

Building evidence for conservation globally

Journal of Threatened Taxa



10.11609/jott.2024.16.11.26063-26186

www.threatenedtaxa.org

26 November 2024 (Online & Print)

16 (11): 26063-26186

ISSN 0974-7907 (Online)

ISSN 0974-7893 (Print)

Open Access





Publisher

Wildlife Information Liaison Development Societywww.wild.zooreach.org

Host

Zoo Outreach Organizationwww.zooreach.org

Srivari Illam, No. 61, Karthik Nagar, 10th Street, Saravanampatty, 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 MolurWildlife 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

Editorial Board

Dr. Russel Mittermeier

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

Prof. Mewa Singh Ph.D., FASc, FNA, FNASC, FNAPsyRamanna 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, Mavinhalia PO, Nilgiris, Tamil Nadu 643223, India

Dr. John FellowesHonorary 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. Ilangovan**, 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 2021–2023

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, Kuvenpura 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. Ferdinand 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, Anantapur, India

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

Dr. Aparna Watve, Pune, Maharashtra, India

Dr. Qiang Liu, Kishuangbanna 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. Mander Datar, Agharkar Research Institute, Pune, Maharashtra, India

Dr. M.K. Janarthanan, 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), Rajasthani, 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. Warrier, 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, Ilandudno, North Wales, LL30 1UP

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

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

Mr. Jatishwar 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

For Focus, Scope, Aims, and Policies, visit https://threatenedtaxa.org/index.php/JoTT/aims_scopeFor 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: Mixed media with fine liners, colour pencils, and watercolour background of an Indian funnel web spider. © Elakshi Mahika Molur.



Diet composition and diet choice of Lesser Mouse-tailed Bat *Rhinopoma hardwickii* (Gray, 1831) (Rhinopomatidae: Chiroptera)

Pawan Kumar Misra¹ , Sayma Farheen² , ShaktiVardhan Singh³  & Vadamalai Elangovan⁴ 

^{1,2,3,4} Department of Zoology, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh 226025, India.

¹ pawanmshr17@gmail.com, ² farheen786stu@gmail.com, ³ shaktivardhansingh@gmail.com,

⁴ elango70@yahoo.com (corresponding author)

Abstract: The food composition and food choice of *R. hardwickii* were assessed through guano analysis at different seasons and geographical locations. Guano samples of *R. hardwickii* were collected from the roost sites of the Gangetic plains and arid region of Uttar Pradesh. Each intact pellet was dissolved and recognizable insect body parts like legs, antennae, wings, and mouth parts were separated and photographed. Each insect remnant was identified to its lowest rank as much as possible. A total of 10 roost sites of *R. hardwickii* were observed in the arid region and Gangetic plains of Uttar Pradesh and all of them were found in historical monuments. A total of 61 pellets of 10 sites yielded 1,035 remnants of insects. The highest percentage of remnants belongs to legs, followed by wings, antennae, abdominal segments, and mouthparts. The remnants belong to eight insect orders such as Coleoptera, Hemiptera, Orthoptera, Hymenoptera, Dermaptera, Diptera, Lepidoptera, and Plecoptera. The remnants of order Hemiptera showed the highest frequency of occurrence followed by orders Coleoptera, Orthoptera, and Hymenoptera, and these four orders of insects constitute the major portion of the diet of *R. hardwickii*. The orders Dermaptera, Diptera, Lepidoptera, and Plecoptera contributed a small proportion to the diet of *R. hardwickii*. The remnants of orders Lepidoptera and Plecoptera were occasional. The result of the current study shows that the food choice of *R. hardwickii* did not differ significantly across roost sites, while differed seasonally. Further, it reveals that the Lesser Mouse-tailed Bat acts as a potential and natural insect balancing agent.

Keywords: Agricultural pest, arid zone, biological pest controller, guano analysis, insect remnant, insectivorous bat, seasonal food habit.

Editor: H. Raghuram, Sri. S. Ramasamy Naidu Memorial College (Autonomous), Virudhunagar, India. **Date of publication:** 26 November 2024 (online & print)

Citation: Misra, P.K., S. Farheen, S. Singh & V. Elangovan (2024). Diet composition and diet choice of Lesser Mouse-tailed Bat *Rhinopoma hardwickii* (Gray, 1831) (Rhinopomatidae: Chiroptera). *Journal of Threatened Taxa* 16(11): 26110-26115. <https://doi.org/10.11609/jott.7791.16.11.26110-26115>

Copyright: © Misra et al. 2024. 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 financial assistance of Science and Engineering Research Board, Department of Science and Technology, New Delhi through a major research project (No. EEQ/2018/000104) to VE is acknowledged.

Competing interests: The authors declare no competing interests.

Ethical statement: Relevant ethical permits were secured for data collection vide Letter No. 214/11/DAAS/BBAU/2011 of Babasaheb Bhimrao Ambedkar University and Archaeological Survey of India, Lucknow circle for bat survey (F. No. 10-16/23/2013-M 11535).

Author details: PAWAN KUMAR MISRA did his PhD on "Isolation and characterization of guanophilic fungi of the bats of Uttar Pradesh" and currently working on educational sector. SAYMA FARHEEN has completed her postgraduation from Babasaheb Bhimrao Ambedkar University and currently pursuing her PhD in Lucknow University, Lucknow, UP. SHAKTIvardhan SINGH has completed his PhD on "Behavioural ecology of the Mouse-tailed Bat, *Rhinopoma hardwickii*" and currently working on educational sector. VADAMALAI ELANGOVAN is professor in the Department of Zoology, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh and working on behavioural ecology of bats since 1996. VE is currently working on "conventional and alternative reproductive strategies of the Indian Flying Fox".

Author contributions: PKM and SF performed the experimental work, analysed the data and drafted the manuscript. SS supported the field work and data collection. VE designed the experiment and edited the manuscript.

Acknowledgements: The financial assistance of Science and Engineering Research Board, Department of Science and Technology, New Delhi through a major research project (No. EEQ/2018/000104) to VE is acknowledged. We thank the Archaeological Survey of India for permitting us to conduct the field survey in old monuments of Uttar Pradesh.



INTRODUCTION

Bats are voracious in nature and feed on large scale of insects in a night. Insectivorous bats are the primary consumers of many nocturnal insects (Kunz & Pierson 1994). They prey on a variety of agricultural insect pests such as tobacco budworms, corn borers, plant hoppers, and oriental armyworms (Whitaker 1993). Noctuid moths are major agricultural pests which are popular for long-distance and seasonal migrations (Wolf et al. 1990; Westbrook et al. 1995), they are abundantly eaten by bats (Thompson 1982; Robinson 1990). Insectivorous bats can suppress the pest population to its lowest level than other known natural enemies (Van Driesche & Bellows 1996). A large colony of insectivorous bats can deplete the insect pest at large scale; therefore, they act as potential biological pest control agents (Lee & McCracken 2005). Several genera of bats including *Taphozous*, *Rhinopoma*, *Tadarida* and *Miniopterus* form large colonies, from few hundreds up to several million individuals (Constantine 1967; McCracken et al. 1994; Elangovan et al. 2018).

The genus *Rhinopoma* is monophyletic with only four known species such as *R. hardwickii* (Gray, 1831), *R. microphyllum* (Brünnich, 1792), *R. muscatellum* (Thomas, 1903), and *R. macinnesi* (Hayman, 1937). They preferred to live in groups, forming colonies of hundreds to thousands of individuals (Elangovan et al. 2018). Very few studies have been carried out on the diet selection of *R. hardwickii*. Feldman et al. (2000) reported that they foraged exclusively in open areas but did not discuss about diet choice. Advani (1981) reported that *R. microphyllum kinneari* (Wroughton, 1912) mainly fed on Coleoptera, Lepidoptera, and Orthoptera throughout the year, while Isoptera was the preferred diet during summer and monsoon seasons. No detailed report is available on diet composition and diet selection of *R. hardwickii* at various seasons and habitats in India. Thus, to fulfil the lacuna, a study on diet composition and diet selection of *R. hardwickii* was carried out in arid zones of Bundelkhand and adjoining area of Gangetic plains in Uttar Pradesh.

MATERIALS AND METHODS

Faecal pellets collection and analysis

Field surveys were carried from April 2019 to February 2020 at arid zones of Bundelkhand (i.e., Hamirpur, Lalitpur, Jalaun, and Jhansi) and its adjacent districts of Gangetic plains (i.e., Lucknow and Barabanki)

in Uttar Pradesh. Guano samples were collected from the roost sites by spreading 2 x 2 m polythene sheet beneath the roost. In addition, the bats were captured using mist net, each individual was kept in a cotton bag until defecation, and thereafter they were released at the site of capture. Fresh faecal pellets were collected seasonally, i.e., summer (March–June), monsoon (July–August), and winter (November–February). Guano samples were kept in sample vials and stored at -20°C until analysis. Each intact pellet was soaked and dissolved in distilled water, teased gently using a fine brush and the insect remnants were separated using forceps. The recognizable insect body parts like legs, antennae, wings and mouth parts were separated and photographs were taken under a stereo microscope (RSMr3, Radical Scientific) using Digital Camera. Each insect remnant was identified to its lowest rank as much as possible by following Brues et al. (1954) and online resources. The identified remnants of different sites were grouped into legs, antennae, wings, and mouth parts and the frequency of occurrence was obtained.

Statistical analysis

Normality tests were performed to determine the distribution of the data set ($p < 0.05$), therefore non-parametric test (Kruskal Wallis H test) was applied to determine the seasonal and regional variations in the food choice of *R. hardwickii*. Guidelines of the American Society of Mammalogists for the care and use of mammals were followed (Sikes et al. 2011).

RESULTS

A total of 10 roost sites of *R. hardwickii* were observed in the arid region (Hamirpur, Lalitpur, Jalaun, and Jhansi) and Gangetic plains (Lucknow and Barabanki) of Uttar Pradesh (Figure 1). All the roosts of *R. hardwickii* were found in historical monuments of the Uttar Pradesh. A total of 61 pellets of 10 roost sites yielded 1035 remnants of insects. The highest proportion of remnants was legs (47.29%) followed by wings (26.44%), antennae (7.62%), abdominal segments (5.31%), and mouth parts (0.19%), while the proportion of unidentified body parts of insects was 13.12%.

The insect remnants belong to eight insect orders such as Coleoptera, Hemiptera, Orthoptera, Hymenoptera, Dermaptera, Diptera, Lepidoptera, and Plecoptera. Further, the valuable diagnostic features of the remnants allowed us to identify up to family level, e.g., Scarabaeidae, Carabidae and Staphylinidae

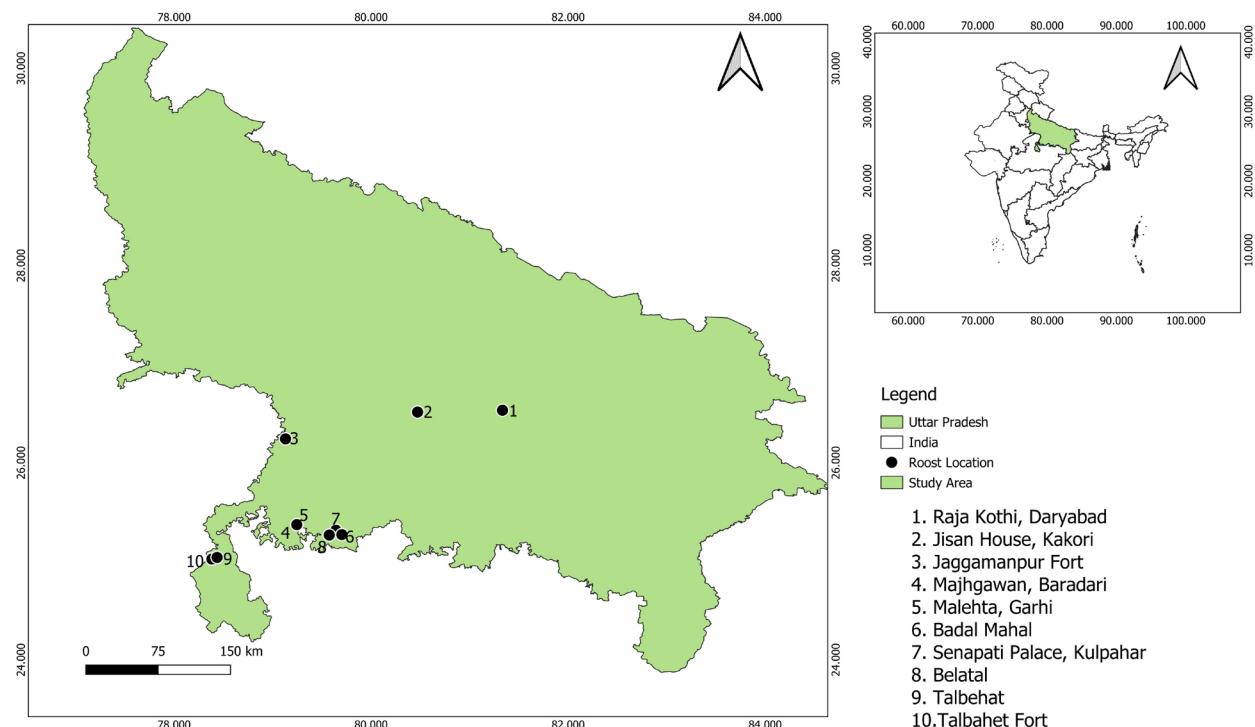


Figure 1. Roost sites of *Rhinopoma hardwickii* in Uttar Pradesh.

Table 1. The insect remnants retrieved from faecal pellets of *Rhinopoma hardwickii* at different roost locations. The values are given in percentage.

Roost locations/insects order	Lucknow	Barabanki	Lalitpur	Jalaun	Jhansi	Mahoba	Hamirpur
Coleoptera	29.55	9.09	7.58	8.33	9.85	15.91	19.70
Hemiptera	5.34	0.00	13.74	1.53	6.11	14.50	58.78
Orthoptera	7.89	2.63	13.16	10.53	39.47	7.89	18.42
Hymenoptera	3.45	0.00	93.10	0.00	3.45	0.00	0.00
Dermoptera	33.33	0.00	33.33	0.00	33.33	0.00	0.00
Diptera	0.00	100.00	0.00	0.00	0.00	0.00	0.00
Lepidoptera	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Plecoptera	0.00	100.00	0.00	0.00	0.00	0.00	0.00

(Coleoptera), Gryllidae and Gryllicrididae (Orthoptera), Cynidae (Hemiptera), Formicidae (Hymenoptera). The remnants of order Hemiptera consist of legs (tarsi with claw; Images 1AH–AI) and wings (hemi-elytra; Images 2L–O). The remnants of order Coleoptera consist of legs (femur, coxae and tibia, tarsi with claw; Images 1A–V), and wings (elytra; Images 2A–K), while the order Orthoptera consists of coxae and tibia with claw (Images 1W–AG) and leathery non-membranous wings (Images 2P–S). Tarsi of Coleoptera were usually heteroamorous and apparently with three to five segments and one pair of claws (Images 1A–V), while of Hemiptera with

three segments and claw (Images 1AH–AI). The wing remnants of Orthoptera were membranous, venation rather complete but not complex with pentagonal or quadrant shape cells (Images 2P–S). They had large legs with spines, tibia with stout spines and movable spur, tympanum located in front of tibia/rarely spinose and tarsi with 4–5 segmented claws (Images 1W–AG).

The remnants of Hemiptera showed the highest frequency in faeces (14.69%) followed by Coleoptera (13.27%), Orthoptera (5.21%), and Hymenoptera (2.65%). The remnants of orders Dermaptera (0.26%), Diptera (0.17%), Lepidoptera (0.088%), and Plecoptera

Table 2. Seasonal variation in food preference of *Rhinopoma hardwickii*. Values are given as Mean \pm SD. The dash (-) indicates the absence of particular insect order during the season.

Season	Summer	Monsoon	Winter	χ^2	p -value
Coleoptera	3.70 \pm 0.75	1.88 \pm 0.49	2.80 \pm 1.94	3.42	0.18
Hemiptera	1.75 \pm 0.25	2.27 \pm 0.798	3.58 \pm 3.18	0.38	0.82
Orthoptera	0.95 \pm 0.08	1.22 \pm 0.86	1.08 \pm .12	1.293	0.52
Hymenoptera	-	7.00 \pm 6.00	-	0.50	0.48
Dermoptera	-	-	-	-	-
Diptera	1	1	1	-	1
Lepidoptera	1	-	-	-	-
Plecoptera	-	-	-	-	-
Unidentified	8.42 \pm 5.45	16.1 \pm 8.92	11.45 \pm 4.42	1.5	0.47
χ^2	15.285	9.414	9.106	-	-
p-value	0.018	0.152	0.059	-	-

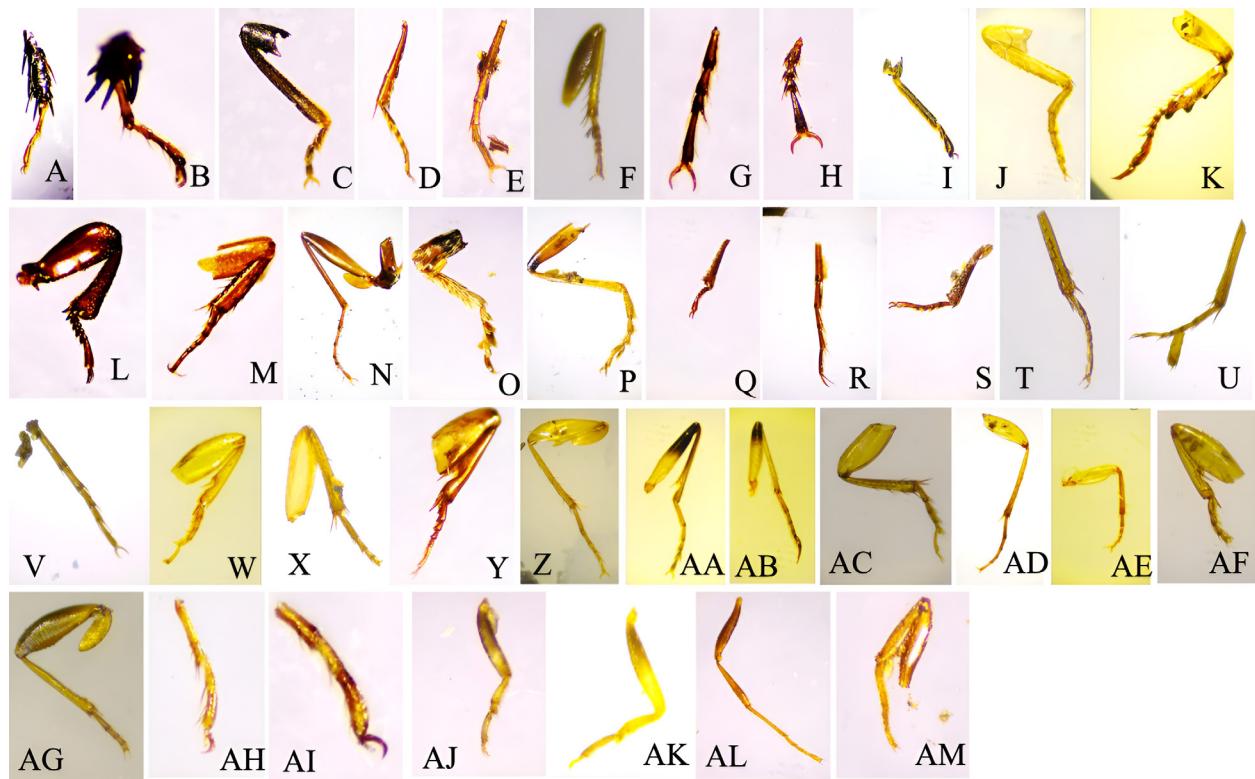


Image 1. Legs of insects isolated from the guano of *Rhinopoma hardwickii*: A–V—Coleoptera | W–AG—Orthoptera | AH–AI—Heteroptera | AJ–AK—Dermaptera | AL–AM—Hymenoptera. © Pawan Kumar Misra & Sayma Farheen.

(0.088%) were found in a small proportion. Further, a major proportion of insect remnants was unidentifiable (63.53%) because they were either broken or incomplete. The remnants of orders Lepidoptera and Plecoptera were occasional (Table 1). The remnants retrieved from faecal pellets showed variation in diet choice of *R. hardwickii* at different localities, i.e., coleopterans were

highest in Kakori, hemipterans in Hamirpur (Maleta), orthopterans in Jhansi and hymenopterans in Lalitpur (Table 1). There was no significant difference observed in the occurrence of remanence of various insect orders in 10 different roost sites, Coleoptera ($\chi^2 = 0.800$, $p = 0.999$), Hemiptera ($\chi^2 = 0.788$, $p = 0.990$), Orthoptera ($\chi^2 = 4.50$, $p = 0.342$), Hymenoptera ($\chi^2 = 0.330$, $p =$

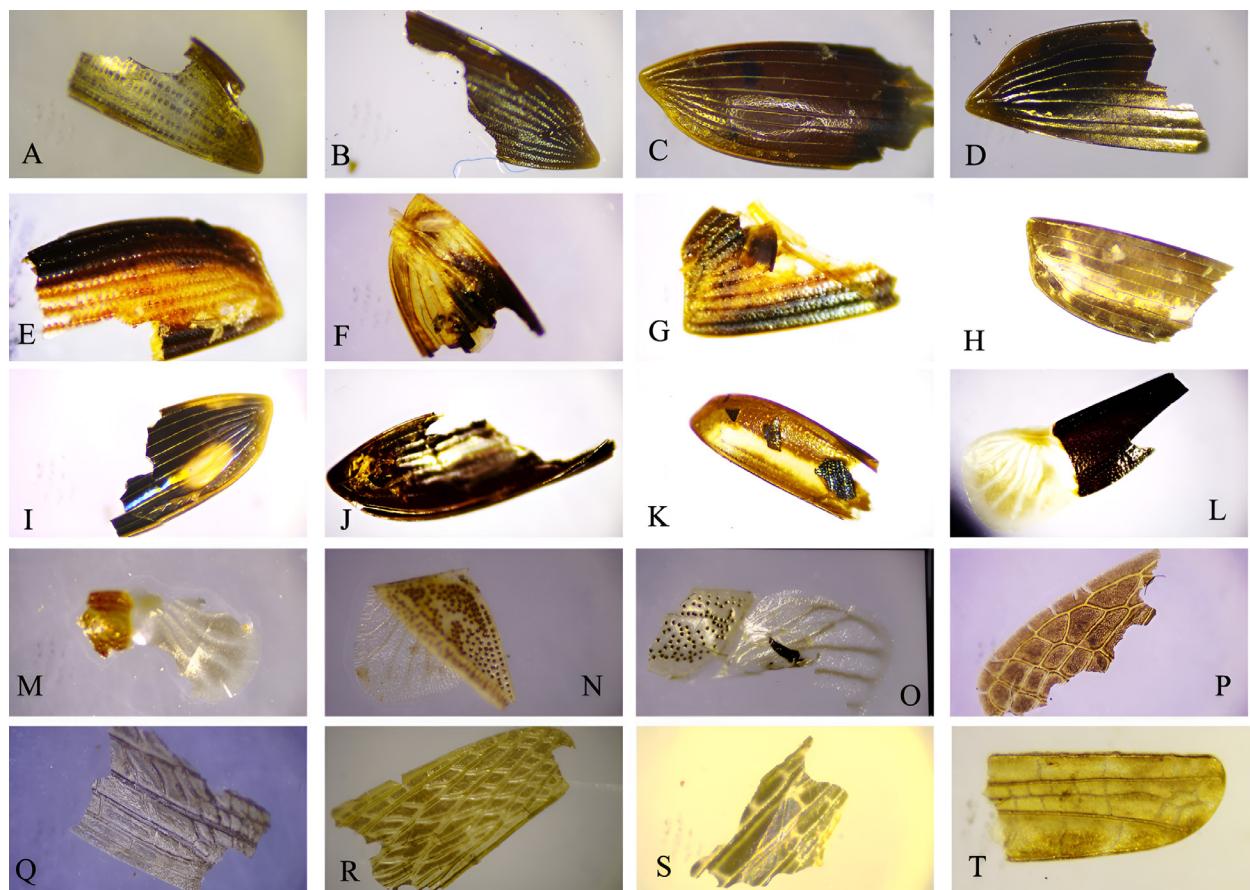


Image 2. Remnants of insect wings isolated from the guano of *Rhinopoma hardwickii*: A–K—Coleoptera | L–O—Hemiptera | P–S—Orthoptera | T—Plecoptera. © Pawan Kumar Misra & Sayma Farheen.

0.563), Diptera ($\chi^2 = 1.00$, $p = 0.317$), Lepidoptera and Plecoptera ($\chi^2 = 0.00$, $p = 1.00$).

The food choice of *R. hardwickii* varied with seasons, the remnants of Coleoptera were higher during summer, Hemiptera during winter, and Orthoptera during monsoon seasons (Table 2). The food choice of *R. hardwickii* showed a significant difference during summer ($\chi^2 = 15.285$, $p = 0.018$), while the food choice did not differ during monsoon and winter seasons ($p > 0.05$, Table 2).

DISCUSSION

The results of present study showed that the Lesser Mouse-tailed Bats consumed insects belonging to eight insect orders across the geographical locations and seasons. The most preferred food items belong to orders Hemiptera, Coleoptera, Orthoptera and least preferred items belong to orders Dermaptera, Diptera, Lepidoptera and Plecoptera. Feldman et al. (2000) and

Whitaker & Yom-Tov (2002) investigated the habitat utilization and dietary composition of *R. hardwickii* and found that they used open habitat and fed coleopteran insects which contributed about 51% of the diet. Heteropteran (order Hemiptera) insects were the second most commonly found food items and contributed 30.4% of the diet of *R. hardwickii* (Whitaker & Yom-Tov 2002). The diet selection of many insectivorous bats depends upon dental and cranial morphology, wing shape, and echolocation call (Neuweiler 2000; Altringham 2011; Weterings & Umponstira 2014). The results of faecal pellet analysis revealed that the legs and wings constituted more than 74% of the remnants isolated, while antennae, abdomen, and mouth parts contributed less than 15%. The highest percentage of legs and wings in the isolated remnants probably be due to the composition of chitin in legs and wings. The Bundelkhand region of Uttar Pradesh comes under dry-arid zone wherein scarcity of water occurs except rainy season, while Lucknow and Barabanki are fertile Gangetic plains. The flora and fauna also vary naturally

among the regions; no difference was observed in the obtained remnants and food choices of *R. hardwickii*. Although, the food choices vary across roost sites (geographical regions) but did not differ significantly. The food choice of *R. hardwickii* was influenced by seasons. The earlier studies deduced that the prey availability and prey selection of most insectivorous bats were probably influenced by temporal, seasonal, and geographical factors (Whitaker 1995; Whitaker et al. 1996).

Arthropods destroy over 18% of the annual production of crops worldwide (Culliney 2014). The use of agricultural insecticides causes harmful impact on consumer and environment. Therefore, use of biocontrol agents for the suppression of insect pest is very important and the insectivorous bats are good source of insect pest suppressors as they consume a large number of insects of various orders. According to Boyles et al. (2013), insectivorous bats decreased the cost of pesticide about USD 22.9 billion a year and also reduced the development of pesticide resistance. Similarly, the current study revealed that the mouse-tailed bats consume a wide range of insects belong to eight orders across seasons, and geographical areas of Uttar Pradesh. Further, the food choice of *R. hardwickii* varies with seasons, and Coleoptera was the most preferred food item in summer, while Hemiptera and Orthoptera were preferred food items during winter and in monsoon seasons, respectively. Since, the mouse-tailed bats consume a lot of insects and play active role as insect suppressor, their roost sites and populations need adequate conservation for their sustenance and human welfare.

REFERENCES

Advani, R. (1981). Food and feeding ecology of the Rat-tailed Bat in the Rajasthan desert. *Acta Theriologica* 26: 269–272.

Altringham, J.D. (2011). *Bats: From evolution to Conservation*. Oxford: Oxford University Press, New York, 319 pp.

Boyles J.G., L.S. Catherine, P.M. Cryan & G.F. McCracken (2013). On Estimating the Economic Value of Insectivorous Bats: Prospects and Priorities for Biologists, pp. 501–515. In: Adams, R.A. & S.C. Pedersen (eds.). *Bat Evolution, Ecology and Conservation* (2013th ed.). Springer, New York. https://doi.org/10.1007/978-1-4614-7397-8_24

Brues, C.T., A.L. Melander & F.M. Carpenter (1954). *Classification of Insects*, Vol. 108. Bulletin of the Museum of Comparative Zoology. Cambridge, Massachusetts, 801 pp.

Constantine, D.G. (1967). *Activity patterns of the Mexican Free-tailed Bat*. University of New Mexico Publications in Biology, University of New Mexico Press, Albuquerque, 79 pp.

Culliney, T.W. (2014). Crop losses to arthropods. pp. 201–226. In: Pimentel D. & R. Peshin. (eds.): *Integrated Pest Management*.

Pesticide Problems, Vol. 3. Springer, New York, 474 pp.

Elangovan, V., V. Mathur, M. Kumar & Y.S. Priya (2018). Diversity and Conservation of Chiropteran Fauna, pp. 57–87. In: Sivaperuman, K. & Venkataraman (eds.). *Indian Hotspots*. Springer Nature Singapore Pte Ltd. 397 pp. <https://doi.org/10.1007/978-981-10-6605-4>

Feldman, R., J.O. Whitaker, & Y. Yom-Tov (2000). Dietary composition and habitat use in a desert insectivorous bat community in Israel. *Acta Chiropterologica* 2: 15–22.

Gray, J.E. (1831). Description of some new genera and species of bats. *Zoological Miscellany* 1: 37–38.

Hayman, R.W. (1937). Mammals collected by the Lake Rudolf Rift Valley Expedition. *The Annals and Magazine of Natural History* 19(10): 530–531.

Kunz, T.H. & E.D. Pierson (1994). Bats of the world: an introduction. pp. 1–46. In: Nowak, R.W. (ed.). *Walker's bats of the world*. Johns Hopkins University Press, Baltimore, MD, 288 pp.

Lee, Y-F. & G.F. McCracken (2005). Dietary variation of Brazilian Free-tailed Bats links to migratory populations of insects. *Journal of Mammalogy* 86: 67–76. [https://doi.org/10.1644/1545-1542\(2005\)086<0067:DVOBFB>2.0.CO;2](https://doi.org/10.1644/1545-1542(2005)086<0067:DVOBFB>2.0.CO;2)

McCracken, G.F., M.K. McCracken & A.T. Vawter (1994). Genetic structure in migratory populations of the bat *Tadarida brasiliensis mexicana*. *Journal of Mammalogy* 75: 514.

Neuweiler, G. (2000). *The Biology of Bats*. Oxford: Oxford University Press, New York, 310 pp.

Robinson, M.F. (1990). Prey selection by the Brown Long-eared Bat *Plecotus auratus*. *Myotis* 28: 5–18.

Sikes, R.S., L.G. William & The Animal Care and Use Committee of the American Society of Mammalogists (2011). Guidelines of the American Society of Mammalogists for the use of wild mammals in research. *Journal of Mammalogy* 92(1): 235–253. <https://doi.org/10.1644/10-MAMM-F-355.1>

Thomas, O. (1903). On the species of the genus *Rhinopoma*. *Journal of Natural History* 11(65): 496–499.

Thompson, M.J.A. (1982). A Common Long-eared Bat *Plecotus auritus*: moth predator-prey relationship. *Naturalist* 107: 87–97.

Van Driesche, R.G. & T.S. Bellows (1996). Pest Origins, Pesticides, and the History of Biological Control. pp. 3–20. In: van Driesche R.G. & T.S. Bellows (eds.): *Biological Control*. Springer, Boston, 539 pp. https://doi.org/10.1007/978-1-4613-1157-7_1

Westbrook, J.K., R.S. Eyster, W.W. Wolf, P.D. Lingren & J.R. Raulston (1995). Migration pathways of corn earworm (Lepidoptera: Noctuidae) indicated by tetroon trajectories. *Agriculture and Forest Meteorology* 73: 67–87. [https://doi.org/10.1016/0168-1923\(94\)02171-F](https://doi.org/10.1016/0168-1923(94)02171-F)

Weterings, R. & C. Umponstria (2014). Bodyweight-forearm ratio, cranial morphology, and call frequency relate to prey selection in insectivorous bats. *Electronic Journal of Biology* 10: 21–27.

Whitaker, J.O. Jr. (1993). *Bats, Beetles, and Bugs*. BATS 11(1): 23.

Whitaker, J.O. Jr. (1995). Food of the big brown bat *Eptesicus fuscus* from maternity colonies in Indiana and Illinois. *American Midland Naturalist* 134: 346–350. <https://doi.org/10.2307/2426304>

Whitaker, J.O., Jr.; C. Neefus & T.H. Kunz (1996). Dietary Variation in the Mexican Free-tailed Bat *Tadarida brasiliensis mexicana*. *Journal of Mammalogy* 77(3): 716–724.

Wolf, W.W., J.K. Westbrook, J.R. Raulston, S.D. Pair & S.E. Hobbs (1990). Recent airborne radar observations of migrant pests in the United States. *Philosophical Transactions of the Royal Society of London, B. Biological Sciences* 328: 619–630. <https://doi.org/10.1098/rstb.1990.0132>

Whitaker, J.O. & Y. Yom-Tov (2002). The diet of some insectivorous bats from northern Israel. *Mammalian Biology-Zeitschrift für Säugetierkunde* 67: 378–380. <https://doi.org/10.1078/1616-5047-00053>

Wroughton, R.C. (1912). Some new Indian mammals. *Journal of Bombay Natural History Society* 21: 767–773.

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. Karen 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. Nitithyanandan, Environmental Department, La 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. Kuri 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. Karen 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. Priyadarshan 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. Priyadarshan 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, Soughall, 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 Dhabi, UAE.
Prof. Dr. Wayne J. Fuller, Near East University, Mersin, Turkey
Prof. Chandrashekher U. Rironker, 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
Mr. H. Biju, 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 Jayopal, 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 Inskip, Bishop Auckland Co., Durham, UK
Dr. Tim Inskip, 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, Budhanilkantha Municipality, Kathmandu, Nepal
Dr. Susan Cheyne, Borneo Nature Foundation International, Palangkaraya, 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 Helleni 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. Bharat Baviskar, Wild-CER, Nagpur, Maharashtra 440013, India

Reviewers 2021–2023

Due to paucity of space, the list of reviewers for 2021–2023 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,
3A2 Varadarajulu Nagar, FCI Road, Ganapathy, Coimbatore,
Tamil Nadu 641006, India
ravi@threatenedtaxa.org & ravi@zooreach.org

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

Articles

Endemicity and diversity of birds of the Kuvempu University Campus, Shivamogga District, Karnataka: an updated checklist

– M.N. Harisha & B.B. Hosetti, Pp. 26063–26077

Unregulated wild orchid trade in Manipur: an analysis of the Imphal Valley markets from the Indo-Burma hotspot

– Kamei Kambuikhonlu Kabuini & Maibam Dhanaraj Meitei, Pp. 26078–26088

Watershed survey of streams in western Bhutan with macroinvertebrates, water chemistry, bacteria and DNA barcodes

– Juliann M. Battle, Bernard W. Sweeney, Bryan Currinder, Anthony Aufdenkampe, Beth A. Fisher & Naimul Islam, Pp. 26089–26103

Communications

Indian Leopard predation on the sub-adult Himalayan Griffon Vulture (Accipitridae: Accipitriformes)

– Soumya Sundar Chakraborty, Debal Ray, Apurba Sen, P.J. Harikrishnan, Nabi Kanta Jha & Rounaq Ghosh, Pp. 26104–26109

Diet composition and diet choice of Lesser Mouse-tailed Bat *Rhinopoma hardwickii* (Gray, 1831) (Rhinopomatidae: Chiroptera)

– Pawan Kumar Misra, Sayma Farheen, ShaktiVardhan Singh & Vadimalai Elangovan, Pp. 26110–26115

DNA barcoding and distribution of *Osteobrama peninsulae* (Teleostei: Cyprinidae) in India

– Boni Amin Laskar, Asha Kiran Tudu, Shibananda Rath & Laishram Kosygin, Pp. 26116–26123

Diving into diversity: aquatic beetles of Sukhna Wildlife Sanctuary, Chandigarh, India

– Karmannye Om Chaudhary, Pp. 26124–26130

Review

An updated checklist of snakes (Reptilia: Squamata) in northeastern India derived from a review of recent literature

– Bijay Basfore, Manab Jyoti Kalita, Narayan Sharma & Ananda Ram Boro, Pp. 26131–26149

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

November 2024 | Vol. 16 | No. 11 | Pages: 26063–26186

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

DOI: [10.11609/jott.2024.16.11.26063-26186](https://doi.org/10.11609/jott.2024.16.11.26063-26186)

Viewpoint

Decades of IUCN recommendations for biocontrol of invasive pest on the Guam cycad: you can lead policy-makers to conservation proposals but you cannot make them follow

– Thomas E. Marler, Anders J. Lindström, L. Irene Terry & Benjamin E. Deloso, Pp. 26150–26162

Short Communications

Photographic record of Kashmir Gliding Squirrel *Eoglaucomys fimbriatus* (J.E. Gray, 1837) from the Gurez Valley, Jammu & Kashmir, India

– G. Mustufa Lone, Bilal A. Bhat, Mir Shabir Hussain & Arif Nabi Lone, Pp. 26163–26166

Winter population of raptor species in the Vellore dump yard of Coimbatore City, India

– V. Balaji & R. Venkitachalam, Pp. 26167–26171

Notes

Phenotypic variations in Mindoro Warty Pig *Sus oliveri* (Cetartiodactyla: Suidae)

– John Carlo Redeña-Santos, Anna Pauline O. de Guia, Nikki Heherson A. Dagamac & Fernando García Gil, Pp. 26172–26175

First photographic evidence of the Chinese Pangolin *Manis pentadactyla* (Linnaeus, 1758) in Raimona National Park, Assam, India

– Dipankar Lahkar, M. Firoz Ahmed, Bhanu Sinha, Pranjal Talukdar, Biswajit Basumatary, Tunu Basumatary, Ramie H. Begum, Nibir Medhi, Nitul Kalita & Abishek Harihar, Pp. 26176–26179

Habenaria spencei (Orchidaceae): rediscovery other than its type locality and new distribution record to Karnataka, India

– Shreyas Betageri & Katrahalli Kotresha, Pp. 26180–26184

Book Review

Fairies of the day and angels of the night

– Chitra Narayanasami, Pp. 26185–26186

Publisher & Host



Threatened Taxa