

Building evidence for conservation globally

Journal of Threatened Taxa



Open Access



10.11609/jott.2024.16.1.24451-24614
www.threatenedtaxa.org

26 January 2024 (Online & Print)
16(1): 24451-24614
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 Organisation
www.zooreach.org

43/2 Varadarajulu Nagar, 5th Street West, Ganapathy, Coimbatore, Tamil Nadu 641006, India
Registered Office: 3A2 Varadarajulu Nagar, FCI Road, Ganapathy, Coimbatore, Tamil Nadu 641006, 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),
43/2 Varadarajulu Nagar, 5th Street West, Ganapathy, Coimbatore, Tamil Nadu 641006, India

Deputy Chief Editor

Dr. Neelesh Dahanukar

Noida, Uttar Pradesh, India

Managing Editor

Mr. B. Ravichandran, WILD/ZOO, Coimbatore, Tamil Nadu 641006, 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 641006, India

Dr. B.A. Daniel, ZOO/WILD, Coimbatore, Tamil Nadu 641006, 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, Mavinahalla 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

Ms. Sindhura Stothra Bhashyam, Hyderabad, India

Web Development

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

Typesetting

Mrs. Radhika, ZOO, Coimbatore, India

Mrs. Geetha, ZOO, Coimbatore India

Fundraising/Communications

Mrs. Payal B. Molur, Coimbatore, India

Subject Editors 2020–2022

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, Mangalagangotri, Mangalore, Karnataka, India

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

Dr. Kiran Ramchandra Ranadive, Annasaheb Magar Mahavidyalaya, Maharashtra, 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, Department of Plant and Soil Science, Texas Tech University, Lubbock, Texas, USA.

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. A.G. Pandurangan, Thiruvananthapuram, Kerala, India

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

Dr. Kannan C.S. Warrior, Institute of Forest Genetics and Tree Breeding, Tamil Nadu, 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, Llandudno, North Wales, LL30 1UP

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

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

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

Cover: Green Sea Turtle *Chelonia mydas* watercolour by Elakshi Mahika Molur.



INTRODUCTION

Bengaluru, the fifth largest city in India, is known as the Garden City owing to its natural vegetation, rich parks, gardens, lakes, and streets lined with large canopied flowering trees (Rajashekara & Venkatesha 2016). Rapid urbanization and massive increase in population density have affected the existence and diversity of wildlife (Ramachandra et al. 2017; Yang et al. 2022). Birds are common inhabitants and are an important component of any ecosystem as they are involved in several trophic levels in the food web (Blair 1999). In the urban ecosystem, the development of huge green spaces contributed to the sustainable conservation of bird species (Campbell et al. 2022; Choudaj et al. 2023). The abundance of bird species and their variety within a specific region can have consequences for both terrestrial and aquatic ecosystems, which are interconnected within the broader food web (Turner 2003). The declining abundance of bird species in specific regions, particularly urban areas, is a cause for concern, especially when considering metrics related to urbanization and pollution (Donaldson et al. 2007).

Factors such as climatic stability and seasonality have a positive influence on avian diversity and are important determinants of avian diversity (Graham et al. 2006). In urban areas, compared to previous years, an increase in the daily mean number and visibility of a new proportion of bird species were witnessed during the COVID-19 pandemic seasons (Basile et al. 2021). The avifaunal diversity reported in Bangladesh during lockdown revealed the relative abundance and detectability of Red-vented Bulbul *Pycnonotus cafer* which was directly related to their breeding season during the seasons from March to August (Shome et al. 2021). The diversity of biological resources depends on climatic, physical conditions, topographic features, altitudinal differences between highland and lowland areas, and the geological history of a region (Parmesan & Yohe 2003). Anthropogenic climate change has a widespread impact on many biological processes and migratory patterns of birds due to the unavailability of primary requirements of food, shelter, roosting, and nesting sites for birds which vary during different seasons (Cockrem 1995). A study by Shome et al. (2021) during the summer and rainy times of Covid pandemic seasons revealed the altered species composition of migratory birds belonging to the family Cuculidae. The restricted human activities and food limitations during the COVID-19 pandemic had an impact on the progressive decline and in the abundance of *Columbia*

livia in open feeding hotspots (Soh et al. 2021).

Biotic assemblages are significantly influenced by urbanization factors, leading to restricted turnover rates of bird species and reduced richness of native species due to human settlements (Godefroid 2001). The impact of COVID-19 on bird species, including richness, abundance, and diversity, has been substantial. Recent studies have highlighted the effects of lockdowns on avifauna populations, with observations of nearly 24 bird species' abundance during the spring of 2020 in North America (Schrimpf et al. 2021). Uncommon species like the Black-rumped Flameback *Dinopium benghalense*, not reported in 2019 or the pre-period of 2020, became abundant during the lockdown in Bengaluru. Similarly, the Large-billed Crow was predominantly detected in the post-lockdown period of 2020 in New Delhi (Madhok & Gulati 2022). A study by Estela et al. (2021) on the nocturnal birds of Cali City, Colombia, revealed a decreased species richness of 40–58 % during lockdown restrictions.

The overnight limitations of anthropogenic activities (anthropause) led to the lag between the lockdown and species diversity which exhibited the gradual recovery of species. Though databases such as citizen sciences, iNaturalist, and eBird offer data on population statistics of bird species, scientific evidence concerning the pandemic impact on avifaunal diversity, and seasonal variation detectability is scarce. Therefore, the present article aims to focus on the occurrence, seasonal abundance, species diversity, species richness, species dominance, and species evenness of bird population in different seasons during the pandemic lockdown season. This generated data could be useful for designing high throughput conservation strategies for better management of the avian population.

MATERIALS AND METHODS

Study area and data collection

The research was conducted at Hinnakki Village Lake in the Bengaluru district of Karnataka, India (Figure 1), situated at 12.774N & 77.678E, with an altitude of 889 m (2,918 ft) in the southern part of Karnataka. The average annual rainfall in the region is approximately 1,958.6 mm, with maximum and minimum annual temperatures recorded at 36.7 °C and 13.9 °C, respectively. The dominant vegetation type in the selected study area is tropical deciduous. The study encompassed the lake region and adjacent habitats, including agroforestry, agricultural fields, and anthropogenic regions, as part



Figure 1. The study area, Hinnakki village lake, Bengaluru (extracted from Google maps).

of a systematic examination of the seasonal abundance of birds. Four seasons—winter (December–February), summer (March–May), monsoon (June–August), and retreating monsoon (September–November)—were considered for the study (Girma et al. 2017). The survey employed a point transect method (Newson et al. 2009), with four regions covering 12 spots spaced at least 300 m apart. The study period extended from December 2021 to November 2022, with surveys conducted in the morning (0630–0830 h) and early evening (1630–1830 h) during each site visit. Each spot was visited seasonally 20 times, and bird identification was conducted using CASON 8 x 40 binoculars. Bird frequency was categorized as rare (R), uncommon (UC), common (C), and very common (VC) following the protocol by Kumar & Gupta (1970). Photographs of birds were captured using a Sony DSCHX 400V 20MP camera, and bird identification and checklists were meticulously performed (Ali 2002; Manakadan et al. 2011; Grimmett et al. 2016).

Mathematical formulation for data analysis

Data analysis was carried out using the following equations:

- Shannon Wiener index—The type of diversity used was α -diversity which is the diversity of species within a community or habitat. (Wiener diversity index 1949).
Diversity index: $H = -\sum P_i \ln P_i$
where $P_i = S/N$
 S = number of individuals of one species
 N = total number of all individuals in the sample
 \ln = logarithm to base e

- Margalef's index was used as a simple measure of species richness (Margalef 1958).

$$\text{Margalef's index} = (S - 1) / \ln N$$

S = total number of species

N = total number of individuals in the sample

\ln = natural logarithm

- Pielou's Evenness Index (e) was used to calculate the evenness of species (Pielou 1966).

$$\text{Pielou's Evenness Index} = e = H / \ln S$$

H = Shannon – Wiener diversity index

S = total number of species in the sample

- Simpson's diversity index (D) was used to calculate the species dominance (Simpson 1949).

$$\text{Simpson index} = D = 1 - (\sum n * (n - 1) / N * (N - 1))$$

n = number of individuals of each species

N = total number of individuals of all species

- Relative abundance

$$\text{Relative abundance} = \frac{\text{Number of checklists in which a bird is recorded}}{\text{Total number of checklists}} \times 100$$

RESULTS AND DISCUSSION

The ecology of birds is intricately tied to rainfall and vegetation, where fluctuations in these environmental factors have direct and indirect effects on avian abundance. Demographic parameters further contribute to the biodiversity shift in birds. In the study area, the total recorded rainfall was 1958.6 mm, with the highest monthly rainfall of 131.6 mm occurring in September.

Summer temperatures ranged from a maximum of 36.7°C to a minimum of 24.2°C in April, while winter temperatures ranged from a maximum of 19.6°C to a minimum of 13.9°C in November. The highest diurnal temperature variation was 17°C in February (max = 33°C, min = 16°C), while the lowest was 1.8°C in December (max = 19.6°C, min = 17.8°C). The harsh environment significantly impacts vital rates in the avian population, with factors such as heat stress and hypothermia affecting survival and population trends. Rainfall, in particular, correlates with breeding success and factors associated with migratory bird assemblages. The study validates a positive correlation between environmental metrics and avian diversity and richness (Saracco et al. 2018).

A total of 55 species of birds belonging to 52 genera belonging to 32 families of 13 orders were recorded during the post-lockdown period in the study area (Imags 1–55; Figure 2). Among the observed bird species, 53 are classified as 'Least Concern,' while two species fall under the category of 'Near Threatened,' namely the Black-headed Ibis and the Oriental Darter (Table 1). The documentation included a total of 18 aquatic birds and 37 terrestrial birds. The Rock Pigeon was identified as the most commonly found species, constituting 6.935% of the observed bird population, owing to its behavioral adaptability to urban settings and resilience to anthropogenic disturbances (Polyavina et al. 2022). The Black-headed Ibis was found to be the most uncommon species (0.012%), which might be due to their preferred habitat and foraging areas such as shallow seasonal or permanent wetlands, marshlands,

and water-logged crop fields (Barik et al. 2021). The decrease in marshy vegetation in the current study area due to the alteration of the landscape, which involves the construction of concrete buildings, and roads and also turning paddy fields into dry agricultural lands, affected the avian diversity. The order Passeriformes exhibited the highest relative abundance at 38.18%, attributed to Passerines' predominant diet, which includes insects, nuts, seeds, nectar, berries, and fruits (Bhatti et al. 2017). Most of the passerines were found feeding on Indian Banyan *Ficus bengalensis*, Sacred Fig *Ficus religiosa*, Bur Flower-tree *Neolamarckia cadamba*, Jamaican Berry *Muntingia calabura*, and Bamboo *Dendrocalamus* sp. The family Ardeidae, encompassing herons and egrets, registered the highest relative abundance at 12.7%. The reason for their abundance might be due to the number of water bodies surrounded by a huge number of trees and bushes, which facilitate the nesting of birds. The abundance and richness of Ardeidae species depend on the quality of water bodies, vegetation cover, and the availability of food (Ahlam et al. 2019).

The current observation held during the winter season showed the richness of bird species such as Grey-headed Swamphen *Porphyrio poliocephalus*, Black-winged Stilt *Himantopus himantopus*, Pied Kingfisher *Ceryle rudis*, White-cheeked Barbet *Psilopogon viridis*, and Rosy Starling *Pastor roseus*. In the summer season, Indian Spot-billed Duck *Anas poecilorhyncha*, Indian Golden Oriole *Oriolus kundoo*, and Black-headed Ibis have been found (Figure 3). The significant variation in avifaunal diversity and abundance in different seasons could be due to seasonal migration patterns, habitat changes, and

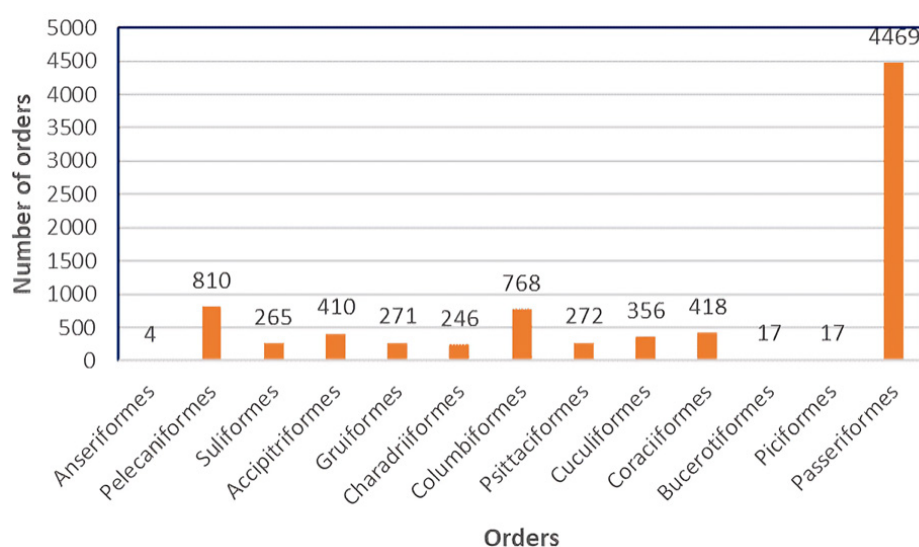


Figure 2. Representation of the bird count belonging to respective orders.

Table 1. Encounter rates, occurrence, conservation status, and the diet type of avian communities reported in the study area.

Scientific name	Common name	Conservation status \ IUCN	Frequency of observation	Winter season	Summer season	Monsoon season	Retreating monsoon season	Total	Relative abundance
<i>Anas poecilorhyncha</i>	Indian Spot-billed Duck	LC	R	0	4	0	0	4	0.048
<i>Threskiornis melanocephalus</i>	Black-headed Ibis	NT	R	0	0	0	1	1	0.012
<i>Egretta garzetta</i>	Little Egret	LC	R	6	12	18	10	46	0.558
<i>Ardea cinerea</i>	Grey Heron	LC	R	5	8	2	2	17	0.206
<i>Ardea purpurea</i>	Purple Heron	LC	R	30	51	38	20	139	1.688
<i>Mesophayx intermedia</i>	Intermediate Egret	LC	UC	50	77	85	60	272	3.303
<i>Bubulcus ibis</i>	Cattle Egret	LC	R	10	20	22	15	67	0.813
<i>Ardeola grayii</i>	Indian Pond Heron	LC	UC	40	59	75	55	229	2.781
<i>Ardea alba</i>	Great Egret	LC	R	5	10	15	9	39	0.473
<i>Phalacrocorax fuscicollis</i>	Indian Cormorant	LC	UC	80	60	70	50	260	3.158
<i>Anhinga melanogaster</i>	Oriental Darter	NT	R	3	2	0	0	5	0.061
<i>Elanus caeruleus</i>	Black-winged Kite	LC	R	1	2	0	0	3	0.036
<i>Milvus migrans</i>	Black Kite	LC	UC	58	62	51	55	226	2.745
<i>Haliastur indus</i>	Brahminy Kite	LC	UC	47	45	39	43	174	2.113
<i>Accipiter badius</i>	Shikra	LC	R	2	3	1	1	7	0.085
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	LC	UC	88	44	26	53	211	2.562
<i>Porphyrio poliocephalus</i>	Grey-headed Swampphen	NE	R	10	0	0	0	10	0.121
<i>Fulica atra</i>	Eurasian Coot	LC	R	5	10	20	15	50	0.607
<i>Himantopus himantopus</i>	Black-winged Stilt	LC	R	5	0	0	0	5	0.061
<i>Vanellus indicus</i>	Red-wattled Lapwing	LC	UC	65	50	60	66	241	2.927
<i>Columba livia</i>	Rock Pigeon	LC	VC	148	150	135	138	571	6.935
<i>Spilopelia chinensis</i>	Spotted Dove	LC	UC	50	62	45	40	197	2.393
<i>Psittacula krameri</i>	Rose-ringed Parakeet	LC	UC	50	60	84	78	272	3.303
<i>Centropus sinensis</i>	Greater Coucal	LC	UC	38	48	58	35	179	2.174
<i>Eudynamis scolopacea</i>	Asian Koel	LC	UC	59	45	40	33	177	2.149
<i>Coracias benghalensis</i>	Indian Roller	LC	R	20	5	8	15	48	0.583
<i>Halcyon smyrnensis</i>	White-throated Kingfisher	LC	UC	78	39	45	65	227	2.757
<i>Ceryle rudis</i>	Pied Kingfisher	LC	R	4	0	0	0	4	0.048
<i>Merops philippinus</i>	Blue-tailed Bee-eater	LC	R	35	39	31	34	139	1.688
<i>Ocyrocus birostris</i>	Indian Grey Hornbill	LC	R	2	8	0	0	10	0.121
<i>Upupa epops</i>	Hoopoe	LC	R	4	3	0	0	7	0.085
<i>Dinopium benghalense</i>	Black-rumped Flameback	LC	R	2	0	0	0	2	0.024
<i>Psilopogon viridis</i>	White-cheeked Barbet	LC	R	5	0	0	0	5	0.061
<i>Psilopogon haemacephalus</i>	Coppersmith Barbet	LC	R	8	2	0	0	10	0.121
<i>Lanius cristatus</i>	Brown Shrike	LC	C	90	100	60	85	335	4.068
<i>Oriolus kundoo</i>	Indian Golden Oriole	LC	R	0	6	0	0	6	0.072
<i>Dicrurus macrocercus</i>	Black Drongo	LC	VC	180	210	75	50	515	6.255
<i>Corvus splendens</i>	House Crow	LC	C	110	113	60	70	353	4.287

Scientific name	Common name	Conservation status \ IUCN	Frequency of observation	Winter season	Summer season	Monsoon season	Retreating monsoon season	Total	Relative abundance
<i>Corvus macrorhynchos</i>	Large-billed Crow	LC	VC	180	200	90	100	570	6.923
<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	LC	C	85	78	60	77	300	3.643
<i>Pycnonotus cafer</i>	Red-vented Bulbul	LC	UC	70	50	30	50	200	2.429
<i>Petrochelidon luivcola</i>	Streak-throated Swallow	LC	C	100	135	50	80	365	4.433
<i>Argya striata</i>	Jungle Babbler	LC	R	6	3	2	3	14	0.171
<i>Sturnia pagodarum</i>	Brahminy Starling	LC	R	4	8	0	0	12	0.145
<i>Acridotheres tristis</i>	Common Myna	LC	VC	180	153	86	93	512	6.218
<i>Acridotheres fuscus</i>	Jungle Myna	LC	C	120	105	50	60	335	4.068
<i>Pastor roseus</i>	Rosy Starling	LC	R	150	0	0	0	150	1.821
<i>Copsychus saularis</i>	Oriental Magpie Robin	LC	R	30	21	22	20	93	1.129
<i>Saxicoloides fulicatus</i>	Indian Robin	LC	R	28	24	20	23	95	1.153
<i>Terpsiphone paradisi</i>	Indian Paradise Flycatcher	LC	R	1	2	0	0	3	0.036
<i>Cinnyris asiaticus</i>	Purple Sunbird	LC	R	20	12	5	8	45	0.546
<i>Nectarinia zeylonica</i>	Purple-rumped Sunbird	LC	R	15	10	5	5	35	0.426
<i>Passer domesticus</i>	House Sparrow	LC	UC	55	42	30	35	162	1.967
<i>Motacilla maderaspatensis</i>	White-browed Wagtail	LC	UC	79	74	63	67	283	3.437
<i>Anthus rufulus</i>	Paddy Field Pipit	LC	R	20	33	15	18	86	1.044

Rdi: 0–1.75% as rare (R), 1.76–3.5% as uncommon (UC), 3.6–5.25% as common (C), 5.26–7% as very common (VC)
IUCN Red List: Least Concern (LC), Near Threatened (NT).

Table 2. Avian diversity in different seasons.

Biodiversity indices	Winter season	Summer season	Monsoon season	Retreating monsoon Season
Shannon Wiener index (Species diversity)	3.434	3.379	3.408	3.4
Margalef's index (Species richness)	6.506	6.052	5.112	5.228
Pielou evenness index (Species evenness)	0.869	0.873	0.93	0.922
Simpson's index (Species dominance)	0.04	0.043	0.038	0.038
Number of encounters	2446	2359	1691	1737
Number of species	52	48	39	40

climatic conditions (Aynalem & Bekele 2008). Invasive exotic species such as Common Lantana *Lantana camara*, Alligator Weed *Alternanthera phyloxiroides*, Parthenium Weed *Parthenium hysterophorus*, Water Hyacinth *Eichhornia crassipes*, and Water Lettuce *Pistia stratiotes* was also observed. Biological invasion in water bodies can cause significant damage to the abundance of aquatic communities such as fish, zooplankton, and aquatic invertebrates (Schirmel et al. 2016). The biological oxygen demand of water bodies may, in turn, affect the bird population (Klemetsen et al. 2013; Mallin et al. 2016).

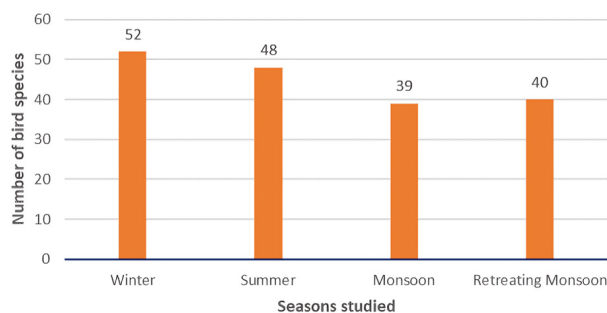
CONCLUSION

The present research provides information on the status of the bird population in the Bengaluru district. The conversion of green spaces into concrete structures due to urbanization has influenced bird diversity. Urbanization has varying control over the avian population. The study identified a reduction in the wetland bird population. A biodiversity shift was observed in the avian population of species such as *Columba livia*, *Corvus macrorhynchos*, and *Corvus splendens*, were seen in common wherein the density

Table 3. Representation of the number of species belonging to each family observed in the study area.

Orders	Family	No. of genera	No. of species	Abundance
Anseriformes	Anatidae	1	1	1.81
Pelecaniformes	Threskiornithidae	1	1	1.81
	Ardeidae	5	7	12.7
Suliformes	Phalacrocoracidae	1	1	1.81
	Anhingidae	1	1	1.81
Accipitriformes	Accipitridae	4	4	7.27
Gruiformes	Rallidae	3	3	5.45
	Recurvirostridae	1	1	1.81
Charadriiformes	Charadriidae	1	1	1.81
Columbiformes	Columbidae	2	2	3.63
Psittaciformes	Psittacidae	1	1	1.81
Cuculiformes	Cuculidae	2	2	3.63
Coraciiformes	Coraciidae	1	1	1.81
	Alcedinidae	2	2	3.63
	Meropidae	1	1	1.81
Bucerotiformes	Bucerotidae	1	1	1.81
	Upupidae	1	1	1.81
Piciformes	Picidae	1	1	1.81
	Megalaimidae	1	2	3.63
Passeriformes	Laniidae	1	1	1.81
	Oriolidae	1	1	1.81
	Dicruridae	1	1	1.81
	Corvidae	1	2	3.63
	Pycnonotidae	1	2	3.63
	Hirundinidae	1	1	1.81
	Sturnidae	3	4	7.27
	Muscicapidae	3	3	5.45
	Nectariniidae	2	2	3.63
	Leiotherichidae	1	1	1.81
	Passeridae	2	2	3.63
	Motacillidae	1	1	1.81
13	32	49	55	

of the Near Threatened *Threskiornis melanocephalus* and *Anhinga melanogaster* populations was lower. Factors such as the magnitude of human activity during lockdown, pollution indices such as agricultural runoff, air and noise quality parameters, and food availability also influenced the migration pattern of birds. Regular monitoring of the wetland's biodiversity is an important prerequisite to tracking the changes in avian population and diversity. The study also discussed the importance of confounding factors such as seasonal variations in

**Figure 3. Effect of seasonal variations on the number of bird species.**

the avian population. The involvement and support of residents are critical in conserving the vegetation, which can have a direct impact on the avian population and diversity.

REFERENCES

- Ahlam, C., B. Ettayib, M. Fateh & D. Soumia (2019). Effects of vegetation and water seasonal variation on habitat use of herons (Aves, Ardeidae) in Tonga Lake (North-East Algeria). *Bolyai Biologia* (2): 25–40. <https://doi.org/10.24193/subbbiol.2019.2.03>
- Ali, S. (2002). *The book of Indian birds*. Oxford University Press. New Delhi, 326 pp.
- Aynalem, S. & A. Bekele (2008). Species composition, relative abundance and distribution of bird fauna of riverine and wetland habitats of Infranz and Yiganda at southern tip of Lake Tana, Ethiopia. *Tropical Ecology* 49(2): 199.
- Barik, S., G.K. Saha & S. Mazumdar (2021). How the habitat features influence Black-headed Ibis (*Threskiornis melanocephalus*) in a suburban area? A study from mid-West Bengal, India. *Proceedings of the Zoological Society of London* 75(1): 39–47.
- Basile, M., L.F. Russo, V.G. Russo, A. Senese & N. Bernardo (2021). Birds seen and not seen during the COVID-19 pandemic: The impact of lockdown measures on citizen science bird observations. *Biological Conservation* 256: 109079.
- Bhatti, Z. (2017). A study on status and distribution of Passeriformes in Bagh district of Azad Kashmir. *Journal of Bioresource Management* 4(1): 3.
- Blair, R.B. (1999). Birds and butterflies along an urban gradient: Surrogate taxa for assessing biodiversity? *Ecological Applications* 9(1): 164–170. [https://doi.org/10.1890/1051-0761\(1999\)009\[0164:baba\]2.0.co;2](https://doi.org/10.1890/1051-0761(1999)009[0164:baba]2.0.co;2)
- Campbell, C.E., D.N. Jones, M. Awasthy & A.L. Chauvenet (2022). How do we study birds in urban settings? A systematic review. *Biodiversity and Conservation* 31(1): 1–20.
- Cockrem, J.F. (1995). Timing of seasonal breeding in birds, with particular reference to New Zealand birds. *Reproduction, Fertility, and Development* 7(1): 1–19. <https://doi.org/10.1071/rd9950001>
- Choudaj, K. & C. Shaha (2023). Natural remnants are refuges for rare birds in an urban area: a study from Pune city, India. *Ornis Hungarica* 31(1): 62–71.
- Donaldson, M.R., K.M. Henein & M.W. Runtz (2007). Assessing the effect of developed habitat on waterbird behaviour in an urban riparian system in Ottawa, Canada. *Urban Ecosystems* 10(2): 139–151. <https://doi.org/10.1007/s11252-006-0015-2>
- Estela, F.A., C.E. Sanchez-Sarria, E. Arbelaez-Cortes, D. Ocampo, M. Garcia-Arroyo, A. Perlaza-Gamboa & I. MacGregor-Fors (2021). Changes in the nocturnal activity of birds during the COVID-19

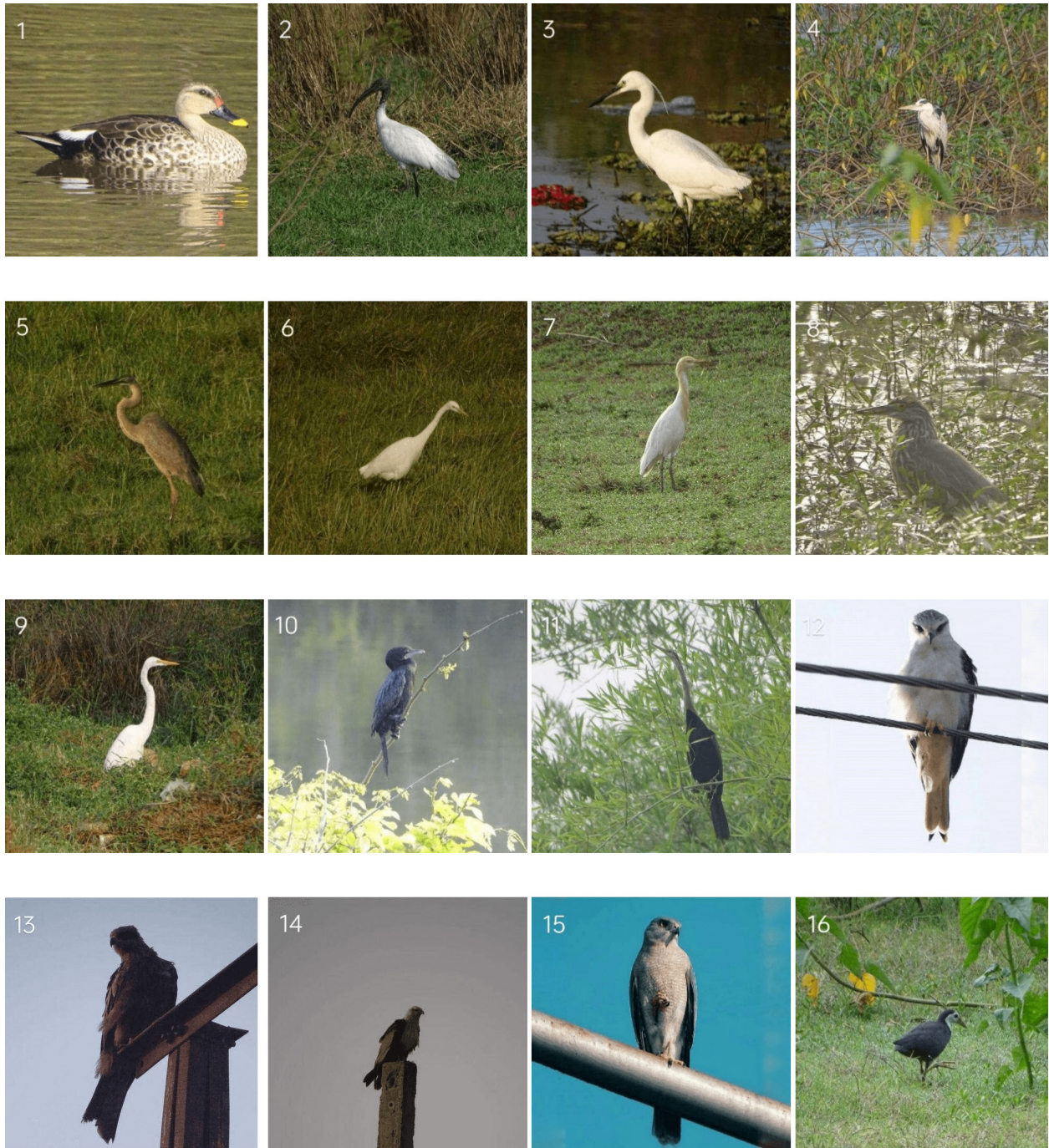


Image 1–16. Representation of bird species noted in the study area: 1—*Anas poecilorhyncha* | 2—*Threskiornis melanocephalus* | 3—*Egretta garzetta* | 4—*Ardea cinerea* | 5—*Ardea purpurea* | 6—*Mesophoyx intermedia* | 7—*Bubulcus ibis* | 8—*Ardeola grayii* | 9—*Ardea alba* | 10—*Phalacrocorax fuscicollis* | 11—*Anhinga melanogaster* | 12—*Elanus caeruleus* | 13—*Milvus migrans* | 14—*Haliastur indus* | 15—*Accipiter badius* | 16—*Amaurornis phoenicurus*. © H. Hemanth.

pandemic lockdown in a neotropical city. *Animal Biodiversity and Conservation* 44(2): 213–217. <https://doi.org/10.32800/abc.2021.44.0213>

Gaston, K.J. & R.A. Fuller (2007). Biodiversity and extinction. *Progress in Physical Geography* 31(2): 213–225. <https://doi.org/10.1177/0309133307076488>

Godefroid, S. (2001). Temporal analysis of the Brussels flora as an

indicator for changing environmental quality. *Landscape and Urban Planning* 52(4): 203–224. [https://doi.org/10.1016/S0169-2046\(00\)00117-1](https://doi.org/10.1016/S0169-2046(00)00117-1)

Girma, Z., Y. Mamo, G. Mengesha, A. Verma & T. Asfaw (2017). Seasonal abundance and habitat use of bird species in and around Wondo Genet Forest, south-central Ethiopia. *Ecology and Evolution* 7(10): 3397–3405.

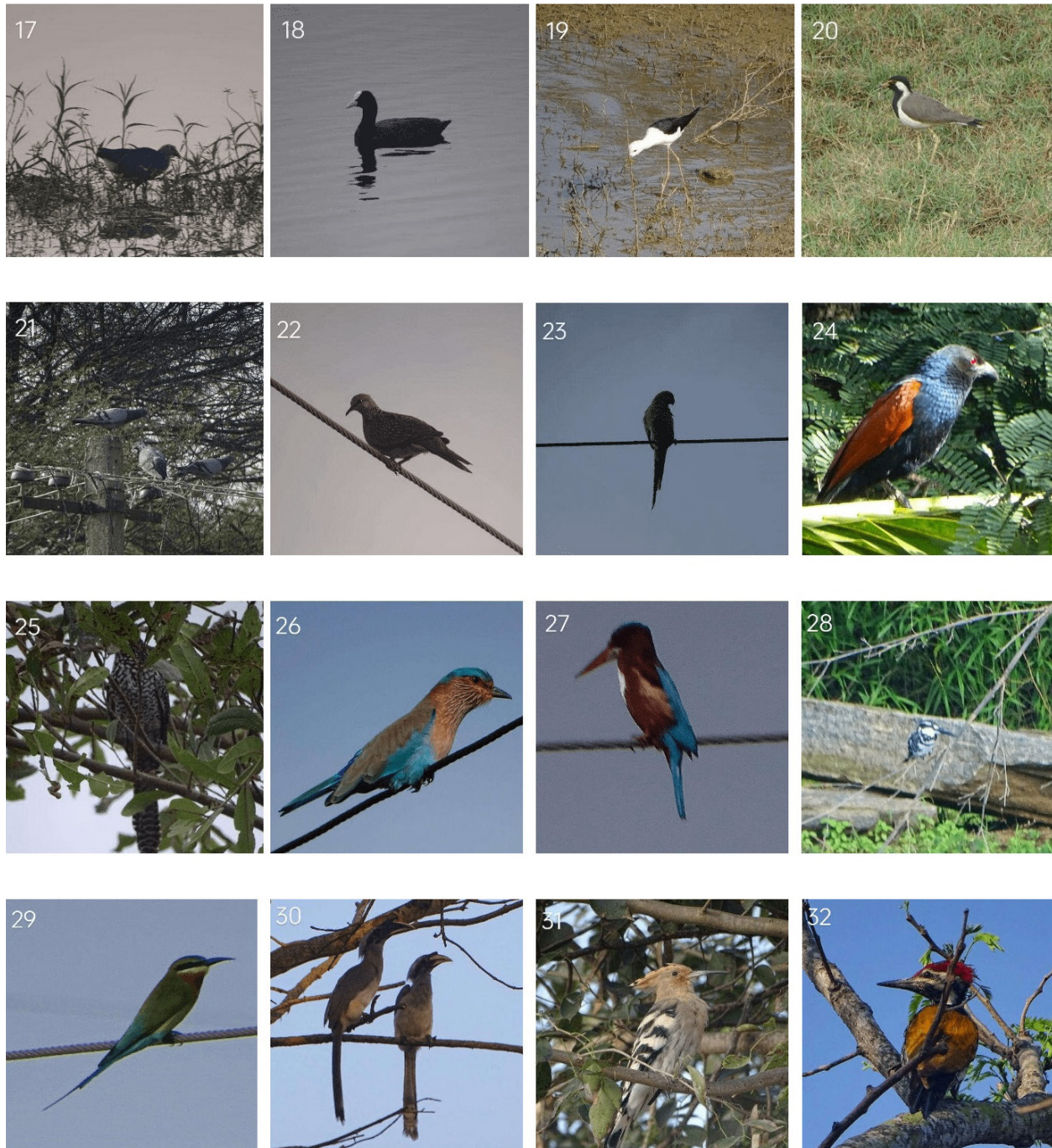


Image 17–32. Representation of bird species noted in the study area (continued): 17—*Porphyrio poliocephalus* | 18—*Fulica atra* | 19—*Himantopus himantopus* | 20—*Vanellus indicus* | 21—*Columba livia* | 22—*Spilopelia chinensis* | 23—*Psittacula krameri* | 24—*Centropus sinensis* | 25—*Eudynamys scolopacea* | 26—*Coracias benghalensis* | 27—*Halcyon smyrnensis* | 28—*Ceryle rudies* | 29—*Merops philippinus* | 30—*Ocyrceros birostris* | 31—*Upupa epops* | 32—*Dinopium benghalense*. © H. Hemanth.

Graham, C.H., C. Moritz & S.E. Williams (2006). Habitat history improves prediction of biodiversity in rainforest fauna. *Proceedings of the National Academy of Sciences of the United States of America* 103(3): 632–636. <https://doi.org/10.1073/pnas.0505754103>

Grimmett, R., C. Inskipp & T. Inskipp (2016). *Birds of the Indian Subcontinent: India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and the Maldives*. Bloomsbury Publishing, London, 528 pp.

Jetz, W., C.H. Sekercioglu & K. Böhning-Gaese (2008). The worldwide

variation in avian clutch size across species and space. *PLoS Biology* 6(12): 2650–2657. <https://doi.org/10.1371/journal.pbio.0060303>

Julliard, R., F. Jiguet & D. Couvet (2004). Common birds facing global changes: what makes a species at risk? *Global Change Biology* 10(1): 148–154. <https://doi.org/10.1111/j.1365-2486.2003.00723.x>

Klemetsen, A. & R. Knudsen (2013). Diversity and abundance of water birds in a subarctic lake during three decades. *Fauna Norvegica* 33: 21–27. <https://doi.org/10.5324/FN.V33I0.1584>



Image 33–48. Representation of bird species noted in the study area (continued): 33—*Psilopogon viridis* | 34—*Psilopogon haemacephalus* | 35—*Lanius cristatus* | 36—*Oriolus kundoo* | 37—*Dicrurus macrocercus* | 38—*Corvus splendens* | 39—*Corvus macrorhynchos* | 40—*Pycnonotus jocosus* | 41—*Pycnonotus cafer* | 42—*Petrochelidon luvicola* | 43—*Argys striata* | 44—*Sturnia pagodarum* | 45—*Acridotheres tristis* | 46—*Acridotheres fuscus* | 47—*Pastor roseus* | 48—*Copsychus saularis*. © H. Hemanth.

- Kumar, P. & S.K. Gupta (1970). Diversity and Abundance of Wetland Birds around Kurukshetra, India. *Our Nature* 7(1): 212–17.
- Madhok, R. & S. Gulati (2022). Ruling the roost: Avian species reclaim urban habitat during India's COVID-19 lockdown. *Biological Conservation* 271: 109597. <https://doi.org/10.1016/j.biocon.2022.109597>
- Mallin, M., M. McIver, E. Wambach & A. Robuck (2016). Algal blooms, circulators, waterfowl, and eutrophic Greenfield Lake, North

- Carolina. *Lake and Reservoir Management* 32: 168–181. <https://doi.org/10.1080/10402381.2016.1146374>
- Manakadan, R., J.C. Daniel & N. Bhopale (2011). *Birds of the Indian Subcontinent: A Field Guide*. Oxford University Press, India, 400 pp.
- Mönkkönen, M., J.T. Forsman & F. Bokma (2006). Energy availability, abundance, energy-use and species richness in forest bird communities: a test of the species-energy theory. *Global Ecology and Biogeography: A Journal of Macroecology* 15(3): 290–302.

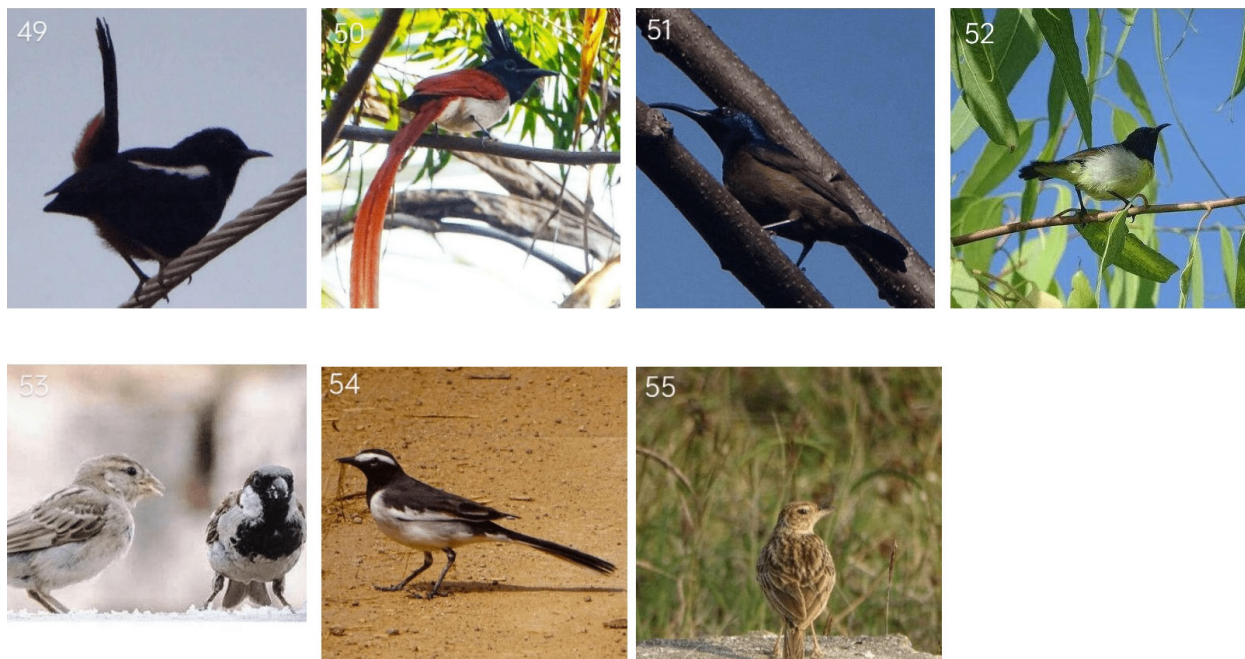


Image 49–55. Representation of bird species noted in the study area (continued): 49—*Saxicoloides fulicatus* | 50—*Terpsiphone paradisi* | 51—*Cinnyris asiaticus* | 52—*Nectarinia zeylonica* | 53—*Passer domesticus* | 54—*Motacilla maderaspatensis* | 55—*Anthus rufulus*. © H. Hemanth.

<https://doi.org/10.1111/j.1466-8238.2006.00224.x>

Newson, S.E., N. Ockendon, A. Joys, D.G. Noble & S.R. Baillie (2009). Comparison of habitat-specific trends in the abundance of breeding birds in the UK. *Bird Study* 56(2): 233–243. <https://doi.org/10.1080/00063650902792098>

Parmesan, C. & G. Yohe (2003). A globally coherent fingerprint of climate change impacts across natural systems. *Nature* 421(6918): 37–42. <https://doi.org/10.1038/nature01286>

Pimm, S.L., C.N. Jenkins, R. Abell, T.M. Brooks, J.L. Gittleman, L.N. Joppa, P.H. Raven, C.M. Roberts & J.O. Sexton (2014). The biodiversity of species and their rates of extinction, distribution, and protection. *Science* 344(6187): 1246752. <https://doi.org/10.1126/science.1246752>

Polyavina, O.V. & M.A. Lebedeva (2022). The diversity of plumage coloration and behavioral features of synanthropic blue rock pigeon of urbanized territories. *Samara Journal of Science* 11(3): 106–111.

Rajashekara, S. & M.G. Venkatesha (2016). Seasonal Incidence and Diversity Pattern of Avian Communities in the Bangalore University Campus, India. *Proceedings of the Zoological Society of London* 70(2): 178–193. <https://doi.org/10.1007/s12595-016-0175-x>

Ramachandra, T.V., H.A. Bharath, G. Kulkarni & S. Vinay (2017). Green spaces in Bengaluru: quantification through geospatial techniques. *Indian Forester* 143(4): 307–320.

Root, T.L., J.T. Price, K.R. Hall, S.H. Schneider, C. Rosenzweig & J.A. Pounds (2003). Fingerprints of global warming on wild animals and plants. *Nature* 421(6918): 57–60. <https://doi.org/10.1038/nature01333>

Saracco, J., S. Fetting, G. Miguel, D. Mehlman, B. Thompson & S. Albert (2018). Avian demographic responses to drought and fire: a community-level perspective. *Ecological Applications* 28(7): 1773–1781.

Schirmel, J., M. Bundschuh, M.H. Entling, I. Kowarik & S. Buchholz (2016). Impacts of invasive plants on resident animals across ecosystems, taxa, and feeding types: a global assessment. *Global Change Biology* 22(2): 594–603.

Schrimpf, M.B., P.G. Des Brisay, A. Johnston, A.C. Smith, J. Sánchez-Jasso, B.G. Robinson & N. Koper (2021). Reduced human activity during COVID-19 alters avian land use across North America. *Science Advances* 7(39): eabf5073.

Shome, A.R., M.F. Jaman, M.F. Rabbe & M.M. Alam (2021). Bird diversity, composition and response during COVID-19 in an urban landscape, Jamalpur, Bangladesh. *Dhaka University Journal of Biological Sciences* 30(2): 261–274.

Soh, M.C., R.Y. Pang, B.X. Ng, B.P.H. Lee, A.H. Loo & B.H. Kenneth (2021). Restricted human activities shift the foraging strategies of feral pigeons (*Columba livia*) and three other commensal bird species. *Biological Conservation* 253(78): 108927.

Turner, W.R. (2003). Citywide biological monitoring as a tool for ecology and conservation in urban landscapes: the case of the Tucson Bird Count. *Landscape and Urban Planning* 65(3): 149–166. [https://doi.org/10.1016/s0169-2046\(03\)00012-4](https://doi.org/10.1016/s0169-2046(03)00012-4)

Walther, G.R., S. Berger & M.T. Sykes (2005). An ecological “footprint” of climate change. *Proceedings. Biological Sciences / The Royal Society* 272(1571): 1427–1432. <https://doi.org/10.1098/rspb.2005.3119>

Yang, X., H. Cui & C. Chen (2022). Bird flight resistance analysis and planning strategies in urban regeneration areas: a case study of a certain area in Shenzhen, China. *Sustainability* 14(19): 12123. <https://doi.org/10.3390/su141912123>

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
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, Kalpavriksh, 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. Monsoony 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. Uniyal, 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
Dr. R. Ravinesh, Gujarat Institute of Desert Ecology, Gujarat, 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 Dubai, UAE.
Prof. Dr. Wayne J. Fuller, Near East University, Mersin, Turkey
Prof. Chandrashekher 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

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

Birds

Dr. Hem Sagar Baral, Charles Sturt University, NSW Australia
Mr. H. Byju, Coimbatore, Tamil Nadu, India
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 Sundev, 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. P.A. Azeez, Coimbatore, Tamil Nadu, India

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 Cheyney, 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 2020–2022

Due to pausity of space, the list of reviewers for 2020–2022 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.

Print copies of the Journal are available at cost. Write to:
The Managing Editor, JoTT,
c/o Wildlife Information Liaison Development Society,
43/2 Varadarajulu Nagar, 5th Street West, Ganapathy, Coimbatore,
Tamil Nadu 641006, India
ravi@threatenedtaxa.org



www.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)

January 2024 | Vol. 16 | No. 1 | Pages: 24451–24614

Date of Publication: 26 January 2024 (Online & Print)

DOI: 10.11609/jott.2024.16.1.24451-24614

Article

Use of remote sensing and GIS in assessing the impact of *Prosopis juliflora* proliferation on land use, land cover and diversity of native flora at Point Calimere Wildlife Sanctuary, India

– Sourav Gupta, Subhasish Arandhara, Selvarasu Sathishkumar & Nagarajan Baskaran, Pp. 24451–24462

Communications

Two *Ceratosporella* (Fungi: Ascomycota) species from oak leaf litter in Almora, Uttarakhand, India

– Manish Kumar Dubey, Ram Sanmukh Upadhyay & Ramesh Chandra Gupta, Pp. 24463–24468

The genus *Holigarna* Buch.-Ham. ex Roxb. (Anacardiaceae) in the central Western Ghats, Karnataka, India

– Kumbhar Mudakappa Manjunath, H.S. Shashwathi, H.M. Rakshitha Jain & Y.L. Krishnamurthy, Pp. 24469–24484

Report of *Bathypoecilia indica* Dallas, 1851 (Hemiptera: Heteroptera: Pentatomidae) as a pest of pomegranate *Punica granatum* L. cultivated in Maharashtra State

– P.S. Kudnar, Gaurang G. Gowande & Hemant V. Ghate, Pp. 24485–24495

First documentation of diversity of the Heteroptera of Cotton University Campus, Kamrup (Metropolitan), Assam, India

– Santana Saikia & Anjana Singha Naorem, Pp. 24496–24502

Checklist of hawkmoths (Lepidoptera: Bombycoidea: Sphingidae) in the Central Highlands of Vietnam

– Trang Q. Le & Lien V. Vu, Pp. 24503–24528

Observations on the courtship behaviour of Deocata Pipefish *Microphis deocata* (Hamilton, 1822) (Actinopterygii: Syngnathiformes: Syngnathidae) in an aquarium

– Anu Saikia, Jayanta Kumar Nath & Dandadhar Sarma, Pp. 24529–24534

Freshwater fish diversity and IUCN Red List status of glacial-fed (Bheri) and spring-fed (Babai) rivers in the wake of inter-basin water transfer

– Kumar Khatri, Bibhuti Ranjan Jha, Smriti Gurung & Udhav Raj Khadka, Pp. 24535–24549

Population status and habitat use of White-crested Kalij Pheasant *Lophura leucomelanos hamiltoni* (J.E. Gray, 1829) in the Limber Wildlife Sanctuary, Jammu & Kashmir, India

– Arif Nabi Lone, Bilal A. Bhat & Khursheed Ahmad, Pp. 24550–24556

Assessment of diversity, abundance, and seasonal variations of bird species in Bengaluru District, India during COVID-19 lockdown

– H. Hemanth, Rajalakshmi K.S. Vinanthi & Kuppusamy Alagesan Paari, Pp. 24557–24567

An annotated checklist of the birds in Loharghat Forest Range, Assam, India

– Taniya Talwar, Leons Mathew Abraham, Borojit Rabha & Mrigen Rabha, Pp. 24568–24583

Trade of skulls as novelty and aquarium objects are an additional threat to porcupines

– Jessica Chavez, Kuntayuni & Vincent Nijman, Pp. 24584–24588

Review

Fishes of Cocibolca, the great Central American lake

– Topiltzin Contreras-MacBeath, Byron Josue Rodríguez Pérez, Humberto Mejia-Mojica & Juan Manuel Rivas-González, Pp. 24589–24596

Short Communications

Twice blooming flowers of *Antigonon leptopus* Hook. & Arn. (Magnoliopsida: Caryophyllales: Polygonaceae), a key forage source for insects during wet season in habitats disturbed by humans

– P. Suvarna Raju, P. Srikanth & A.J. Solomon Raju, Pp. 24597–24600

Two new weevil species of the genus *Mylocherus* Schoenherr, 1823 (Coleoptera: Curculionidae: Entiminae) from India

– G. Mahendiran, M.M. Nagaraja & M. Sampathkumar, Pp. 24601–24606

Notes

Additional record of the Black Turmeric *Curcuma caesia* Roxb. (Zingiberales: Zingiberaceae) in Bhutan

– Karma Orong, Namgay Shacha, Kezang Tobgay & Rinchen Namgay, Pp. 24607–24610

A record of Chestnut-and-Black Royal *Tajuria yajna istrodea* De Nicéville, 1887 (Lepidoptera: Lycaenidae) from Arunachal Pradesh, India

– Ruksha Limbu, Ramandeep Achint, Renu Gogoi, Roshan Upadhaya & Jyoti Gaur, Pp. 24611–24614

Publisher & Host



Threatened Taxa