosa caliginosa* (Savigny, 1826) (Annelida: Clitellata: Haplotaxida) from Kashmir Valley, Jammu & Kashmir, India

– Ishti Aq Ahmed Najjar, Anisa B. Khan & Abdul Hai, Pp. 17138–17146

Short Communications

Avian congregation sites in the Gulf of Kachchh, Gujarat, India

– Jigar D. Joshi, Sandeep B. Munjpara, Kinjal Joshi, Harshad Salvi & R.D. Kamboj, Pp. 17147–17152

Checklist of brachyuran mangrove crabs of Kerala, India

– Kurian Mathew Abraham & Apreshgi Kolothuthara Prakasan, Pp. 17153–17160

Notes

A new country record of Smooth-backed Gliding Gecko *Gekko lionotum* (Annandale, 1905) (Squamata: Gekkonidae) from Bangladesh

– M. Rashedul Kabir Bhuiyan, M. Fazle Rabbe, Mohammad Firoj Jaman, Ananda Kumar Das & Samiul Mohsanin, Pp. 17161–17164

***Amblyomma gervaisi* (Ixodida: Ixodidae: Amblyomma) infestation in a Rat Snake from northwestern Himalayan region: a case study**

– Aman D. Moudgil, Ankur Sharma, Adarsh Kumar, Amit Singla & Surender Bansal, Pp. 17165–17167

Parasitic enteritis in the free-ranging Common Myna *Acridotheres tristis* (Aves: Passeriformes: Sturnidae)

– Rakesh Kumar, Aman Dev Moudgil, Sameeksha Koundal, Rajendra Damu Patil & Rajesh Kumar Asrani, Pp. 17168–17170

Member



Publisher & Host

