

Journal of Threatened Taxa

Building evidence for conservation globally



Open Access

10.11609/jott.2021.13.12.19675-19886

www.threatenedtaxa.org

26 October 2021 (Online & Print)

Vol. 13 | No. 12 | Pages: 19675-19886

ISSN 0974-7907 (Online)

ISSN 0974-7893 (Print)



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

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road, Saravanampatti,
Coimbatore, Tamil Nadu 641035, India
Ph: +91 9385339863 | www.threatenedtaxa.org
Email: sanjay@threatenedtaxa.org

EDITORS

Founder & Chief Editor

Dr. Sanjay Molur

Wildlife Information Liaison Development (WILD) Society & Zoo Outreach Organization (ZOO),
12 Thiruvannamalai Nagar, Saravanampatti, Coimbatore, Tamil Nadu 641035, India

Deputy Chief Editor

Dr. Neelesh Dahanukar

Noida, Uttar Pradesh, India

Managing Editor

Mr. B. Ravichandran, WILD/ZOO, Coimbatore, India

Associate Editors

Dr. Mandar Paingankar, Government Science College Gadchiroli, Maharashtra 442605, India

Dr. Ulrike Streicher, Wildlife Veterinarian, Eugene, Oregon, USA

Ms. Priyanka Iyer, ZOO/WILD, Coimbatore, Tamil Nadu 641035, India

Dr. B.A. Daniel, ZOO/WILD, Coimbatore, Tamil Nadu 641035, India

Editorial Board

Dr. Russel Mittermeier

Executive Vice Chair, Conservation International, Arlington, Virginia 22202, USA

Prof. Mewa Singh Ph.D., FASC, FNA, FNASC, FNAPsy

Ramanna Fellow and Life-Long Distinguished Professor, Biopsychology Laboratory, and
Institute of Excellence, University of Mysore, Mysuru, Karnataka 570006, India; Honorary
Professor, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore; and Adjunct
Professor, National Institute of Advanced Studies, Bangalore

Stephen D. Nash

Scientific Illustrator, Conservation International, Dept. of Anatomical Sciences, Health Sciences
Center, T-8, Room 045, Stony Brook University, Stony Brook, NY 11794-8081, USA

Dr. Fred Pluthero

Toronto, Canada

Dr. Priya Davidar

Sigur Nature Trust, Chadapatti, Mavinhalla PO, Nilgiris, Tamil Nadu 643223, India

Dr. Martin Fisher

Senior Associate Professor, Battcock Centre for Experimental Astrophysics, Cavendish
Laboratory, JJ Thomson Avenue, Cambridge CB3 0HE, UK

Dr. John Fellowes

Honorary Assistant Professor, The Kadoorie Institute, 8/F, T.T. Tsui Building, The University of
Hong Kong, Pokfulam Road, Hong Kong

Prof. Dr. Mirco Solé

Universidade Estadual de Santa Cruz, Departamento de Ciências Biológicas, Vice-coordenador
do Programa de Pós-Graduação em Zoologia, Rodovia Ilhéus/Itabuna, Km 16 (45662-000)
Salobrinho, Ilhéus - Bahia - Brasil

Dr. Rajeev Raghavan

Professor of Taxonomy, Kerala University of Fisheries & Ocean Studies, Kochi, Kerala, India

English Editors

Mrs. Mira Bhojwani, Pune, India

Dr. Fred Pluthero, Toronto, Canada

Mr. P. Ilangoan, Chennai, India

Web Maintenance

Mrs. Latha G. Ravikumar, ZOO/WILD, Coimbatore, India

Typesetting

Mr. Arul Jagadish, ZOO, Coimbatore, India

Mrs. Radhika, ZOO, Coimbatore, India

Mrs. Geetha, ZOO, Coimbatore India

Fundraising/Communications

Mrs. Payal B. Molur, Coimbatore, India

Subject Editors 2018–2020

Fungi

Dr. B. Shivaraju, Bengaluru, Karnataka, India

Dr. R.K. Verma, Tropical Forest Research Institute, Jabalpur, India

Dr. Vatsavaya S. Raju, Kakatiya University, Warangal, Andhra Pradesh, India

Dr. M. Krishnappa, Jnana Sahyadri, Kuvempu University, Shimoga, Karnataka, India

Dr. K.R. Sridhar, Mangalore University, Mangalagangothri, Mangalore, Karnataka, India

Dr. Gunjan Biswas, Vidyasagar University, Midnapore, West Bengal, India

Plants

Dr. G.P. Sinha, Botanical Survey of India, Allahabad, India

Dr. N.P. Balakrishnan, Ret. Joint Director, BSI, Coimbatore, India

Dr. Shonil Bhagwat, Open University and University of Oxford, UK

Prof. D.J. Bhat, Retd. Professor, Goa University, Goa, India

Dr. Ferdinando Boero, Università del Salento, Lecce, Italy

Dr. Dale R. Calder, Royal Ontario Museum, Toronto, Ontario, Canada

Dr. Cleofas Cervancia, Univ. of Philippines Los Baños College Laguna, Philippines

Dr. F.B. Vincent Florens, University of Mauritius, Mauritius

Dr. Merlin Franco, Curtin University, Malaysia

Dr. V. Irudayaraj, St. Xavier's College, Palayamkottai, Tamil Nadu, India

Dr. B.S. Kholia, Botanical Survey of India, Gangtok, Sikkim, India

Dr. Pankaj Kumar, Kadoorie Farm and Botanic Garden Corporation, Hong Kong S.A.R., China

Dr. V. Sampath Kumar, Botanical Survey of India, Howrah, West Bengal, India

Dr. A.J. Solomon Raju, Andhra University, Visakhapatnam, India

Dr. Vijayasankar Raman, University of Mississippi, USA

Dr. B. Ravi Prasad Rao, Sri Krishnadevaraya University, Anantpur, India

Dr. K. Ravikumar, FRLHT, Bengaluru, Karnataka, India

Dr. Aparna Watve, Pune, Maharashtra, India

Dr. Qiang Liu, Xishuangbanna Tropical Botanical Garden, Yunnan, China

Dr. Noor Azhar Mohamed Shazili, Universiti Malaysia Terengganu, Kuala Terengganu, Malaysia

Dr. M.K. Vasudeva Rao, Shiv Ranjani Housing Society, Pune, Maharashtra, India

Prof. A.J. Solomon Raju, Andhra University, Visakhapatnam, India

Dr. Mandar Datar, Agharkar Research Institute, Pune, Maharashtra, India

Dr. M.K. Janarthanam, Goa University, Goa, India

Dr. K. Karthigeyan, Botanical Survey of India, India

Dr. Errol Vela, University of Montpellier, Montpellier, France

Dr. P. Lakshminarasimhan, Botanical Survey of India, Howrah, India

Dr. Larry R. Noblick, Montgomery Botanical Center, Miami, USA

Dr. K. Haridasan, Pallavur, Palakkad District, Kerala, India

Dr. Analinda Manila-Fajard, University of the Philippines Los Baños, Laguna, Philippines

Dr. P.A. Sinu, Central University of Kerala, Kasaragod, Kerala, India

Dr. Afroz Alam, Banasthali Vidyapith (accredited A grade by NAAC), Rajasthan, India

Dr. K.P. Rajesh, Zamorin's Guruvayurappan College, GA College PO, Kozhikode, Kerala, India

Dr. David E. Boufford, Harvard University Herbaria, Cambridge, MA 02138-2020, USA

Dr. Ritesh Kumar Choudhary, Agharkar Research Institute, Pune, Maharashtra, India

Dr. Navendu Page, Wildlife Institute of India, Chandrabani, Dehradun, Uttarakhand, India

Invertebrates

Dr. R.K. Avasthi, Rohtak University, Haryana, India

Dr. D.B. Bastawade, Maharashtra, India

Dr. Partha Pratim Bhattacharjee, Tripura University, Suryamaninagar, India

Dr. Kailash Chandra, Zoological Survey of India, Jabalpur, Madhya Pradesh, India

Dr. Ansie Dippenaar-Schoeman, University of Pretoria, Queenswood, South Africa

Dr. Rory Dow, National Museum of Natural History Naturalis, The Netherlands

Dr. Brian Fisher, California Academy of Sciences, USA

Dr. Richard Gallon, Ilandudno, North Wales, LL30 1UP

Dr. Hemant V. Ghate, Modern College, Pune, India

Dr. M. Monwar Hossain, Jahangirnagar University, Dhaka, Bangladesh

Mr. Jatishwor Singh Irungbam, Biology Centre CAS, Branišovská, Czech Republic.

Dr. Ian J. Kitching, Natural History Museum, Cromwell Road, UK

Dr. George Mathew, Kerala Forest Research Institute, Peechi, India

Dr. John Noyes, Natural History Museum, London, UK

For Focus, Scope, Aims, and Policies, visit https://threatenedtaxa.org/index.php/JoTT/aims_scope

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

For Policies against Scientific Misconduct, visit https://threatenedtaxa.org/index.php/JoTT/policies_various

continued on the back inside cover

Caption: Stripe-backed Weasel *Mustela strigidorsa*. Medium—digital, Software—procreate, Device—iPad + Apple pencil © Dhanush Shetty.



Evaluation of fish diversity and abundance in the Kabul River with comparisons between reaches above and below Kabul City, Afghanistan

Ugyen Kelzang¹ , Ahmad Farid Habibi² & Ryan J. Thoni³

¹ Forest Research Institute (Deemed to be University), Kaulagarh Road, PO. I.P.E., Dehradun, Uttarakhand 248195, India.

¹ Present address: Ministry of Health, P.O. Box: 726, Lhado Lam, Kawajangsa, Thimphu, Bhutan.

² Faryab University, Faryab Province, Afghanistan.

³ Feather River College, 570 Golden Eagle Avenue, Quincy, CA 95971, United States.

¹ ugyen.kelzang@gmail.com (corresponding author), ² faridhabibi558@gmail.com, ³ ryan.thoni@slu.edu

Abstract: The fish fauna of the Kabul River downstream of the City of Kabul face threats from increasing human population such as pollution, overfishing, and increased development. Despite the rapid increase of these activities leading to threats to fishes in the Kabul River, no studies have examined the changes in diversity, distribution, and abundance of fish fauna in the Kabul River surrounding of Kabul City. In this study, the Kabul River was divided into two zones (upstream and downstream) consisting of six sampling sites (3 sites per zone). Of the total of 1,190 fishes collected, Cypriniformes was the dominant order with one family, six genera, and eight species. Cyprinidae was the dominant family of that order with 81.4% ($n=969$) of total individuals. Species abundance was higher in the upstream reaches in almost all analyses. Upstream sites recorded 11 species, while seven species were recorded from downstream sites. Fish species richness was significantly higher upstream versus downstream reaches (9.67 ± 1.53 vs. $6.33 \pm .58$; $U= .00$, $z= -1.99$, $p= .04$, $r= .81$). Species diversity upstream was significantly higher than downstream ($H' = 1.90 \pm 0.15$, $D_j = 0.81 \pm 0.02$). Similarly, species evenness was also higher upstream than downstream ($J' = 0.84 \pm 0.01$). Low diversity, abundance, and evenness in downstream reaches are likely due to anthropogenic activities affecting the river in and around Kabul City.

Keywords: Anthropogenic, diversity indices, native species, pollution, species composition.

Editor: J.A. Johnson, Wildlife Institute of India, Dehradun, India.

Date of publication: 26 October 2021 (online & print)

Citation: Kelzang, U., A.F. Habibi & R.J. Thoni (2021). Evaluation of fish diversity and abundance in the Kabul River with comparisons between reaches above and below Kabul City, Afghanistan. *Journal of Threatened Taxa* 13(12): 19743–19752. <https://doi.org/10.11609/jott.7532.13.12.19743-19752>

Copyright: © Kelzang et al. 2021. 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: The Rufford Foundation provided funding support to carry out this research project (Grant Application ID: 27579-1).

Competing interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Author details: UGYEN KELZANG is a conservation enthusiast and working on the conservation and management of aquatic biodiversity in Bhutan. He studied MSc environment management and BSc Sustainable Development. He is currently employed as a project officer at the Ministry of Health of Bhutan. AHMAD FARID HABIBI is a lecturer at Faryab University in Afghanistan. His research interests include the conservation of freshwater biodiversity, environmental education, and disaster management. RYAN J. THONI is an ichthyologist specializing in studying the diversity and evolution of Himalayan fish fauna. His research spans the Himalayas with a strong focus on Bhutan, Nepal, and the Tien Shan Range in Kyrgyzstan and Tajikistan.

Author contributions: UK performed a compilation of data, analysis, interpretation, and wrote the first draft of the manuscript. AFH did all fieldwork like field sampling and field data collection. RJT reviewed and edited the first draft of the manuscript. All authors reviewed and incorporated all the comments received from the reviewers and incorporated them in the manuscript. Before submitting, all authors read and approved the final version of the manuscript.

Acknowledgements: The authors are thankful to the Rufford Foundation for granting Rufford Small Grants (Grant Application ID: 27579-1) to initiate and implement this research project.



INTRODUCTION

Fishes are the most diverse and abundant group of vertebrates in the world (Powers 1989; Ravi & Venkatesh 2008), making up nearly 50 % of all vertebrate diversity. Further, fishes are important keystone species in many ecosystems and exhibit diverse behaviours and ecologies (Spencer & King 1984; Allan 2004; Dudgeon et al. 2006; Wu et al. 2014). They play important roles managing balanced trophic dynamics within a system. Additionally, fishes contribute to food security throughout most of the world, making up as much as 17 % of the world population's protein intake (Bennett et al. 2018) and fishing is one of the most common livelihoods globally (FAO 2014).

An assessment done by the International Union for Conservation of Nature (Reid et al. 2013), on more than 5,000 species, reported that freshwater fishes are the most threatened group of vertebrates in the world. The Himalayan region holds a variety of both warm and cold-water fishes (Jayaram 2010). Coad (2015) reported that there are 85 species of fishes belonging to 10 families in the landlocked country of Afghanistan, however, FishBase.org (2020) reports 125 species (all freshwater species) known to occur in Afghanistan – a gulf that reflects the paucity of reliable data on fish diversity in Afghanistan. Though, several studies on the fishes have been conducted throughout different regions of the Himalaya (Vishwanath et al. 1998; Shrestha 1999; Goswami et al. 2007; Jayaram 2010; Gurung et al. 2013; Thoni & Gurung 2014; Gurung & Thoni 2015; Prasad et al. 2020), in Afghanistan, such studies are very limited in scope and number, despite the fact that several fishes found in the country are endemic and likely threatened (UNEP 2003). In order to preserve biodiversity in a given area, we must understand what the diversity is and how it is impacted by different resource uses, development processes, and management strategies.

The Kabul River is home to a diverse fish community including the globally endangered Golden Mahseer *Tor putitora* (UNEP 2008). The Kabul River is mainly used for irrigation, waste disposal, watering livestock, and fishing. The river runs through the most densely populated areas of the city. In the Kabul River, water pollution is a significant threat to the freshwater ecosystem (Weir 2018). The United Nations Environment Protection (UNEP 2003) reported pollution of the Kabul River in the city of Kabul mainly by the release of industrial effluents, domestic waste, and development activities. To date no biodiversity indices-based research efforts on fish fauna have been carried out in Afghanistan. Hence, this study

aims to assess the diversity, distribution, and abundance of fish fauna in the Kabul River downstream of Kabul City compared to upstream.

MATERIAL AND METHODS

Study area

This study was conducted along reaches of the Kabul River above and below Kabul City, located at 34.542°N 68.803°E, at an elevation of 1,791 m (Figure 1). The study area was divided into two different zones: upstream, and downstream. Three sampling sites each from each zone were selected to sample fish (Figure 1; Table 1). Four sampling replicates were taken in each sampling sites, keeping 400 m distance between sampling replicates. Sites were selected to ensure that similar habitat types were represented in upstream and downstream reaches. Fish sampling was carried out between December 2019 to June 2020 by using nets (mesh sizes ranging from ½ inch to 2.5 inch) both in upstream and downstream reaches. We used different mesh sizes of nets so as to minimize the bias in sampling fishes of numerous sizes due to specific gears.

The area receives 312 mm of precipitation on an average annually, with rarer precipitation in the summer months (NEPA 2007). Average annual temperature of the area ranges from 4.3 °C to 19.6 °C, with approximately 12.4 °C to 32.1 °C during summer months and -7.1 °C to 8.3 °C in winter months (Broshears et al. 2005). The area is densely populated (Mack et al. 2009), with much of the non-wood forest product industry (mainly fruits and tree nut farming and industry) dependent upon the Kabul River and its tributaries for the disposal of effluents (dyes, metals, and minerals). A population of roughly 3–5 million people live in the greater Kabul area (Barbè 2013).

Fish sampling

Using the expertise of the local fishermen, ichthyofaunal sampling was done in the selected sampling sites. Fishes were collected using gill nets and fish traps for two days in each sampling site. Fishes were counted, photographed, and identified up to the species level when possible, before being released back into the river. Species that were not readily identified by the project team on site were photographed and all diagnostic data required for identification were taken for further identification and referred to available literature. Taxonomic studies of the fish fauna collected from this study were performed following Mishra (1959), Talwar &

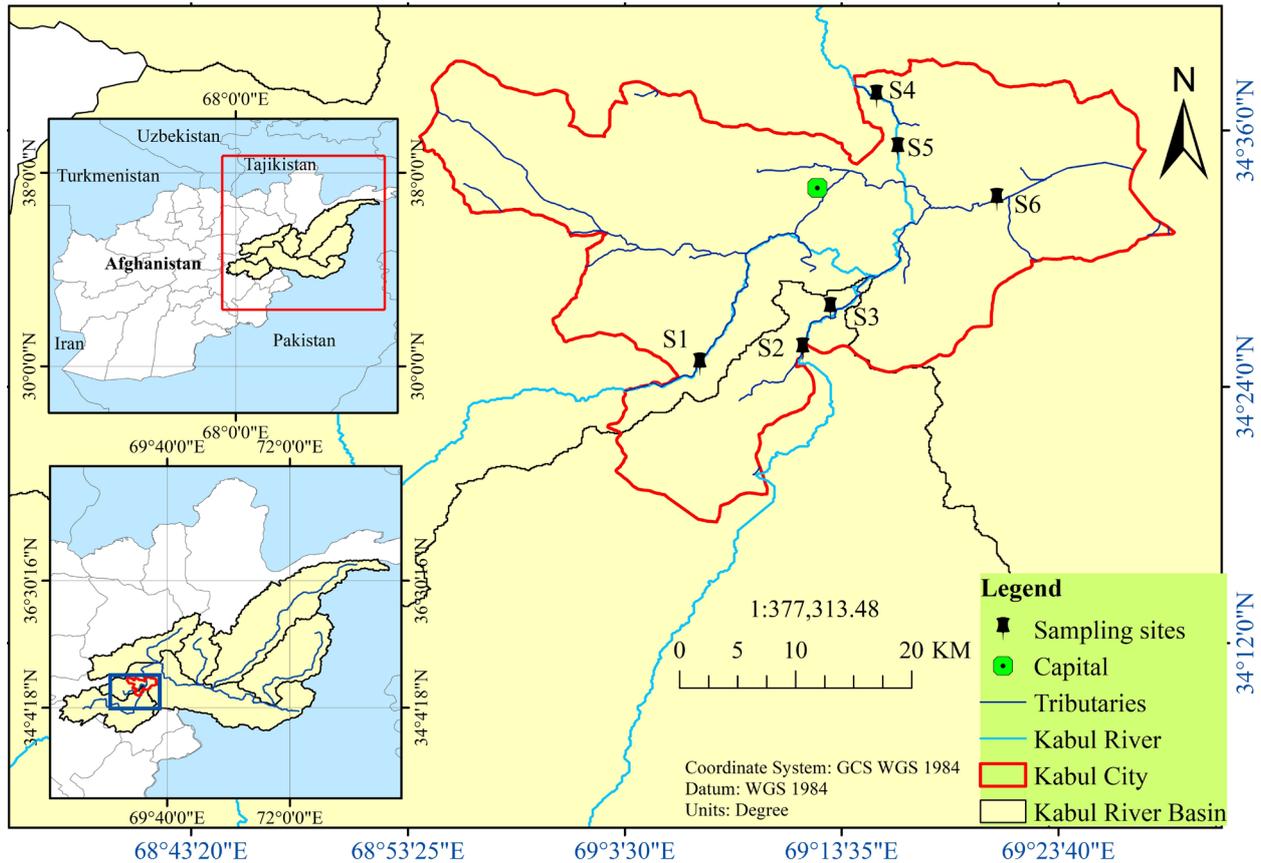


Figure 1. Map of the study area showing sampling sites, Kabul River and its tributaries, and Kabul City, Afghanistan.

Jhingran (1991), Jayaram (1981, 2010), and Coad (2014, 2015).

Analysis of data

A Mann-Whitney test, comparing species diversity and abundance was performed using IBM SPSS Statistics 23.0 to examine differences in species abundance and diversity between upstream and downstream locations. Dendrogram of Bray-Curtis coefficients of similarity (Bray & Curtis 1957) and rank abundance plots of sites were generated using BioDiversity Professional version 2.0 (McAleece 1999). As there seems to be no single diversity index more appropriate than another (Morris et al. 2014), several common diversity indices were tested. Shannon diversity index (Shannon & Wiener 1949), Simpson’s diversity (Pielou 1969), Pielou evenness index (Pielou 1975), Margalef’s richness index (Margalef 1958), Menhinick’s index (Menhinick 1964), and Sorensen’s similarity coefficient (Dice 1945; Sørensen 1948) were calculated using the following formulae:

(a) Shannon diversity index: $H' = -\sum_{i=1}^n p_i \ln p_i$
 where p_i = the proportion of individuals belonging to the i^{th} species.

(b) Simpson’s diversity: $D_1 = 1 - \sum_{i=1}^n p_i^2$
 where p_i = the proportion of individuals belonging to the i^{th} species.

(c) Pielou evenness index: $J' = \frac{H'}{\ln S}$

where H' = Shannon diversity index; S = species richness.

(d) Margalef’s richness index: $D_{Mg} = \frac{S-1}{\ln(N)}$

where S = species richness; N = total number of individuals.

(e) Menhinick’s index: $D_{Mn} = \frac{S}{\sqrt{N}}$

where S = species richness; N = total number of individuals.

(f) Sorensen’s similarity coefficient: $CC = \frac{2C}{S_1+S_2}$

where C = number of species the two communities

Figure 1. Map of the study area showing sampling sites, Kabul River and its tributaries, and Kabul City, Afghanistan.

Sampling zones	Sampling sites	Geographic coordinates		Elevation (m)
		Latitude (D.M.S)	Longitude (D.M.S)	
Upstream	S1	34.41746°N	69.11657°E	1,919
	S2	34.42923°N	69.19619°E	1,814
	S3	34.4609°N	69.21761°E	1,797
Downstream	S4	34.62652°N	69.25344°E	1,761
	S5	34.58567°N	69.27003°E	1,782
	S6	34.54591°N	69.34672°E	1,776

have in common; $S1$ = number of species in community one; $S2$ = number of species in community two.

The initial data entering, data cleaning, data coding, calculation of some descriptive analyses, and generation of charts were conducted using Microsoft Excel 2016. The map of the study area was produced using ArcMap version 10.5.

RESULTS AND DISCUSSION

Fish composition

A total of 1,190 fishes were collected (Table 2) from the study area. Out of the total of all fishes across both zones, 81.4 % (n= 969) of belong to the order Cypriniformes, 18.2 % (n= 216) to Salmoniformes, and 0.4 % (n= 5) to Cichliformes (Figure 2). This is in line with the research carried out by Saund et al. (2012) in the Mahakali River, Nepal, where they have reported Cypriniformes as the most dominant order. Studies conducted by Shendge (2007), Aryani (2015), and Akhi et al. (2020) have reported similar community structures. However, the aquatic habitats of Afghanistan are less conducive to and are geographically isolated from many of the more diverse groups of Asian Siluriformes, resulting in our relatively low diversity of catfishes. Cyprinids can live in cold waters, tolerate very low oxygen levels, and exhibit a broad range of trophic guilds (Royce 1996). Hence, combined with historical processes, they are typically found to be more dominant in freshwater habitats throughout most of the Asian continent.

The order of Cypriniformes was represented by one family, six genera, and eight species. The second most abundant order, Salmoniformes, was represented by one family, two genera, and two species. Cichliformes was only represented by a single species. Among families, Cyprinidae was the most dominant within the

study area, and Salmonidae was second most dominant family. Similarly, Dau & Parkash (2009), Cunico et al. (2011), Choubey & Qureshi (2013), Mohsin et al. (2013), Hu et al. (2019), and Herawati et al. (2020) reported Cyprinidae as the dominant family in regional censuses throughout much of Asia.

Among the predominant fish families, Cyprinidae is one of the most diverse (Boschung & Mayden 2004; Shen et al. 2016) and pollution-disturbance-tolerant families, with more than 2,000 species and 210 genera (Barbour et al. 1999; Grabarkiewicz & Davis 2008). Their ability to survive in unclean habitats validates their dominance in the most polluted part of the Kabul River (Kabul city and downstream reaches).

Species abundance

Within the upstream sites, *Schizothorax sp.* was highly abundant at sites S2 (n= 76) and S3 (n= 117) followed by *Schizothorax esocinus*. At S1, *Oncorhynchus*

Table 2. Overall fish species composition in Kabul River under Kabul City.

Family	Species	N	%
Cyprinidae	<i>Alburnoides holciki</i>	90	7.6
	<i>Ctenopharyngodon idella</i>	54	4.5
	<i>Cyprinus carpio</i>	36	3.0
	<i>Hypophthalmichthys molitrix</i>	81	6.8
	<i>Schizothorax esocinus</i>	228	19.2
	<i>Schizothorax sp.</i>	420	35.3
	<i>Tariqilabeo diplochilus</i>	48	4.0
	<i>Tariqilabeo sp.</i>	12	1.0
Salmonidae	<i>Oncorhynchus mykiss</i>	198	16.6
	<i>Salmo trutta</i>	18	1.5
Cichlidae	<i>Coptodon zillii</i>	5	0.4

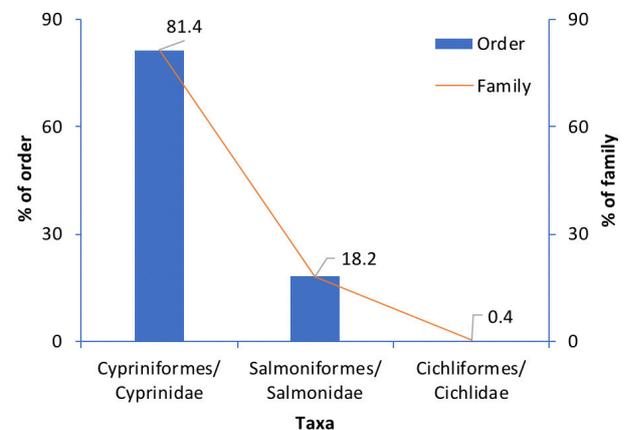


Figure 2. Composition of fishes based on order and family.

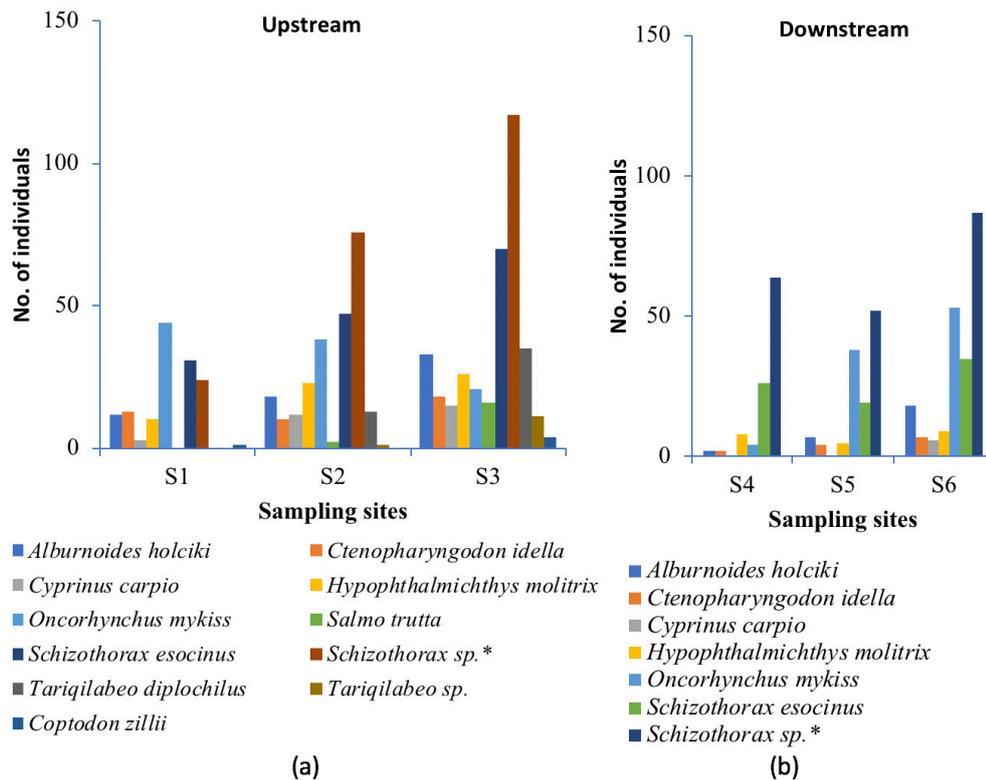


Figure 3. Species abundance in different sampling sites of (a) upstream and (b) downstream (Note: * indicates highest no. of individuals).

mykiss (n= 44) was the most abundant species, followed by *S. esocinus* (n= 31) (Figure 3a). *Schizothorax sp.* was the most abundant species at all three of the downstream sites (S4 n= 64, S5 n= 52, S6 n= 87; Figure 3b). Species abundance significantly differs among the 6 different sampling sites. *Alburnoides holciki* (n= 33), *Ctenopharyngodon idella* (n= 18), *Cyprinus carpio* (n= 15), *Hypophthalmichthys molitrix* (n= 26), *Salmo trutta* (n= 16), *Schizothorax esocinus* (n= 70), *Schizothorax sp.* (n= 117), *Tariqilabeo diplochilus* (n= 35), *Tariqilabeo sp.* (n= 11), and *Coptodon zillii* (n= 4) were recorded more in S3 than in other sites.

Overall, in upstream sites, *Schizothorax sp.* was abundant (n= 217, 72.33 ± 46.61), followed by *Schizothorax esocinus* (n= 148, 49.33 ± 19.60) and *Oncorhynchus mykiss* (n= 103, 34.33 ± 11.93). *Coptodon zillii* (n= 5, 1.67 ± 2.08) was least abundant fish species in the upstream zone (Table 3). Likewise, in the downstream, *Schizothorax sp.* (n= 203, 67.67 ± 17.79) was most abundant and *Cyprinus carpio* (n= 6, 2 ± 3.46) was least abundant.

Pandey et al. (2018) also found abundance and dominance of *Schizothorax spp.* in rivers in Uttarakhand, India. Similar reports on the abundance of schizothoracines were also made in the Tibetan Plateau

(Zhang et al. 2017; Ma et al. 2020). Moreover, Kabul is a cold place located at 1,791 m and Aljazeera (2012) reported -17°C at night in February. Schizothoracines are cold-water species, also living at elevations of up to 3,323 m (Petr et al. 2002). Thus, the abundance of schizothoracines in the Kabul River is in consistency with the other rivers of the Himalaya.

While comparing overall fish abundance between upstream and downstream reaches, upstream (n= 744) was found to be higher than downstream (n= 446). This result is contrary to normal patterns of fish diversity along a river continuum (Edds 1993; Tiemann et al. 2004). In addition, the dendrogram of Bray-Curtis coefficients of similarity in the abundance of fish was produced. As per the cluster analysis, S2 and S6 had a parallel Bray-Curtis similarity in their species abundance of about 83 %. Though these sites are from different locations (upstream and downstream), the high similarity explained between these sites is mainly due to similar level of anthropogenic activities and pollution level. S1, S5, S3, and S2–S6 combined had a common similarity of about 74 %, indicating similarity in species abundance (Figure 4).

Species present at the upstream sites like *Salmo trutta*, *Tariqilabeo diplochilus*, *Tariqilabeo sp.*, and

Table 3. Mean species abundance with standard deviation at upstream and downstream sites.

Species	Upstream		Downstream	
	No. of individuals	Mean \pm Standard Deviation	No. of individuals	Mean \pm Standard Deviation
<i>Alburnoides holciki</i>	63	21.00 \pm 10.82	27	9.00 \pm 8.19
<i>Ctenopharyngodon idella</i>	41	13.67 \pm 4.04	13	4.33 \pm 2.52
<i>Cyprinus carpio</i>	30	10.00 \pm 6.24	6	2.00 \pm 3.46
<i>Hypophthalmichthys molitrix</i>	59	19.67 \pm 8.50	22	7.33 \pm 2.08
<i>Oncorhynchus mykiss</i>	103	34.33 \pm 11.93	95	31.67 \pm 25.11
<i>Salmo trutta</i>	18	6.00 \pm 8.72	-	-
<i>Schizothorax esocinus</i>	148	49.33 \pm 19.60	80	26.67 \pm 8.02
<i>Schizothorax sp.</i>	217	72.33 \pm 46.61	203	67.67 \pm 17.79
<i>Tariqilabeo diplochilus</i>	48	16.00 \pm 17.69	-	-
<i>Tariqilabeo sp.</i>	12	4.00 \pm 6.08	-	-
<i>Coptodon zillii</i>	5	1.67 \pm 2.08	-	-

- indicates absence.

Table 4. Native and non-native fish species recorded in different sites.

Species	Occurrence	Sampling sites					
		S1	S2	S3	S4	S5	S6
<i>Alburnoides holciki</i>	Native	✓	✓	✓	✓	✓	✓
<i>Salmo trutta</i>	Native	x	✓	✓	x	x	x
<i>Schizothorax esocinus</i>	Native	✓	✓	✓	✓	✓	✓
<i>Tariqilabeo diplochilus</i>	Native	x	✓	✓	x	x	x
<i>Coptodon zillii</i>	Native	✓	x	✓	x	x	x
<i>Ctenopharyngodon idella</i>	Non-native	✓	✓	✓	✓	✓	✓
<i>Cyprinus carpio</i>	Non-native	✓	✓	✓	x	x	✓
<i>Hypophthalmichthys molitrix</i>	Non-native	✓	✓	✓	✓	✓	✓
<i>Oncorhynchus mykiss</i>	Non-native	✓	✓	✓	✓	✓	✓

Coptodon zillii were not recorded from the downstream sites. This is likely because of the high intensity of ongoing habitat degradation caused by the discharge of industrial waste and sewage directly into the river system, construction activities, and the high density of human population and their associated anthropogenic effects on the downstream reaches.

Native and non-native species in sampling sites

From the total of nine species recorded from the area (lumping *Schizothorax sp.* with *Schizothorax esocinus* and *Tariqilabeo sp.* with *Tariqilabeo diplochilus*), five species were found to be native and four non-native species (Table 4).

We recorded the highest number of native species from S3 ($n= 286$), followed by S2 ($n= 157$), and S6 ($n=$

140). Similarly, as shown in Table 5, non-native fish species were recorded more in S3 ($n= 84$) followed by S2 ($n= 83$) and S6 ($n= 75$). The lowest number of non-native fish were found in S4 ($n= 14$). It was found that almost all non-native fish species were used for aquaculture in the area. The decrease in native species richness while moving from upstream to downstream was also reported by Loures & Pompeu (2019). They stated that the main reason behind such occurrence is mainly due to increase in non-native species in downstream areas.

Diversity and richness of fish species

The high species richness in S3 and S2 were indicated by Margalef's diversity index (D_{Mg}) (1.69 and 1.64, respectively), as their values were higher than other sampling sites. To examine the similarity of species



Table 5. Sorenson’s similarity coefficient (whose value ranges from 0 to 1) showing degree of similarity among sampling sites.

	S1	S2	S3	S4	S5	S6
S1	1.00	0.78	0.84	0.86	0.86	0.93
S2		1.00	0.95	0.75	0.75	0.82
S3			1.00	0.71	0.71	0.78
S4				1.00	1.00	0.92
S5					1.00	0.92
S6						1.00

Table 6. Mean ± standard deviation of biodiversity indices for upstream and downstream sites in Kabul city.

Diversity Indices/ Sites	Upstream Mean ± SD	Downstream Mean ± SD
Menhinick’s index (D_{Mn})	0.63 ± 0.05	0.53 ± 0.05
Margalef’s diversity index (D_{Mg})	1.59 ± 0.15	1.07 ± 0.04
Shannon diversity index (H')	1.90 ± 0.15	1.36 ± 0.22
Pielou evenness index (J')	0.84 ± 0.01	0.74 ± 0.10
Simpson’s diversity (D_1)	0.81 ± 0.02	0.67 ± 0.09

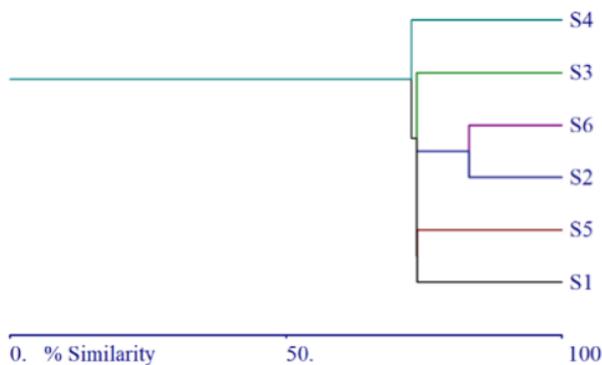


Figure 4. Bray-Curtis similarity dendrogram; cluster analysis (single linkage) based on the Bray-Curtis index of similarity applied to the fish abundance.

richness between the sampling sites, Sorenson’s similarity coefficient (CC) was appraised (Table 5). Sampling sites S2 & S3, S1 & S6, S4 & S6, and S5 & S6 indicated having similarity of 95 %, 93 %, 92 %, and 92 % between them, respectively. Sorenson’s similarity coefficient value between S3, S4, and S5 (CC= 0.71) was the lowest, which also shows 71 % of similarity between them.

Altogether, upstream sites recorded 11 species while downstream sites recorded seven species. High richness upstream ($D_{Mn} = 0.63 \pm 0.05$, $D_{Mg} = 1.59 \pm 0.15$) was supported by Menhinick’s Index (D_{Mn}) and Margalef’s diversity index (D_{Mg}). For downstream, Menhinick’s

index and Margalef’s diversity index were 0.53 ± 0.05 and 1.07 ± 0.04 correspondingly, which was considerably less than upstream (Table 6). This was supported by Mann-Whitney test which revealed that fish richness upstream (9.67 ± 1.53) and downstream ($6.33 \pm .58$) was significantly different ($U= 0.00$, $z= -1.99$, $p= 0.04$, $r= 0.81$) (Table 7).

Fish species diversity was evaluated using various diversity indices. The most diverse site among all was S3 with Shannon diversity index (H') of 2.04 and Simpson’s diversity (D_1) of 0.83. S4 was the site with least diversity ($H'= 1.12$, $D_1= 0.57$). Similarly, species evenness was highest in S3 with Pielou evenness index (J') of 0.85 and lowest in S4 ($J'= 0.62$).

Overall, diversity of fishes was higher in reaches of the Kabul River upstream ($H'= 1.90 \pm 0.15$, $D_1= 0.81 \pm 0.02$) of Kabul City when compared to downstream reaches ($H'= 1.36 \pm 0.22$, $D_1= 0.67 \pm 0.09$) which was indicated both by the Shannon diversity index and Simpson’s diversity. Likewise, species evenness was higher in reaches upstream of Kabul City ($J'= 0.84 \pm 0.01$) compared to downstream reaches ($J'= 0.74 \pm 0.10$). Previous studies have shown a similar pattern in which reaches of rivers upstream of densely populated areas harbour higher diversity of freshwater fishes compared to downstream (Tawari-Fufeyin & Ekaye 2007).

The higher species richness and diversity in upstream reaches in the study area may be due to the constant flow of the river, less modification of land use, less pollution and fewer developmental activities. Urban activities like urban and industrial construction leads to land use change, adding pollution and nutrients to the river system, varying hydro-morphology and hydrologic flow regimes, and creating unstable flow (as the valley remains dry in most of the winter months) which negatively effects fish diversity and richness (Grimm et al. 2000; Wang et al. 2001; Booth 2005; Walsh et al. 2005; Gebrekiros 2016).

Freshwater ichthyofauna conservation

Afghanistan is an arid and landlocked country (Breckle 2007; Wily 2015), but is abundant in water resources (Qureshi 2002). However, as much as 80 % of Afghanistan’s freshwater is contaminated and water pollution is a serious threat to the conservation of aquatic biodiversity and human survival (Weir 2018). In Kabul City, solid waste, waste water (both domestic and industrial), and open sewers directly drain into the Kabul River (UNEP 2003), exacerbated by population growth (Mack et al. 2009), modifying the aquatic habitat. Habitat quality plays a great role in the fish composition,

Table 7. Mann-Whitney U test result of species richness between upstream and downstream.

	Group	N	Mean rank	Mean Sum	U	z	p	r
Species richness	Upstream	3	5.00	15.00	.00	-1.99	.04	.81
	Downstream	3	2.00	6.00				

U—Mann-Whitney U test | z—z statistics | p—significance value | r—effect size.

Table 8. Fish species recorded from the Kabul River in Kabul City, Afghanistan with global conservation status.

Species	Conservation status	Regional status
<i>Alburnoides holciki</i>	Not Evaluated	Native
<i>Ctenopharyngodon idella</i>		Non-Native
<i>Cyprinus carpio</i>		Non-Native
<i>Hypophthalmichthys molitrix</i>		Non-Native
<i>Oncorhynchus mykiss</i>		Non-Native
<i>Salmo trutta</i>	Least concern	Native
<i>Schizothorax esocinus</i>	Not Evaluated	Native
<i>Schizothorax</i> sp.		Native
<i>Tariqilabeo diplochilus</i>	Not Evaluated	Native
<i>Tariqilabeo</i> sp.		Native
<i>Coptodon zillii</i>	Least Concern	Native

diversity, and distribution in any stream or river system (McClendon & Rabeni 1987; Agarwal et al. 2018). Use of agriculture pesticides, and overfishing (Saeed 2018) are other threats to the conservation of the freshwater ecosystem in Kabul City. This study has documented 11 fish species from the area. One species of them is listed under the IUCN Red List of Threatened Species (Table 8). To conserve these species and other associated species in the area, adoption of scientific fishing or sustainable fishing methods, timely monitoring of water quality, and proper management of solid waste and waste water are urgently recommended.

CONCLUSIONS

The Kabul River downstream of Kabul City is threatened by numerous anthropogenic activities. The majority of fishes recorded from the area were from the upstream sites where the aquatic habitat was least disturbed compared to downstream sites. Intensive agriculture, infrastructural development, and ineffective management of waste in the downstream area increases sedimentation, contamination, and changes the overall aquatic habitats and their function. Our study shows

that species diversity, richness, and abundance tend to decrease as we move from sites upstream of Kabul City to sites downstream of Kabul City. Thus, implementation of sustainable development practice is deemed essential, so as to manage the water resources and conserve its biodiversity. Moreover, studies on physiochemical parameters of the river, aquatic macroinvertebrates and fishes, and their association needs to be carried out to generate additional baseline information on the aquatic biodiversity of the area and to monitor water quality.

REFERENCES

Agarwal, N.K., G. Singh, H. Singh, N. Kumar & U.S. Rawat (2018). Ecological impacts of dams on the fish diversity of Bhagirathi River in central Himalaya (India). *Coldwater Fisheries Society of India* 1(1): 74–84.

Akhi, M.M., M.A. Jewel, M.A. Haque, B.K. Sarker, M.S. Khatun, A.K. Paul, M.S. Islam & S.K. Das (2020). Multivariate approaches to determine the relationship between fish assemblage structure and environmental variables in Karatoya River, Bangladesh. *Community Ecology* 21: 171–181. <https://doi.org/10.1007/s42974-020-00015-6>.

Aljazeera (2012). Afghanistan battles against cold and snow. In: Aljazeera. Retrieved on 30 March 2020. <https://www.aljazeera.com/indepth/inpictures/2012221102246504375.html>

Allan, J.D. (2004). Landscapes and riverscapes: the influence of land use on stream ecosystems. *The Annual Review of Ecology, Evolution, and Systematics* 35: 257–284. <https://doi.org/10.1146/annurev.ecolsys.35.120202.110122>

Aryani, N. (2015). Native species in Kampur Kanan River, Riau province Indonesia. *International Journal of Fisheries and Aquatic Studies* 2(5): 213–217.

Barbè, D. (2013). Population Displacement and Urban Transition in Kabul City. *Sciences Po - Fall 2013. Risk Governance in the Large Metropolis*.

Barbour, M.T., J. Gerritsen, B.D. Snyder & J.D. Stribling (1999). *Rapid Bioassessment Protocols for Use in Streams and Wadable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, 2nd Edition*. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Bennett, A., P. Patil, K. Kleisner, D. Rader, J. Virdin & X. Basurto (2018). *Contribution of fisheries to food and nutrition security: Current knowledge, policy, and research*. Duke University, Nicholas Institute for Environmental Policy Solutions.

Bhatt, J.P. & M.K. Pandit (2016). Endangered Golden Masheer *Tor putitora* Hamilton: a review of natural history. *Reviews in Fish Biology and Fisheries* 26(1): 25–38.

Booth, D.B. (2005). Challenges and prospects for restoring urban streams: a perspective from the Pacific Northwest of North America. *Journal of the North American Benthological Society* 24(3): 724–737.

Boschung, H.T. & R.L. Mayden (2004). *Fishes of Alabama*. Smithsonian Institution, Washington, 736 pp.

Bray, J.R. & J.T. Curtis (1957). An ordination of upland forest



- communities of southern Wisconsin. *Ecological Monographs* 27: 325–349.
- Breckle, S.W. (2007).** Flora and vegetation of Afghanistan. *Basic and Applied Dryland Research* 1(2): 155–194.
- Broshears, R.E., M.A. Akbari, M.P. Chornack, D.K. Mueller & B.C. Ruddy (2005).** *Inventory of Ground-Water Resources in the Kabul Basin, Afghanistan*. U.S. Geological Survey Scientific Investigation Report 2005.
- Choubey, K. & Y. Qureshi (2013).** Study of ichthyofaunal biodiversity of Rajnandgaon town, CG, India. *International Research Journal of Biological Sciences* 2(2): 21–24.
- Coad, B.W. (2014).** *Fishes of Afghanistan*. Pensoft Publishers, 393 pp.
- Coad, B.W. (2015).** Native fish biodiversity in Afghanistan. *Iranian Journal of Ichthyology* 2(4): 227–234.
- Cunico, A.M., J.D. Allan & A.A. Agostinho (2011).** Functional convergence of fish assemblages in urban streams of Brazil and the United States. *Ecological Indicators* 11(5): 1354–1359.
- Dau, A. & C. Parkash (2009).** Distribution and abundance of fish populations in Herike wetland-A Ramsar site in India. *Journal of Environmental Biology* 30(2): 247–251.
- Dice, L.R. (1945).** Measurement of the amount of ecologic association between species. *Ecology* 26(3): 297–302.
- Dudgeon, D., A.H. Arthington, M.O. Gessner, Z. Kawabata, D.J. Knowler, C. Lévêque, R.J. Naiman, A. Prieur-Richard, D. Soto, M.L.J. Stiassny & C.A. Sullivan (2006).** Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Reviews* 81(2): 163–182.
- Edds, D.R. (1993).** Fish assemblage structure and environmental correlates in Nepal's Gandaki River. *Copeia* 11: 48–60.
- FAO (2014).** *The State of World Fisheries and Aquaculture 2014: Opportunities and Challenges*. Food and Agriculture Organization.
- FishBase.org (2020).** *FishBase*. World Wide Web electronic publication. <http://www.fishbase.org>, version (1/2020).
- Freyhof, J. (2011).** *Salmo trutta*. In: The IUCN Red List of Threatened Species 2011: e.T19861A9050312. Downloaded on 20 March 2020. <https://doi.org/10.2305/IUCN.UK.2008.RLTS.T19861A9050312.en>
- Freyhof, J. & M. Kottelat (2008).** *Cyprinus carpio*. In: The IUCN Red List of Threatened Species 2008: e.T6181A12559362. Downloaded on 20 March 2020. <https://doi.org/10.2305/IUCN.UK.2008.RLTS.T6181A12559362.en>
- Gebrekiros, S.T. (2016).** Factors Affecting Stream Fish Community Composition and Habitat Suitability. *Journal of Aquaculture and Marine Biology* 4(2): 00076. <https://doi.org/10.15406/jamb.2016.04.00076>
- Goswami, U.C, W. Vishwanath & K.C. Jayaram (2007).** Fish fauna of north east India: natural and anthropogenic. *Natural and Anthropogenic Hazards on Fish and Fisheries* 21.
- Grabarkiewicz, J. & W. Davis (2008).** *An introduction to freshwater fishes as biological indicators*. EPA-260-R-08-016. U.S. Environmental Protection Agency, Office of Environmental Information, Washington, DC.
- Grimm, N.B., J.M. Grove, S.T.A. Pickett & C.L. Redman (2000).** Integrated approaches to longterm studies of urban ecological systems. *BioScience* 50(7): 571–584.
- Gurung, D.B., S. Dorji, U. Tshering & J.T. Wangyal (2013).** An annotated checklist of fishes from Bhutan. *Journal of Threatened Taxa* 5(14): 4880–4886. <https://doi.org/10.11609/JoTT.o3160.4880-6>
- Gurung, D.B. & R.J. Thoni (2015).** *Fishes of Bhutan: a preliminary checklist*. Kuensel Corporation Limited.
- Herawati, T., M. Syaiful, I. Bangkit, A. Sahidin, A. Yustiati, Y. Dhahiyat & Iskandar (2020).** Fish community structure before reservoir inundation in Cipanas, West Java. In *IOP Conference Series: Earth and Environmental Science* Vol. 535, No. 1, p. 012059. IOP Publishing.
- Hu, M., C. Wang, Y. Liu, X. Zhang & S. Jian (2019).** Fish species composition, distribution and community structure in the lower reaches of Ganjiang River, Jiangxi, China. *Scientific Reports* 9: 10100. <https://doi.org/10.1038/s41598-019-46600-2>
- Jayaram, K.C. (1981).** *The freshwater fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka. A Handbook*. Zoological Survey of India, Calcutta.
- Jayaram, K.C. (2010).** *Freshwater fishes of the Indian region, 2nd edition*. Narendra Publishing House, Delhi, India.
- Lalèyè, P. (2020).** *Coptodon zilli*. In: The IUCN Red List of Threatened Species 2020: e.T183163A64508317. Downloaded on 20 March 2020. <https://doi.org/10.2305/IUCN.UK.2020-2.RLTS.T183163A64508317.en>
- Loures, R.C. & P.S. Pompeu (2019).** Temporal changes in fish diversity in lotic and lentic environments along a reservoir cascade. *Freshwater Biology* 64(10): 1806–1820.
- Ma, Q., K. He, X. Wang, J. Jiang, X. Zhang & Z. Song (2020).** Better resolution of Cytochrome b than Cytochrome c Oxidase Subunit I to Identify *Schizothorax* Species (Teleostei: Cyprinidae) from the Tibetan Plateau and Its Adjacent Area. *DNA and Cell Biology* 39(4): 579–598.
- Mack, T.J., M.A. Akbari, M.P. Chornack, I.M. Verstraeten, T.B. Collen & L.N. Plummer (2009).** Water resources availability in Kabul, Afghanistan: a conceptual simulation integrating climatologic, hydrogeologic, geochemical, and remotely sensed data. Program with Abstracts. In *Second Hindu Kush Conference, Symposia and Workshops for Geoscientists, Engineers, Planners, Archeologists and Investors* (pp. 27–79).
- Margalef, R. (1958).** Temporal succession and spatial heterogeneity in phytoplankton, pp. 323–347. In: *Perspectives in Marine biology*, Buzzati-Traverso (ed.), University of California Press, Berkeley.
- McAlece, N. (1999).** BioDiversity Pro, Version 2.00. The Natural History Museum and the Scottish Association for Marine Science.
- McClendon, D.D. & C.F. Rabeni (1987).** Physical and biological variables for predicting population characteristics of the small mouth bass and rock bass in an Ozark stream. *North American Journal of Fisheries Management* 7: 46–56.
- Menhinick, E.F. (1964).** A comparison of some species individual diversity indices applied to samples of field insects. *Ecology* 45: 589–861.
- Mishra, K.S. (1959).** An aid to identification of the common commercial fishes of India and Pakistan. *Record of the Indian Museum* 1–4(57): 172–177.
- Mohsin, A.B.M., S.M. Haque, S.M. Galib, F.H. Fahad, N. Chaki, N. Islam & M. Rahman (2013).** Seasonal abundance of fin fishes in the Padma River at Rajshahi district, Bangladesh. *World Journal of Fish and Marine Sciences* 5(6): 680–685.
- Morris, E.K., T. Caruso, F. Buscot, M. Fischer, C. Hancock, T.S. Maier, T. Meiners, C. Müller, E. Obermaier, D. Prati, S.A. Socher, I. Sonnemann, N. Wäschke, T. Wubet, S. Wurst & M.C. Rillig (2014).** Choosing and using diversity indices: insights for ecological applications from the German Biodiversity Exploratories. *Ecology and Evolution* 4(18): 3514–3524.
- NEPA (2007).** *Afghanistan Initial National Communication to the United Nations Framework Convention on Climate Change*. National Environmental Protection Agency, Islamic Republic of Afghanistan
- Pandey, N., P. Kumar, S. Ali, B.K. Vishwakarma & S. Kumar (2018).** Role of small tributaries in ichthyofaunal diversity of rivers in Uttarakhand. *Journal of Coldwater Fisheries* 1(1): 89–96.
- Petr, T., D.B. Swar & S.B. Swar (Eds.) (2002).** *Cold water fisheries in the trans-Himalayan countries* (No. 431). Food and Agriculture Organization.
- Pielou, E.C. (1975).** *Ecological Diversity*. Wiley, New York, 165 pp.
- Pielou, E.C. (1969).** *An Introduction to Mathematical Ecology*. Wiley, New York, USA, 286 pp.
- Powers, D.A. (1989).** Fish as model systems. *Science* 246(4928): 352–358.
- Prasad, A., A. Shrestha, J.H. Limbu & D. Swar (2020).** Spatial and Temporal Variation of Fish Assemblages in Seti Gandaki River, Tanahu, Nepal. *Borneo Journal of Resource Science and Technology* 10(2): 93–104.
- Pusey, B.J., D.M. Warfe, S.A. Townsend, M.M. Douglas, D. Burrows, M.J. Kennard & P.G. Close (2011).** Conditions, impacts and threats to aquatic biodiversity. In: *Aquatic Biodiversity in Northern Australia: Patterns, Threats and Future*. Charles Darwin University

- Press, Darwin.
- Qureshi, A.S. (2002).** *Water Resources Management in Afghanistan: The Issues and Options* (Vol. 49). International Water Management Institute.
- Ravi, V. & B. Venkatesh (2008).** Rapidly evolving fish genomes and teleost diversity. *Current Opinion in Genetics and Development* 18(6): 544–550.
- Reid, G.M., T.C. MacBeath & K. Csatádi (2013).** Global challenges in freshwater-fish conservation related to public aquariums and the aquarium industry. *International Zoo Yearbook* 47(1): 6–45.
- Royce, W.F. (1996).** *Introduction to the Practice of Fishery Science, Revised Edition: 1st Edition*. Elsevier, 448 pp. <https://doi.org/10.1016/B978-0-12-600952-1.X5000-2>
- Saeed, A. (2018).** Overfishing, pollution and climate change have put Kabul river's Sher Mahi fish in trouble. <https://scroll.in/article/877676/overfishing-pollution-and-climate-change-have-put-Kabul-rivers-sher-mahi-fish-in-trouble>. Retrieved on 13 March 2020.
- Saund, T.B., J.B. Thapa & H.P. Bhatt (2012).** Fish Diversity at Pancheshwar Multipurpose Project Area in Mahakali River. *Nepal Journal of Science and Technology* 13(2): 225–230.
- Shannon, C.E. & W. Wiener (1949).** *The mathematical theory of communication*. Urbana, University of Illinois Press, 177pp.
- Shen, Y., L. Guan, D. Wang & X. Gan (2016).** DNA barcoding and evaluation of genetic diversity in Cyprinidae fish in the midstream of the Yangtze River. *Ecology and Evolution* 6(9): 2702–2713.
- Shendge, A.N. (2007).** Study of fish diversity in Nira River. *Journal of the Indian Fisheries Association* 34: 15–19.
- Shrestha, J. (1999).** Coldwater fish and fisheries in Nepal. Fish and fisheries at higher altitude-Asia. *FAO Fisheries Technical Paper* 385: 13–40.
- Sørensen, T. (1948).** A method of establishing groups of equal amplitude in plant sociology based on similarity of species and its application to analyses of the vegetation on Danish commons. *The Royal Danish Academy of Sciences and Letters* 5(4): 1–34.
- Spencer, C.N. & D.L. King (1984).** Role of fish in regulation of plant and animal communities in eutrophic ponds. *Canadian Journal of Fisheries and Aquatic Sciences* 41(12): 1851–1855.
- Talwar, P.K. & A.G. Jhingran (1991).** *Inland Fishes of India and Adjacent Countries Vol-1&2*. Oxford and OBH Publishing Co. Pvt. Ltd.
- Tawari-Fufeyin, P. & S.A. Ekaye (2007).** Fish species diversity as indicator of pollution in Ikpoba river, Benin City, Nigeria. *Reviews in Fish Biology and Fisheries* 17(1): 21–30.
- Thoni, R.J. & D.B. Gurung (2014).** *Parachilognis bhutanensis*, a new species of torrent catfish (Siluriformes: Sisoridae) from Bhutan. *Zootaxa* 3869(3): 306–312.
- Tiemann, J.S., D.P. Gillette, M.L. Wildhaber & D.R. Edds (2004).** Effects of Lowhead Dams on Riffle-Dwelling Fishes and Macroinvertebrates in a Midwestern River. *Transactions of the American Fisheries Society* 133(3): 705–717. <https://doi.org/10.1577/T03-058.1>
- Turner, G.F. (1999).** What is a fish species? *Reviews in Fish Biology and Fisheries* 9(4): 281–297.
- UNEP (2003).** *Afghanistan: Post-conflict Environmental Assessment*. United Nations Environment Program, Nairobi, Kenya
- UNEP (2008).** *Biodiversity profile of Afghanistan: An output of the national capacity needs self-assessment for global environment management (NCSA) for Afghanistan*. United Nations Environment Program, Kabul, Afghanistan.
- Vishwanath, W., W. Manojkumar, L. Kosygin & K.S. Selim (1998).** Biodiversity of freshwater fishes of Manipur, India. *Italian Journal of Zoology* 65(S1): 321–324. <https://doi.org/10.1080/11250009809386840>
- Walsh, C.J., T.D. Fletcher & A.R. Ladson (2005).** Stream restoration in urban catchments through redesigning storm water systems: looking to the catchment to save the stream. *Journal of the North American Benthological Society* 24(3): 690–705.
- Wang, L., J. Lyons & P. Kanehl (2001).** Impacts of urbanization on stream habitat and fish across multiple spatial scales. *Environmental Management* 28(2): 255–266.
- Weir, D. (2018).** The slow violence of pollution in Afghanistan. In: Conflict and Environment Observatory. Retrieved on 15 February 2020. <https://ceobs.org/the-slow-violence-of-pollution-in-afghanistan/>
- Whittaker, R.H. (1965).** Dominance and Diversity in Land Plant Communities: Numerical relations of species express the importance of competition in community function and evolution. *Science* 147(3655): 250–260.
- Wily, L.A. (2015).** Resolving natural resource conflicts to help prevent war: a case from Afghanistan. *Livelihoods, Natural Resources, and Post-conflict Peacebuilding* 115–137.
- Wu, W., Z. Xu, X. Yin & D. Zuo (2014).** Assessment of ecosystem health based on fish assemblages in the Wei River basin, China. *Environmental Monitoring and Assessment* 186(6): 3701–3716. <https://doi.org/10.1007/s10661-014-3651-7>
- Zhang, C., C. Tong, F. Tian & K. Zhao (2017).** Integrated mRNA and microRNA transcriptome analyses reveal regulation of thermal acclimation in *Gymnocypris przewalskii*: a case study in Tibetan Schizothoracine fish. *PloS one* 12(10): e0186433. <https://doi.org/10.1371/journal.pone.0186433>
- Zhao, H.H. (2011).** *Hypophthalmichthys molitrix*. In: The IUCN Red List of Threatened Species 2011: e.T166081A6168056. Downloaded on 20 March 2020. <https://doi.org/10.2305/IUCN.UK.2011-2.RLTS.T166081A6168056.en>

Dr. Albert G. Orr, Griffith University, Nathan, Australia
Dr. Sameer Padhye, Katholieke Universiteit Leuven, Belgium
Dr. Nancy van der Poorten, Toronto, Canada
Dr. Kareen Schnabel, NIWA, Wellington, New Zealand
Dr. R.M. Sharma, (Retd.) Scientist, Zoological Survey of India, Pune, India
Dr. Manju Siliwal, WILD, Coimbatore, Tamil Nadu, India
Dr. G.P. Sinha, Botanical Survey of India, Allahabad, India
Dr. K.A. Subramanian, Zoological Survey of India, New Alipore, Kolkata, India
Dr. P.M. Sureshan, Zoological Survey of India, Kozhikode, Kerala, India
Dr. R. Varatharajan, Manipur University, Imphal, Manipur, India
Dr. Eduard Vives, Museu de Ciències Naturals de Barcelona, Terrassa, Spain
Dr. James Young, Hong Kong Lepidopterists' Society, Hong Kong
Dr. R. Sundararaj, Institute of Wood Science & Technology, Bengaluru, India
Dr. M. Nithyanandan, Environmental Department, La Ala Al Kuwait Real Estate. Co. K.S.C., Kuwait
Dr. Himender Bharti, Punjabi University, Punjab, India
Mr. Purnendu Roy, London, UK
Dr. Saito Motoki, The Butterfly Society of Japan, Tokyo, Japan
Dr. Sanjay Sondhi, TITLI TRUST, Kalpvriksh, Dehradun, India
Dr. Nguyen Thi Phuong Lien, Vietnam Academy of Science and Technology, Hanoi, Vietnam
Dr. Nitin Kulkarni, Tropical Research Institute, Jabalpur, India
Dr. Robin Wen Jiang Ngiam, National Parks Board, Singapore
Dr. Lionel Monod, Natural History Museum of Geneva, Genève, Switzerland.
Dr. Asheesh Shivam, Nehru Gram Bharti University, Allahabad, India
Dr. Rosana Moreira da Rocha, Universidade Federal do Paraná, Curitiba, Brasil
Dr. Kurt R. Arnold, North Dakota State University, Saxony, Germany
Dr. James M. Carpenter, American Museum of Natural History, New York, USA
Dr. David M. Claborn, Missouri State University, Springfield, USA
Dr. Kareen Schnabel, Marine Biologist, Wellington, New Zealand
Dr. Amazonas Chagas Júnior, Universidade Federal de Mato Grosso, Cuiabá, Brasil
Mr. Monsoon Jyoti Gogoi, Assam University, Silchar, Assam, India
Dr. Heo Chong Chin, Universiti Teknologi MARA (UiTM), Selangor, Malaysia
Dr. R.J. Shiel, University of Adelaide, SA 5005, Australia
Dr. Siddharth Kulkarni, The George Washington University, Washington, USA
Dr. Priyadarsanan Dharma Rajan, ATREE, Bengaluru, India
Dr. Phil Alderslade, CSIRO Marine And Atmospheric Research, Hobart, Australia
Dr. John E.N. Veron, Coral Reef Research, Townsville, Australia
Dr. Daniel Whitmore, State Museum of Natural History Stuttgart, Rosenstein, Germany.
Dr. Yu-Feng Hsu, National Taiwan Normal University, Taipei City, Taiwan
Dr. Keith V. Wolfe, Antioch, California, USA
Dr. Siddharth Kulkarni, The Hormiga Lab, The George Washington University, Washington, D.C., USA
Dr. Tomas Ditrich, Faculty of Education, University of South Bohemia in Ceske Budejovice, Czech Republic
Dr. Mihaly Foldvari, Natural History Museum, University of Oslo, Norway
Dr. V.P. Niyal, Wildlife Institute of India, Dehradun, Uttarakhand 248001, India
Dr. John T.D. Caleb, Zoological Survey of India, Kolkata, West Bengal, India
Dr. Priyadarsanan Dharma Rajan, Ashoka Trust for Research in Ecology and the Environment (ATREE), Royal Enclave, Bangalore, Karnataka, India

Fishes

Dr. Neelesh Dahanukar, IISER, Pune, Maharashtra, India
Dr. Topiltzin Contreras MacBeath, Universidad Autónoma del estado de Morelos, México
Dr. Heok Hee Ng, National University of Singapore, Science Drive, Singapore
Dr. Rajeev Raghavan, St. Albert's College, Kochi, Kerala, India
Dr. Robert D. Sluka, Chiltern Gateway Project, A Rocha UK, Southall, Middlesex, UK
Dr. E. Vivekanandan, Central Marine Fisheries Research Institute, Chennai, India
Dr. Davor Zanella, University of Zagreb, Zagreb, Croatia
Dr. A. Biju Kumar, University of Kerala, Thiruvananthapuram, Kerala, India
Dr. Akhilesh K.V., ICAR-Central Marine Fisheries Research Institute, Mumbai Research Centre, Mumbai, Maharashtra, India
Dr. J.A. Johnson, Wildlife Institute of India, Dehradun, Uttarakhand, India

Amphibians

Dr. Sushil K. Dutta, Indian Institute of Science, Bengaluru, Karnataka, India
Dr. Annemarie Ohler, Muséum national d'Histoire naturelle, Paris, France

Reptiles

Dr. Gernot Vogel, Heidelberg, Germany
Dr. Raju Vyas, Vadodara, Gujarat, India
Dr. Pritpal S. Soorae, Environment Agency, Abu Dhabi, UAE.
Prof. Dr. Wayne J. Fuller, Near East University, Mersin, Turkey
Prof. Chandrashekhar U. Rivonker, Goa University, Taleigao Plateau, Goa, India
Dr. S.R. Ganesh, Chennai Snake Park, Chennai, Tamil Nadu, India
Dr. Himansu Sekhar Das, Terrestrial & Marine Biodiversity, Abu Dhabi, UAE

Birds

Dr. Hem Sagar Baral, Charles Sturt University, NSW Australia
Dr. Chris Bowden, Royal Society for the Protection of Birds, Sandy, UK
Dr. Priya Davidar, Pondicherry University, Kalapet, Puducherry, India
Dr. J.W. Duckworth, IUCN SSC, Bath, UK
Dr. Rajah Jayapal, SACON, Coimbatore, Tamil Nadu, India
Dr. Rajiv S. Kalsi, M.L.N. College, Yamuna Nagar, Haryana, India
Dr. V. Santharam, Rishi Valley Education Centre, Chittoor Dt., Andhra Pradesh, India
Dr. S. Balachandran, Bombay Natural History Society, Mumbai, India
Mr. J. Praveen, Bengaluru, India
Dr. C. Srinivasulu, Osmania University, Hyderabad, India
Dr. K.S. Gopi Sundar, International Crane Foundation, Baraboo, USA
Dr. Gombobaatar Sunde, Professor of Ornithology, Ulaanbaatar, Mongolia
Prof. Reuven Yosef, International Birding & Research Centre, Eilat, Israel
Dr. Taej Mundkur, Wetlands International, Wageningen, The Netherlands
Dr. Carol Inskipp, Bishop Auckland Co., Durham, UK
Dr. Tim Inskipp, Bishop Auckland Co., Durham, UK
Dr. V. Gokula, National College, Tiruchirappalli, Tamil Nadu, India
Dr. Arkady Lelej, Russian Academy of Sciences, Vladivostok, Russia
Dr. Simon Dowell, Science Director, Chester Zoo, UK
Dr. Mário Gabriel Santiago dos Santos, Universidade de Trás-os-Montes e Alto Douro, Quinta de Prados, Vila Real, Portugal
Dr. Grant Connette, Smithsonian Institution, Royal, VA, USA
Dr. M. Zafar-ul Islam, Prince Saud Al Faisal Wildlife Research Center, Taif, Saudi Arabia

Mammals

Dr. Giovanni Amori, CNR - Institute of Ecosystem Studies, Rome, Italy
Dr. Anwaruddin Chowdhury, Guwahati, India
Dr. David Mallon, Zoological Society of London, UK
Dr. Shomita Mukherjee, SACON, Coimbatore, Tamil Nadu, India
Dr. Angie Appel, Wild Cat Network, Germany
Dr. P.O. Nameer, Kerala Agricultural University, Thrissur, Kerala, India
Dr. Ian Redmond, UNEP Convention on Migratory Species, Lansdown, UK
Dr. Heidi S. Riddle, Riddle's Elephant and Wildlife Sanctuary, Arkansas, USA
Dr. Karin Schwartz, George Mason University, Fairfax, Virginia.
Dr. Lala A.K. Singh, Bhubaneswar, Orissa, India
Dr. Mewa Singh, Mysore University, Mysore, India
Dr. Paul Racey, University of Exeter, Devon, UK
Dr. Honnavalli N. Kumara, SACON, Anaikatty P.O., Coimbatore, Tamil Nadu, India
Dr. Nishith Dharaiya, HNG University, Patan, Gujarat, India
Dr. Spartaco Gippoliti, Socio Onorario Società Italiana per la Storia della Fauna "Giuseppe Altobello", Rome, Italy
Dr. Justus Joshua, Green Future Foundation, Tiruchirappalli, Tamil Nadu, India
Dr. H. Raghuram, The American College, Madurai, Tamil Nadu, India
Dr. Paul Bates, Harison Institute, Kent, UK
Dr. Jim Sanderson, Small Wild Cat Conservation Foundation, Hartford, USA
Dr. Dan Challender, University of Kent, Canterbury, UK
Dr. David Mallon, Manchester Metropolitan University, Derbyshire, UK
Dr. Brian L. Cypher, California State University-Stanislaus, Bakersfield, CA
Dr. S.S. Talmale, Zoological Survey of India, Pune, Maharashtra, India
Prof. Karan Bahadur Shah, Budhanilakantha Municipality, Kathmandu, Nepal
Dr. Susan Cheyne, Borneo Nature Foundation International, Palangkaraja, Indonesia
Dr. Hemanta Kafley, Wildlife Sciences, Tarleton State University, Texas, USA

Other Disciplines

Dr. Aniruddha Belsare, Columbia MO 65203, USA (Veterinary)
Dr. Mandar S. Paingankar, University of Pune, Pune, Maharashtra, India (Molecular)
Dr. Jack Tordoff, Critical Ecosystem Partnership Fund, Arlington, USA (Communities)
Dr. Ulrike Streicher, University of Oregon, Eugene, USA (Veterinary)
Dr. Hari Balasubramanian, EcoAdvisors, Nova Scotia, Canada (Communities)
Dr. Rayanna Hellem Santos Bezerra, Universidade Federal de Sergipe, São Cristóvão, Brazil
Dr. Jamie R. Wood, Landcare Research, Canterbury, New Zealand
Dr. Wendy Collinson-Jonker, Endangered Wildlife Trust, Gauteng, South Africa
Dr. Rajeshkumar G. Jani, Anand Agricultural University, Anand, Gujarat, India
Dr. O.N. Tiwari, Senior Scientist, ICAR-Indian Agricultural Research Institute (IARI), New Delhi, India
Dr. L.D. Singla, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, India
Dr. Rupika S. Rajakaruna, University of Peradeniya, Peradeniya, Sri Lanka
Dr. Bahar Baviskar, Wild-CER, Nagpur, Maharashtra 440013, India

Reviewers 2018–2020

Due to paucity of space, the list of reviewers for 2018–2020 is available online.

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.

Journal of Threatened Taxa is indexed/abstracted in Bibliography of Systematic Mycology, Biological Abstracts, BIOSIS Previews, CAB Abstracts, EBSCO, Google Scholar, Index Copernicus, Index Fungorum, JournalSeek, National Academy of Agricultural Sciences, NewJour, OCLC WorldCat, SCOPUS, Stanford University Libraries, Virtual Library of Biology, Zoological Records.

NAAS rating (India) 5.64

Print copies of the Journal are available at cost. Write to:
The Managing Editor, JoTT,
c/o Wildlife Information Liaison Development Society,
No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road,
Saravanampatti, Coimbatore, Tamil Nadu 641035, India
ravi@threatenedtaxa.org



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)

October 2021 | Vol. 13 | No. 12 | Pages: 19675–19886

Date of Publication: 26 October 2021 (Online & Print)

DOI: 10.11609/jott.2021.13.12.19675-19886

www.threatenedtaxa.org

Articles

Roosting habits and habitats of the Indian Flying Fox *Pteropus medius* Temminck, 1825 in the northern districts of Tamil Nadu, India
– M. Pandian & S. Suresh, Pp. 19675–19688

Diversity and distribution of avifauna at Warathenna-Hakkinda Environmental Protection Area in Kandy, Sri Lanka
– Dinelka Thilakarathne, Tithira Lakkana, Gayan Hirimuthugoda, Chaminda Wijesundara & Shalika Kumburegama, Pp. 19689–19701

Grass species composition in tropical forest of southern India
– M. Ashokkumar, S. Swaminathan & R. Nagarajan, Pp. 19702–19713

Communications

Habitat use and conservation threats to Wild Water Buffalo *Bubalus arnee* (Mammalia: Artiodactyla: Bovidae) in Koshi Tappu Wildlife Reserve, Nepal
– Reeta Khulal, Bijaya Neupane, Bijaya Dhami, Siddhartha Regmi, Ganesh Prasad Tiwari & Manita Parajuli, Pp. 19714–19724

Get my head around owls: people perception and knowledge about owls of Andaman Islands
– Shanmugavel Sureshmarimuthu, Santhanakrishnan Babu, Nagaraj Rajeshkumar & Honnavalli Nagaraj Kumara, Pp. 19725–19732

Abundance and diversity of threatened birds in Nangal Wetland, Punjab, India
– Rajwinder Kaur & Onkar Singh Braich, Pp. 19733–19742

Evaluation of fish diversity and abundance in the Kabul River with comparisons between reaches above and below Kabul City, Afghanistan
– Ugyen Kelzang, Ahmad Farid Habibi & Ryan J. Thoni, Pp. 19743–19752

New record of *Myrmarachne melanocephala* MacLeay, 1839 (Araneae: Salticidae) from Jharkhand, India and biogeographical implications of the co-occurrence of its ant model *Tetraponera rufonigra* Jerdon, 1851
– Rahul Kumar, Mirtunjay Sharma & Ajay Kumar Sharma, Pp. 19753–19761

Diversity of spiders (Arachnida: Araneae) and the impact of pruning in Indian sandalwood plantations from Karnataka, India
– S. Padma 1 & R. Sundararaj, Pp. 19762–19772

New records of cheilostome Bryozoa from the eastern coast of India encrusting on the exoskeleton of live horseshoe crabs of Indian Sundarbans
– Swati Das, Maria Susan Sanjay, Basudev Tripathy, C. Venkatraman & K.A. Subramanian, Pp. 19773–19780

On the pteridophytes of Bherjan-Borajan-Padumoni Wildlife Sanctuary, Assam, India
– Pranjal Borah & Jayanta Barukial, Pp. 19781–19790

Population status of *Heritiera fomes* Buch.-Ham., a threatened species from Mahanadi Mangrove Wetland, India
– Sudam Charan Sahu, Manas Ranjan Mohanta & N.H. Ravindranath, Pp. 19791–19798

Additions to the lichenized and lichenicolous fungi of Jammu & Kashmir from Kishtwar High Altitude National Park
– Vishal Kumar, Yash Pal Sharma, Siljo Joseph, Roshinikumar Ngangom & Sanjeeva Nayaka, Pp. 19799–19807

Short Communications

Is release of rehabilitated wildlife with embedded lead ammunition advisable? Plumbism in a Jaguar *Panthera onca* (Mammalia: Carnivora: Felidae), survivor of gunshot wounds
– Eduardo A. Díaz, Carolina Sáenz, E. Santiago Jiménez, David A. Egas & Kelly Swing, Pp. 19808–19812

New record of the Sewing Needle Zipper Loach *Paracanthocobitis linypha* Singer & Page, 2015 (Teleostei: Cypriniformes: Nemacheilidae) from the Chindwin drainage of Manipur, India
– Yumnam Rameshori, Yengkhom Chinglemba & Waikhom Vishwanath, Pp. 19813–19817

Field identification characters to diagnose *Microhyla mukhlesuri* from closely related *M. mymensinghensis* (Amphibia: Microhylidae) and range extension of *M. mukhlesuri* up to West Bengal State, India
– Suman Pratihar & Kaushik Deuti, Pp. 19818–19823

First report of *Scipinia horrida* (Stål) (Heteroptera: Reduviidae) from Assam, with comments on related genus *Irantha* Stål
– Anjana Singha Naorem, Santana Saikia, Anandita Buragohain, Rubina Azmeera Begum, Swapnil S. Boyane & Hemant V. Ghate, Pp. 19824–19830

Flesh fly (Diptera: Sarcophagidae): male terminalia, diversity and expanded geographical distribution from India
– Kanholi Sreejith, Shuvra Kanti Sinha, Santanu Mahato & Edamana Pushpalatha, Pp. 19831–19836

Checklist of moths (Heterocera) of Tadong, Sikkim, India
– Prayash Chettri, Yuki Matsui, Hideshi Naka & Archana Tiwari, Pp. 19837–19848

New distribution records of *Begonia* L., *B. murina* Craib and *B. poilanei* Kiew (Begoniaceae: Cucurbitales) for Laos
– Phongphayboun Phonepaseuth, Phetlasy Souladeth, Soulivanh Lanorsavanh, Shuichiro Tagane, Thyraphon Vongthavone & Keoudone Souvannakhoummane Pp. 19849–19854

Notes

A recent sighting of the Stripe-backed Weasel *Mustela strigidorsa* (Mammalia: Carnivora: Mustelidae) in Hkakabo Razi Landscape, Myanmar
– Sai Sein Lin Oo, Tun Tun, Kyaw Myo Naing & Paul Jeremy James Bates, Pp. 19855–19859

Are the uplifted reef beds in North Andaman letting nesting Olive Ridley Sea Turtle *Lepidochelys olivacea* stranded?
– Nehru Prabakaran, Anoop Raj Singh & Vedagiri Thirumurugan, Pp. 19860–19863

First record of the orb-weaving spider *Araneus tubabdominus* Zhu & Zhang, 1993 (Araneae: Araneidae) from India
– Souvik Sen, John T.D. Caleb & Shelley Acharya, Pp. 19864–19866

The genus *Catapiestus* Perty, 1831 (Coleoptera: Tenebrionidae: Cnodalonini) from Arunachal Pradesh with one new record to India
– V.D. Hegde & Sarita Yadav, Pp. 19867–19869

Rediscovery and extended distribution of *Indigofera santapau* Sanjappa (Leguminosae: Papilionoideae) from the states of Maharashtra and Gujarat, India
– Kumar Vinod Chhotupuri Gosavi, Sanjay Gajanan Auti, Sharad Suresh Kambale & Munivenkatappa Sanjappa, Pp. 19870–19873

Additional distribution records of *Ceropegia anjanerica*, an endemic and 'Endangered' lantern flower of the northern Western Ghats, India
– Samir Shrikant Maity, Ajay Natha Gangurde, Sharad Suresh Kambale, Avinash Ramchandra Gholave, Avinash Asraji Adsul, Ganesh Babaso Pawar & Kumar Vinod Chhotupuri Gosavi, Pp. 19874–19877

Notes on the extended distribution of *Impatiens megamalayana*, a recently described balsam in Western Ghats, India
– Anoop P. Balan & A.J. Robi, Pp. 19878–19883

Book Review

A look over on the scented tree of India (*Santalum album*)
– S. Suresh Ramanan & A. Arunachalam, Pp. 19884–19886

Publisher & Host

