

Building evidence for conservation globally

Journal of Threatened Taxa

10.11609/jott.2024.16.2. 24615-24818

www.threatenedtaxa.org

26 February 2024 (Online & Print)

16(2): 24615-24818

ISSN 0974-7907 (Online)

ISSN 0974-7893 (Print)



Open Access





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

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

Host
Zoo Outreach Organization
www.zooreach.org

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, Mangalagangothri, 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. Karthikeyan, 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 Banos, 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. Warriar, 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. Ghate, 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: Common Keeled Skink *Eutropis carinata* in oil pastels, colour pencils, & micron pen adapted from photograph by H. Byju © Pooja Ramdas Patil.



Coexistence of Indian Pangolin *Manis crassicaudata* (Geoffroy, 1803) (Mammalia: Pholidota: Manidae) and Indian Crested Porcupine *Hystrix indica* (Kerr, 1792) (Mammalia: Rodentia: Hystricidae) in Purulia District, West Bengal, India

Debosmita Sikdar¹ , Shwetadri Bhandari² & Sanjay Paira³

¹ Presidency University, 86/1 College Street, Kolkata, West Bengal 700073, India.

^{2,3} Sarisha Wildlife and Ecology Society (WNE), Sarisha, Nabasan Road, Diamond Harbour, 24 PGS (S), West Bengal 743368, India.

¹ Present address: Aswini Plaza, Sarat Sarani, near Bandel Church, Post and District- Hooghly, West Bengal 712103, India.

¹ debosmitasikdar18@gmail.com (corresponding author), ² wildlifecology2014@gmail.com, ³ sanjaypaira9933@gmail.com

Abstract: The Indian Pangolin *Manis crassicaudata* and the Indian Crested Porcupine *Hystrix indica* are subject to extensive poaching in Purulia District (West Bengal, India), diminishing their populations, and making the study difficult. Applying methodologies that include local sightings, field observations, camera trapping, and quadrat analysis, these species were observed to co-occur in rocky cavities in Ajodhya hills at several locations. Evidence for this included fresh pangolin tail drag marks, claw prints, footprints, scales, porcupine quills, teeth marks, and faecal matter in the same locations within the study area. Quadrat analysis showed that the trees housing the target prey species of the Indian Pangolin as well as the trees bearing fruits favoured by the Indian Crested Porcupine, occurred at maximum frequency within the Quadrat area. We hypothesise that pangolins and porcupines co-occupy rocky cavities for protection from poachers, who can easily break into more typical burrows and set traps in front of them. This may be an example of adaption to poaching, which demonstrates the necessity of conservation measures to alleviate severe anthropogenic pressure.

Keywords: Ajodhya hills, camera trapping, co-inhabitation, diurnal surveys, perception study, poaching, quadrat analysis, rocky cavity.

Editor: S.S. Talmale, Zoological Survey of India, Pune, India.

Date of publication: 26 February 2024 (online & print)

Citation: Sikdar, D., S. Bhandari & S. Paira (2024). Coexistence of Indian Pangolin *Manis crassicaudata* (Geoffroy, 1803) (Mammalia: Pholidota: Manidae) and Indian Crested Porcupine *Hystrix indica* (Kerr, 1792) (Mammalia: Rodentia: Hystricidae) in Purulia District, West Bengal, India. *Journal of Threatened Taxa* 16(2): 24630–24645. <https://doi.org/10.11609/jott.8736.16.2.24630-24645>

Copyright: © Sikdar 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 project was approved and funded by the Government of West Bengal, Directorate of Forests, Office of the Divisional Forest Officer, Purulia Division [Approval letter no. 2552/26-1(WL)] and the Sarisha Wildlife and Ecology Society (WNE) India.

Competing interests: The authors declare no competing interests.

Author details: DEBOSMITA SIKDAR is presently a student at Presidency University, Kolkata. Is a JNCASR (Jawaharlal Nehru Centre for Advanced Scientific Research) summer research fellow, 2023. Worked on understanding alarm behaviour in *Etroplus suratensis* (a cichlid). Worked as project intern at WNE-India, on Sloth Bear and Pangolin conservation. Also, is currently working on understanding the change in sea snake distribution due to global warming, at the Marine Ecology Laboratory, Presidency University, Kolkata. SHWETADRI BHANDARI is the founder and president of the Sarisha Wildlife and Ecology Society (WNE), India. Presently working on Pangolin conservation with the funding support from CWS (Centre for Wildlife Studies) and Elephant conservation with forest department and funding support from WTI (Wildlife Trust Of India). SANJAY PAIRA works as a wildlife biologist at Sarisha Wildlife and Ecology Society (WNE), India. He is a specialist in herpetofauna.

Author contributions: DS—Formal analysis, software, data curation, writing-original draft, writing-review & editing, visualization. SB—Conceptualization, Methodology, validation, resources, supervision, funding acquisition, writing-review & editing. SP—Investigation, resources, project administration, supervision.

Acknowledgements: The authors profoundly acknowledge their gratefulness to the Forest Department of Purulia District, West Bengal, India, for provision of all permits and logistics for conducting the survey. We also extend our gratitude to the Local community of the Mohultarn village for their cooperation during the community interviews, the members of the Sarisha Wildlife and Ecology Society (WNE-India) and the teammates at the fieldwork, for their unwavering enthusiasm and supportive attitude.



INTRODUCTION

Indian pangolins and porcupines have not been extensively studied due to their shyness, nocturnal habits, affinity for inhabiting inaccessible places, and difficulty of spotting them in the wild (Saltz & Alkon 1989; Karawita et al. 2018). Current studies of pangolin conservation come from South Africa (Heath & Coulson 1997; Shepherd et al. 2017). Our study concentrated on the Ajodhya Hills, Purulia, West Bengal, India where Indian Pangolins *Manis crassicaudata* and Indian Crested Porcupines *Hystrix indica* are known to be present as well as poached, with the goal of providing insights into how these species interact and adapt to excessive poaching.

The Indian Pangolin has been assessed as 'Endangered' according to the IUCN Red List of Threatened Species (Mahmood et al. 2019). It has also been listed in the Appendix I of the CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) and a Schedule I species under the Wildlife (Protection) Amendment Act, 2022, to safeguard it from the extensive poaching.

The Indian Crested Porcupine has been assessed as 'Least Concern' on the IUCN Red List (Amori et al. 2021), and is protected under the Schedule I of the Wildlife (Protection) Amendment Act, 2022 to illegalize its poaching.

Description

As the species name *crassicaudata* suggests, the Indian Pangolin is characterized with a prehensile thick (crassus) tail (cauda), with adults weighing up to 16 kg and having a length of approximately 148 cm (Mahmood et al. 2019). Sharp keratinous scales cover the dorsal and lateral surfaces of its body, both dorsal & ventral surfaces of the tail, and over the limbs. It has 11–13 rows of overlapping scales round the mid body with a terminal scale on its ventral side of tail (Mohapatra & Panda 2014). It has curved claws in its forelimbs which are used to dig into termite mounds and ant nests, following which the ants and termites are licked up by its long, sticky saliva-coated tongue. When threatened, it either flees or curls up into a tight ball, depending entirely on its scales, for protection (Chao et al. 2019). The Indian Crested Porcupine weighs approximately 11–18 kg (Prater 2005) and has a body length of 70–90 cm (Prater 2005). Its body is covered with two types of keratinous quills—a longer and slender type which masks the shorter and thicker ones underneath. When threatened, it raises its quills with the help of a muscle attached to the base of its quills and tries to scare away

the threat. It has long claws for digging, sharp incisors, and a keen sense of smell.

Distribution

According to Mohapatra et al. (2015), the Indian Pangolin is found in southern Asia from northern and southeastern Pakistan throughout the Indian subcontinent south of the Himalaya, to northeastern India and Sri Lanka. In India, it is distributed across states like Andhra Pradesh, Bihar, Chhattisgarh, Delhi, Gujarat, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttarakhand, Uttar Pradesh, and West Bengal and has also been reported to be present in Bangladesh, Pakistan, Nepal, and Sri Lanka.

The Indian Crested Porcupine is found in most countries of southwestern, southern and central Asia, including Afghanistan, Armenia, China, Georgia, India, Iran, Iraq, Israel, Lebanon, Nepal, Pakistan, Saudi Arabia, Sri Lanka, Turkey, and Yemen.

Habitat and Diet

The Indian Pangolin is mainly fossorial and is known to excavate burrows in the soil, as well as inhabit crevices of boulders (Mahmood et al. 2019). There are two types of burrows: the resting burrow, where it rests during the day, and the feeding burrow, which it digs to uncover prey (Karawita et al. 2018). The most preferred dietary choices of the Indian Pangolin are the red ants and the termites (Supplemental Images 1A, 1B, 1C, 1D), which are found within its habitat (Karawita et al. 2018; Mahmood et al. 2019).

The Indian Crested Porcupine is semi fossorial and digs burrows or lives in rocky caves. However, it is not an expert climber and spends most of its lifetime on or under the ground. It can be found in rocky hillsides, forests, grasslands, and even agricultural fields where it goes for eating potatoes (Saltz & Alkon 1989), fruits, tubers, roots, etc. Its habitat choice is dependent on the presence of abundant food resources (like fruit trees) and rocky cavities or proper substrate to make the digging of burrows practically possible (Saltz & Alkon 1989).

Behaviour

The Indian Pangolin sleeps in burrows during the daytime and forages at night (Karawita et al. 2018). A study conducted on Indian Pangolins in captivity at the Nandankanan Zoo, India, revealed that they show peak activity between 2000 h and 2100 h (Mahmood et al. 2019). It is also arboreal and can climb trees using its

forelimbs, hindlimbs, and the prehensile tail which acts as an 'extra limb' (Mahmood et al. 2019). It is myrmecophagous (Beca et al. 2022) and termitophagous (Chao et al. 2019) and known to prefer the ant species *Camponotus confucii*, *C. compressus*, and termite species *Odontotermis obesus*, as shown by a study conducted in the Potohar Plateau, Pakistan (Mahmood et al. 2013).

The Indian Crested Porcupine has been found to feed preferably on underground bulbs, such as potatoes (Saltz & Alkon 1989), and fallen fruits from trees and is considered a 'generalist herbivore'. It has been found to consume a greater variety of food items in the summer season, compared to that in the winter season; the reason can be attributed to the fact that it shows greater activity in summer than in winter (Corsini et al. 1995) thus exploring more area from the burrow for foraging in the summer, hence the diversification in its diet (Akram et al. 2017). Its activity radius was found to be greater in the late summer (when forest is already enriched with nutrient sources) than in the early summer (when nutrient sources become available initially) (Saltz & Alkon 1989). Therefore, it can be predicted that higher the concentration of food resources in an area or near the living burrow, the greater the preference of the porcupine to inhabit there, to get a variety of food sources. It is known to remain in proximity to its burrow during the brightly moonlit nights (to avoid predators) and its habitation is closely linked with the 'forage availability'. It leaves its burrow shortly before sunset and returns only at sunrise (Corsini et al. 1995).

MATERIALS AND METHODS

Study area

The current study was conducted in the Gajaburu Hills (Supplemental Image 2) near Mohultarn Village in the Sirkabad Beat, Arsha Range of the Purulia Division Forest Department, West Bengal, India. The global positioning system (GPS) coordinates of the place are 23.24° N, 86.22° E. Six sites were selected within the study area as the focal sites.

Study design

The study was conducted from November 2022–April 2023. These months were chosen for the study so that the behaviour of the target animals could be monitored in the duration of winter season, as well as partly in the summer season, for preventing any bias of the behaviour towards a particular season. The first requirement was identification of potential

sampling sites, which was accomplished with the help of perception study of local people and rigorous field surveys in November 2022. Quadrata analysis was added as a part of the study to further validate if the chosen sampling sites could support the co-existence of the pangolin and the porcupine. The data was collected by taking photographs of animal prints and by collecting quills, faecal matter, and scales.

Community interviews and Perception study

Community interviews are one of the most cost-effective methods to determine pangolin and porcupine distribution in regions where their population has declined overtime and to further access their current population status. Most surveys that used this method, reported successful recognition of target species by the locals who were interviewed (Willcox et al. 2019). The locals in Purulia recognize the Indian Pangolin as 'Soorjomukhi' and they could easily identify and describe it. We interviewed local hunters and local people living in the Mohultarn village to study their perception, which helped us in identification of the priority sites for pangolin and porcupine burrow distribution and how to distinguish these burrows from those of other burrowing animals present in the associated habitats. However, for the validation of the statements made by the local people, we cross checked the information provided by the locals with the available scientific records and observations mentioned in the existing scientific literature.

Diurnal field surveys

The field surveys were conducted for a period of six months, from November 2022–April 2023. In November 2022, field surveys were undertaken once each week (four times). Following this, field surveys were conducted twice each month for the rest of the five months from December 2022–April 2023 (10 times). Each in-person field survey was limited to four to five hours (with recesses) at a time, to prevent manual error in data collection due to fatigue. The frequency of field surveys was reduced from four in November 2022 to two in the rest of the months because the initial time-consuming process of identifying the potential sampling sites within the study area was completed in November 2022. Accordingly, six potential sites were identified within the study area. In total, 14 field surveys were conducted during the whole study period.

The site selection criteria included the detection of recent claw marks, tail drag marks, footprints, faecal samples (dung), quills, bite marks, feeding signs (broken

ant nests and termite mounds), scratch marks, and burrows of our target animals (Indian Pangolin and Indian Crested Porcupine). To determine if the burrows had been occupied most recently, we checked for the absence of leaves and cobwebs (Willcox et al. 2019) and by looking for the presence of fresh soil or fresh activity signs of the pangolin and porcupine near the burrow entrance (Waseem et al. 2020).

In November 2022, the field surveys were conducted randomly (to prevent bias) on a day of each week, with a minimum of seven days gap before the next survey, to remove the effects of any human interference. During December 2022–April 2023, the surveys were focussed on collection of data from already identified sites, setting of camera traps and performing quadrat analysis. These surveys were undertaken with a gap of approximately 14 days between each survey. For example, if the first survey in December was performed on the Friday of the first week of December, the second survey in December was performed on the Friday of the third week of December. Following this, the next survey was conducted on the Friday of the first week in January 2023, and again on the Friday of the third week in January 2023.

The surveyors who comprised of seven trained individuals and two experienced local villagers (employed as para-biologists (Karawita et al. 2018) to guide us to the actual field sites (during the daytime)) were divided into three groups: Group A—two trained individuals and a local villager; Group B—two other trained individuals and the other local villager; Group C—three trained individuals. Each group was placed in-charge of two sampling sites (six in total).

Camera trapping

Once the potential habitats and feeding signs of the pangolin and the porcupine were detected, camera traps (Cuddeback X-Change™ Color model 1279) (Supplemental Image 3) were set at those selected sampling sites (six in number) targeting the entrance of resting burrows, feeding burrows, termite mounds, ant nests, edge of a rivulet, and in places where fresh bites and feeding signs were observed. Installation of camera traps was done separately and following a routine which was different with respect to the capturing of photographs of animal signs using the Nikon D3400 camera (Refer to 'Data collection and capturing photographs' of materials and methods section).

The six selected sampling sites where field surveys were conducted, were also chosen as the six camera trap stations. The exact GPS coordinates (taken using GPS Map Camera Application in Xiaomi Redmi Note 8) of

these six stations were noted as follows:

Site 1: 23.23° N 86.27° E, Site 2: 23.20° N 86.28° E, Site 3: 23.22° N 86.26° E, Site 4: 23.25° N 86.24° E, Site 5: 23.24° N 86.27° E, Site 6: 23.21° N 86.28° E.

Twelve camera traps were required during the entire study period. During the first four field surveys in November 2022, no camera traps were set. The first set of six camera traps were installed (during the day) on the Friday of the first week of December 2022 at the six different sampling sites (coordinates mentioned above) in the study area. The six camera traps remained in the field for a period of 14 days, following which those were removed from the six sampling sites on the Friday of the third week of December 2022. Then, as the first set of six camera traps were removed, the second set of another six camera traps were re-installed at the six sampling sites on the Friday of the third week of December 2022. The second set remained installed for 14 days, after which they were removed on the Friday of the first week of January 2023, and again the initial first set of six camera traps were re-installed on the same day. This process of installation and removal of camera traps were followed till the Friday of the third week of April 2023, resulting in 132 days of camera trap data. The timings of camera trap installation, removal and re-installation were strictly maintained between 1200 and 1400.

Quadrat method

Quadrat method (25 × 25 m) was used for vegetation analysis at the six selected sites where camera traps were set, in the study area.

The collection of quadrat data was first performed in the first week of November 2022. Following this, three technical replicates (data provided as supplementary material) of the quadrat data were obtained on three separate days— Friday of the first week of December 2022, Friday of the first week of February 2023, and Friday of the first week of April 2023, with a gap of one month between the technical replicates. This was done to monitor any change (if at all) of the vegetation cover at the sampling sites in the study area, during the study. Collection of quadrat data was part of the workflow of the diurnal field surveys conducted at the frequency as mentioned in the "diurnal field surveys" section.

Two sampling sites were placed under one group of team members (consisting of three members in each team). Each sampling site also corresponded to a quadrat area (25 × 25 m). Therefore, there were six quadrat areas, with each group responsible for taking quadrat data from two sites. For each quadrat area, three biological replicates (of the species of trees) were

counted on the same day, by the three team mates independently and separately, to prevent the possibility of bias in counting due to influence of the result of counting obtained by one teammate over the others.

For the data collection of quadrat analysis, the type of trees and number of each type of tree was noted down, from six quadrat areas, considered in the six sites within the study area. Three technical replications of the data collection were done at each of the six sites, thus resulting in 18 datasets (refer to supplementary material) for each type of tree.

Data collection and capturing photographs

Data collection was done from six selected sites within the study area and included the capturing of photographs (Image 1A) (using Nikon D3400 digital camera) of rocky burrows, termite mounds, ant nests, feeding signs, fresh prints of body parts on ground, and trees within the quadrat areas. Also, faecal matter and

detached body parts such as quills (of Indian Crested Porcupine) and scales (of Indian Pangolin) (Images 1B,C) were collected.

Data collection and capturing of photographs was conducted on all six sampling sites, during every diurnal field survey. Data was collected during one random day in each week in November 2022, with a gap of minimum seven days (four data collections in November); followed by data collection in the Friday of the first week of December 2022, then in the Friday of the third week of December 2022, then in the Friday of the first week of January 2023, followed by the Friday of the third week of January 2023, and so on, till April 2023. Therefore, data collections were done twice each month from December 2022–April 2023 (10 times), accounting for total 14 data collection rounds.

Data analysis

The statistical analysis of the data obtained through



Image 1. Indian Pangolin and its scales found in study area: A—Individual detected in one of the six sampling sites in our study area | B—ventral surface of a scale found detached from the body | C—dorsal surface of the scale found detached from the body. © Shwetadri Bhandari.

quadrate method was performed using Microsoft Excel and R version 4.3.0.

The Mean $\pm$ SEM values of the number of trees commonly occurring within the quadrates, were used for plotting the graph. The commonly occurring trees were further divided into two groups:

- 1) The Favoured group—trees favoured by Indian Pangolin and Indian Crested Porcupine within the quadrate areas, and
- 2) The Unfavoured group—trees unfavoured by Indian Pangolin and Indian Crested Porcupine, within the quadrate areas.

Ethical considerations

The project was undertaken and executed only after the provision of required permits for the fieldwork, by the Forest Department of West Bengal, Purulia Division (Approval letter number: 2552/26-1(WL); date of approval: 06/09/2022). The surveys were carried out by following all the instructions of the forest rangers. The two villagers (anonymised for the sake of research integrity) were involved in the surveys as parabiologists, only after informing them thoroughly about our survey goals, in their colloquial language, without using scientific jargons, and only when they voluntarily consented for contribution in the study. Absolute care was taken to maintain silence during the surveys and to leave the areas without any major changes after the surveys.

The data collection was non-invasive, involving perception study, surveys, camera trapping, quadrate analysis, and collection of faecal matter. Additionally, since the Indian Pangolin and the Indian Crested Porcupine are nocturnal and exhibit movements in their habitats at night, the in-person data collection and surveys were done during the day. Camera traps were hidden out of view of the animals and set in such a way, to prevent any interaction of the camera traps with any animals. Certain body parts like quills (of the Indian Crested Porcupine) and scales (of the Indian Pangolin) were collected only when those were left on the ground after their natural detachment from the animal bodies.

RESULTS

Signs of pangolin and porcupine presence

Rocky cavities were detected at multiple locations in the Gajaburu hills, where the evidence of the Indian Pangolin and the Indian Crested Porcupine sharing their living space were detected. However, we have

depicted the evidence observed at only one rocky cavity (henceforth called 'focal rocky cavity') in the Results section because results captured by camera at this site had maximum clarity. At sites other than the six focal sites, the rocky cavities were at such an angle of the terrain, that although the evidence was visible, photographing those up close was not logistically possible, without hampering the evidence.

In Image 2A, the focal rocky cavity is clearly visible, with the fresh and recent tail drag marks, footprints, and claw prints (the magnified views of these have been shown in Images 2B,C, respectively of the Indian Pangolin, in the sandy soil layer at the entrance of the focal rocky cavity. Interestingly, further inwards from the sandy soil layer, towards the focal rocky cavity, the detached quills of the Indian Crested Porcupine (Image 2D) were also detected. Additionally, a boulder was found approximately 2–3 m from the focal rocky cavity, on which we spotted fresh dung (faecal sample) of the Indian Crested Porcupine. This indicates recent co-usage of the same rocky cavity by both the Indian Pangolin and the Indian Crested Porcupine.

Habitat suitability

A Karam *Neolamarckia cadamba* tree was detected (Image 3A) within 5 m of the focal rocky cavity, where co-existential evidence of the Indian Pangolin and Indian Crested Porcupine was detected. The Karam tree was observed with a termite mound growing on the lower part of its trunk and red ants were spotted all over its trunk and branches. Another huge and well-developed termite mound was detected (Image 3B) approximately 7 m from the focal rocky cavity and 3 m from the Karam tree. It shows that this site with termite mounds and presence of red ants in proximity to the rocky cavity, is the preferred habitat for the Indian Pangolin, due to the abundant food sources nearby.

Numerous fallen Bael fruits were found already cracked open, and their inner contents eaten by the Indian Crested Porcupine (Image 4A). We further spotted the teeth (incisor) marks of the Indian Crested Porcupine (Image 4B) on a Bael *Aegle marmelos* fruit. The left-side teeth marking (marked in red towards left edge in Image 4B) possibly shows the porcupine having tried to drag its incisors across the hard outer covering of the fruit, thus trying to pry it open. The right-side teeth marking (marked in red towards right edge in Image 4B) possibly shows the porcupine having tried to get a firm hold of the fruit with its teeth, while trying to fracture the hard covering of the Bael fruit, to feed on the meat inside it. Again, this feeding evidence was detected near our focal

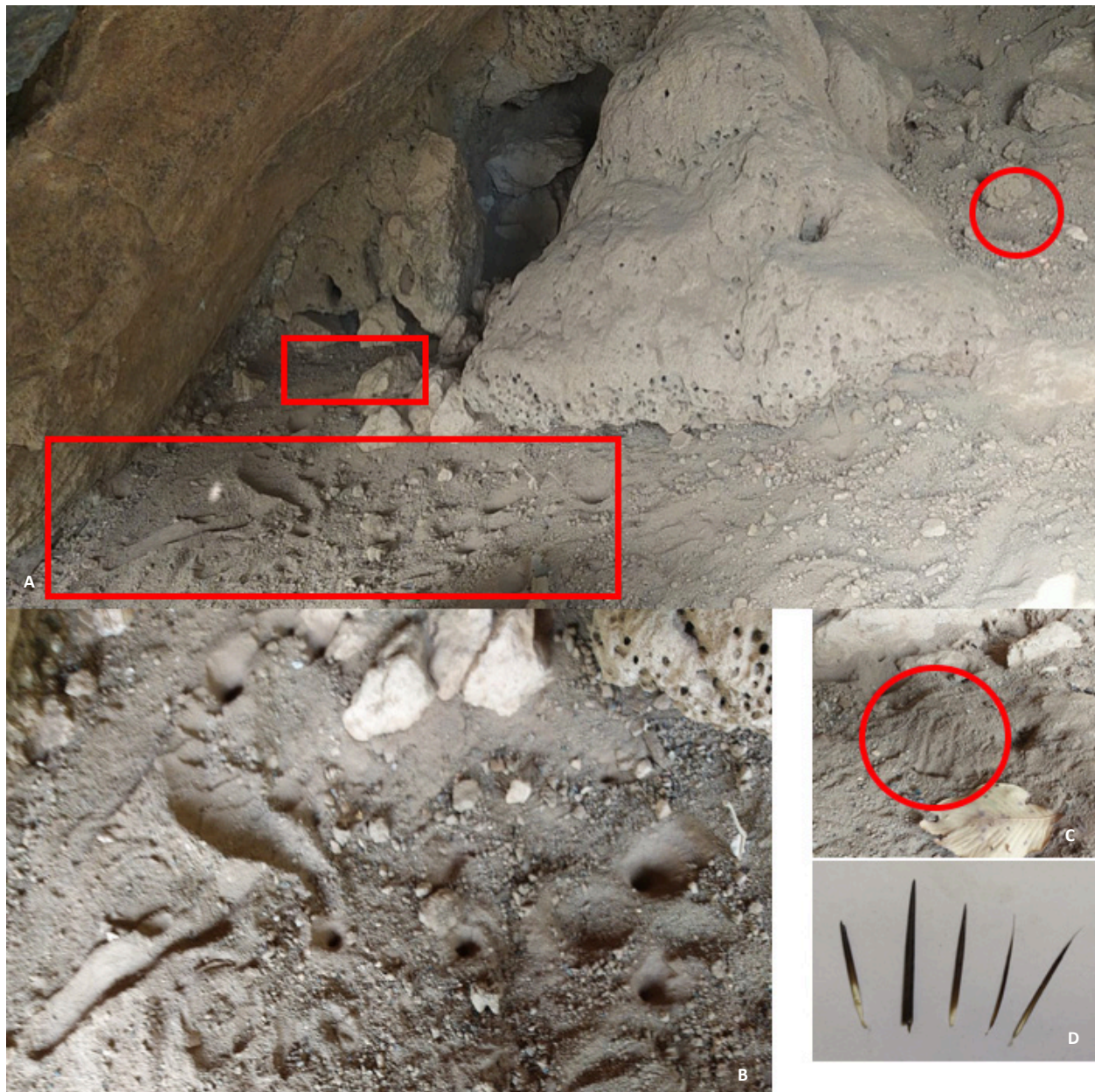


Image 2. Signs of pangolin and porcupine presence: A—focal rocky cavity with position of tail drag marks, footprints (bigger red rectangle) and claw prints (red circle) of Indian Pangolin, and detached quills (smaller red rectangle) of the Indian Crested Porcupine, at the entrance | B—magnified view of the entrance of focal rocky cavity with tail drag marks (towards left) and footprints (towards right) of the Indian Pangolin | C—magnified view of the entrance of focal rocky cavity with claw prints (shown in red circle) of the Indian Pangolin | D—detached quills of the Indian Crested Porcupine collected from the entrance of the focal rocky cavity. © Debosmita Sikdar.

rocky cavity, indicating that our considered site also has nutrient sources for the Indian Crested Porcupine, which therefore has an affinity to stay in this habitat, which is further proved by the presence of fresh dung of the Indian Crested Porcupine on a boulder (Image 4C) at that place.

Quadrates analysis

The results of all six quadrates were combined in a single table (Table 1) and graph (Figure 1) to visualize the relationship between the types of trees most commonly spotted in the quadrates (plotted on the x-axis) versus the total number of each type of tree counted in the quadrates (plotted on the y-axis) considered, where the focal rocky cavities were present, as well as camera traps

were set. Among the eight types of commonly occurring trees, there were four types of trees which occurred most frequently in the quadrates areas namely: Tendu *Diospyros melanoxylon*, Bael *Aegle marmelos*, Karam *Neolamarckia cadamba*, and Sisu *Dalbergia sissoo*. These four trees were grouped under 'the Favoured group' (Refer to 'Data analysis' sub-section under 'Methods' section). The remaining four trees namely: White Siris *Albizia procera*, Indian Plum or Kul *Ziziphus mauritiana*, Banyan *Ficus benghalensis*, and Palash *Butea monosperma* are grouped under 'the Unfavoured group' (Refer to 'Data analysis' sub-section under 'Methods' section).

Trees such as *Dalbergia sissoo*, which provide humid conditions in their roots for supporting the formation of ant nests and termite mounds, are often found within the habitat of the Indian Pangolin (Mahmood et al. 2013). Also, the Karam tree that was found in our focal site, bore termite mounds and red ants on it. Therefore, the presence of Karam and Sisu tree in our quadrates (containing the focal rocky cavity), favours the presence of the Indian Pangolin in the area.

Additionally, we observed that the Indian Crested Porcupine had fed on Bael fruits. Also, the Tendu tree produces sweet fruits, which local people often collect for eating. Although, we have not found evidence of the Indian Crested Porcupine having fed on Tendu fruits, yet scientific literature suggests that it prefers eating fruits, bulbs, tubers, and roots of plants, even potatoes

from agricultural fields (Saltz & Alkon 1989). Therefore, the presence of Bael and Tendu trees in the quadrates (containing the focal rocky cavity), favours the presence of the Indian Crested Porcupine in the area.

Thus, the trees which housed the target prey species of the Indian Pangolin (red ants and termites) and the trees bearing fruits favoured by the Indian Crested Porcupine, occurred at maximum frequency within the quadrate area, which already contained the focal rocky cavity. This overlapping of favoured food sources of the pangolin and porcupine in the same area, is an indication that both the species may co-inhabit in the area, and occupy the same living burrow, as indicated

Table 1. Results of the quadrate analysis. The trees - *Diospyros melanoxylon*, *Aegle marmelos*, *Neolamarckia cadamba*, and *Dalbergia sissoo* - occurred at maximum frequency within the quadrate areas.

	Types of trees most commonly spotted in the quadrates	No. of trees of each type counted in the quadrates (Mean±SEM)
1.	White Siris <i>Albizia procera</i>	12±0.28
2.	Indian Plum or Kul <i>Ziziphus mauritiana</i>	15±0.63
3.	Banyan <i>Ficus benghalensis</i>	2±0.25
4.	Palash <i>Butea monosperma</i>	9±0.44
5.	Tendu <i>Diospyros melanoxylon</i>	29±0.78
6.	Bael <i>Aegle marmelos</i>	21±0.86
7.	Karam <i>Neolamarckia cadamba</i>	26±1.27
8.	Sisu <i>Dalbergia sissoo</i>	23±0.70



Image 3. Habitat suitability signs for the Indian Pangolin: A—Karam tree with termite mounds on its trunk, found near the focal rocky cavity within the quadrate area | B—termite mound observed near the focal rocky cavity within the quadrate area. © Debosmita Sikdar.

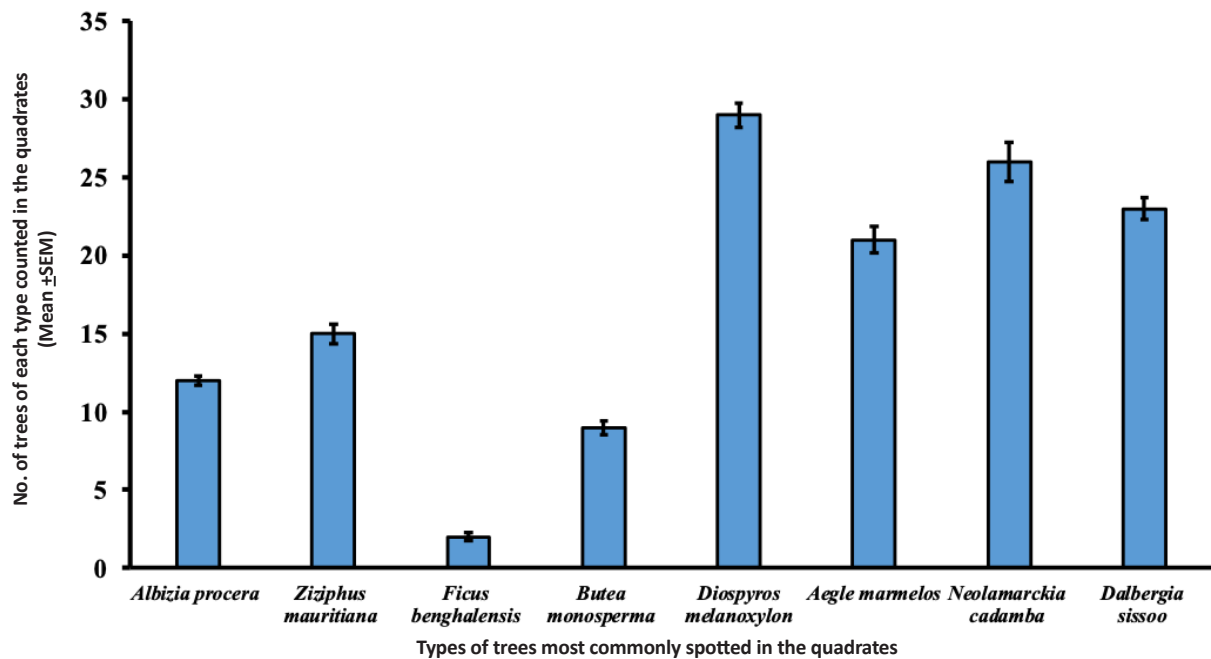


Figure 1. Graphical representation of result of quadrate analysis.

The two trees (*Neolamarckia cadamba* and *Dalbergia sissoo*) which housed the target prey species of the Indian Pangolin (red ants and termites) and the two trees (*Diospyros melanoxylon* and *Aegle marmelos*) which bear fruits favoured by the Indian Crested Porcupine, occurred at maximum frequency within the quadrate areas.

by the indirect evidence near the entrance of our focal rocky cavity.

Statistical analysis of quadrate data

The dataset for the Favoured group was analysed using R version 4.3.0 to check for normal distribution of the dataset, using the Shapiro-Wilk normality test. However, the original dataset did not show normal distribution (Shapiro-Wilk Normality test: $W = 0.958$, $P = 0.016$ as $P < 0.05$; so, log transformation of the dataset was taken and then the dataset showed normal distribution (Shapiro-Wilk normality test: $W = 0.972$, $P = 0.112$) as $P > 0.05$.

Similarly, the original dataset for the Unfavoured group did not show normal distribution (Shapiro-Wilk normality test: $W = 0.938$, $P = 0.002$) as $P < 0.05$. Even the subsequent log transformations of the original dataset could not yield normal distribution of data (Shapiro-Wilk normality test: $W = 0.796$, $P = 2.227 \times 10^{-8}$), and (Shapiro-Wilk normality test: $W = 0.707$, $P = 1.902 \times 10^{-10}$) respectively, as $P < 0.05$.

The datasets of the Favoured and Unfavoured groups were analysed using a non-parametric test called Wilcoxon signed-ranks test, by taking into consideration the original datasets of both groups. The null hypothesis was: There is no significant difference between number of trees of Favoured group and number of trees of

Unfavoured groups in the quadrates considered at focal sites. The alternate hypothesis was: there is significant difference between number of trees of Favoured group and number of trees of Unfavoured groups in the quadrates considered at focal sites.

After running the analysis, the alternate hypothesis was accepted (Wilcoxon signed-ranks test: $W = 100$, $P < 2.200 \times 10^{-16}$) as $P < 0.05$. This indicates that at the quadrate areas, the trees which contain the food sources of both the Indian Pangolin and the Indian Crested Porcupine, are significantly different in number, with respect to those trees which do not contain food sources of both animals. Thus, the presence of trees of the Favoured group in an area facilitates the co-inhabitation of both animals and has significant potential for supporting the presence of both the Indian Pangolin and the Indian Crested Porcupine simultaneously, as evidenced by the data collected from our focal sites.

DISCUSSION

According to the report of the 2002 census of wild animals in southern West Bengal, conducted by the West Bengal Forest Department, only 42 pangolins were found in the Purulia district (Samanta et al. 2021). The possible reason for their scanty population is that the



Image 4. Existential evidence of Indian Crested Porcupine: **A**—*Aegle marmelos* fruits found near the focal rocky cavity, cracked open and inner contents fed by the Indian Crested Porcupine | **B**—*Aegle marmelos* fruit recovered near the focal rocky cavity with biting marks (made by incisors) of the Indian Crested Porcupine | **C**—dung of the Indian Crested Porcupine found on a boulder near the entrance of the focal rocky cavity.
© Debosmita Sikdar.

Indian Pangolin is extensively hunted and poached for its meat (Hughes 2014), which is consumed locally and as a luxury food; and scales which are internationally traded (Mohapatra et al. 2015). The scales combined with other materials are used in traditional Chinese medicine, to promote blood circulation, stimulate lactation, reduce swelling, expel pus (Xu et al. 2016) and cure rheumatism (Hughes 2014).

The scales of an average adult Indian Pangolin weigh about 3.5 kg in total. According to a report, in 1996 the pangolin scales were sold for INR1000/kg in Mizoram, which increased to INR12,000– INR13,000/kg in 2013 (Mohapatra et al. 2015). According to another report from 2006–2007, the scales were sold for USD \$132/kg at wholesale markets, and USD \$160/kg at retail markets, which have increased four-fold at the wholesale markets and six-fold at the retail markets (Xu et al. 2016).

There was a report on pangolin spotting in the Ajodhya Hills, in the Purulia District, West Bengal on 12 August 2021 by a camera trap survey, and there were also reports of rescue of two Indian Pangolins by the forest department of Purulia from poachers at Bararola and Serengdi village adjacent to the Ajodhya Hills on 22 August 2021 and 28 August 2021, respectively (Samanta et al. 2021).

The techniques employed by the poachers for entrapping a pangolin include the digging up of muddy

burrows or driving them out by smoking or flushing them out with water, pitfall trapping, and using hunting dogs. Then the captured pangolins are killed by boiling them in water or knocked unconscious by hitting with a club. The scales are then either peeled off the pangolin or it is entirely skinned (Mohapatra et al. 2015). Banerjee (2022) discusses about the traditional ‘Shikar’ or hunting ritual carried out in the Ajodhya Hills, Purulia on ‘Baishakhi Purnima’, the full moon day in summer, wherein the Santhal (local tribe) men wander in the forests and kill wild porcupine, pangolin, deer, monkey, wild boar, and bear.

The Indian Crested Porcupine is also subject to extensive poaching to obtain its meat, and quills, which are used for making traditional medicines. Lupo & Schmitt (2005) state the porcupines were hunted using spears. However, the porcupines are recently hunted using special traps called ‘fibre purse’ or ‘bag trap’, which is set in front of the burrow of the animal. These special traps are built in a specific way, consisting of fibres or ropes hanging down from a layer of rocks on the top. Then, the hunters frighten the porcupine and force it to move into the trap, wherein quills of the porcupine get entangled in the dangling fibres, and when trying to pull away and escape, the rocks fall on its delicate body, thus injuring and immobilising the porcupine, which gets subsequently poached.

The Indian Pangolin and the Indian Crested Porcupine in Purulia, coexist in the same rocky cavity. From the perspective of the Indian Pangolin, it protects itself by staying in the rocky cavity occupied by the porcupine, by making it difficult for the poachers to break or dig open a hard rocky cavity, as opposed to a soft, muddy burrow. Additionally, by occupying pre-formed rocky cavities, the pangolin can save the energy that it would have spent in digging a burrow in the soil, thus, more energy is available for foraging, mating, and offspring rearing.

From the perspective of the Indian Crested Porcupine, it gains huge advantage of co-inhabiting with the Indian Pangolin by decreasing its probability of getting poached by 50%. When the porcupine co-exists with a pangolin, then considering that both Indian Pangolin and Indian Crested Porcupine have overlapping time period of peak activity at night, the probability that the porcupine exits the burrow at a specific time is one-half of the probability of exiting the burrow when it was the lone occupant of the burrow. Thus, the probability of the porcupine getting entrapped in the 'fibre purse', is reduced by half (50%) with respect to probability of being poached when it occupied the burrow alone.

A study from southwestern Sri Lanka, had reported the co-occupancy of the 'same habitats' by burrowing animals such as the Indian Pangolin, the Greater Bandicoot Molerat *Bandicota indica* and the Indian Crested Porcupine *Hystrix indica* (Karawita et al. 2018). The general trend being observed in case of the co-inhabitations, is that these behaviours are exhibited mostly in the areas involving high human-wildlife interactions.

CONCLUSION

The present study undertaken at the Purulia District of West Bengal, India, depicts that the Indian Pangolin and the Indian Crested Porcupine may coexist and share the same habitat. The reason for such behaviour, can be attributed to help them in coping up with extreme anthropogenic intrusion in their niche. An immediate necessity for their conservation also arises to diminish their population decline, caused by extensive poaching.

Future Work

IUCN estimates predict that the global Indian Pangolin population is likely to decrease by over 50% in the next 20 years (Waseem et al. 2020). Moreover, among all the Asian Pangolins, the Indian Pangolin is the least studied in terms of their abundance, population status,

burrow characteristics and habitat preference (Karawita et al. 2018). This lack of proper quantitative data about the Indian Pangolin in India, Nepal, and Bangladesh, hampers understanding of the behaviour and ecology of the species. Future research and thorough surveys on pangolin populations are needed to shed light on this aspect.

It is important to determine if the Indian Pangolin shows such behaviours in presence of any other animals, whether it co-inhabits with other animals during the breeding, offspring rearing seasons and study their behaviours in other types of habitats, especially in the tropical wet rainforests. The study of these activities are essential to formulate effective conservation strategies for the 'Endangered' Indian Pangolin.

REFERENCES

- Akram, F., O. Ilyas & A. Haleem (2017). Food and feeding habits of Indian crested Porcupine in Pench tiger reserve, Madhya Pradesh, India. *Ambient Science* 4(1): 62–66.
- Amori, G., R. Hutterer, B. Kryštufek, N. Yigit, G. Mitsainas & L. Palomo (2021). *Hystrix indica* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2021: e.T10751A197516522. <https://doi.org/10.2305/IUCN.UK.2021-1.RLTS.T10751A197516522.en>. Accessed on 16 February 2024.
- Beca, G., L.E. Valentine, M. Galetti & R.J. Hobbs (2022). Ecosystem roles and conservation status of bioturbator mammals. *Mammal Review* 52(2): 192–207. <https://doi.org/10.1111/mam.12269>
- Banerjee, A. (2022). Boddington's Santal Medicine and Connected Folklore vis-à-vis Vidyasagar's understanding of Anthropological Study. *Journal of the Asiatic Society* 63(4): 131–154.
- Chao, J.T., H.F. Li & C.C. Lin (2019). The role of Pangolins in ecosystems, pp. 43–48. In: Challender, D.W.S., H.C. Nash & C. Waterman (eds.). *Pangolins: Science, Society and Conservation*. Academic Press, Elsevier, London, 658 pp.
- Corsini, M.T., S. Lovari & S. Sonnino (1995). Temporal activity patterns of crested Porcupines *Hystrix cristata*. *Journal of Zoology* 236(1): 43–54. <https://doi.org/10.1111/j.1469-7998.1995.tb01783.x>
- Heath, M.E. & I.M. Coulson (1997). Preliminary studies on relocation of Cape Pangolins *Manis temminckii*. *South African Journal of Wildlife Research* 27: 51–56. <https://doi.org/10.10520/EJC117030>
- Hughes, J.E. (2014). Thinking (with) the Indian Pangolin: A human-animal perspective on India's colonial and princely histories. Nehru Memorial Museum and Library, Teen Murti House, New Delhi, India, 45 pp.
- Karawita, H., P. Perera, P. Gunawardane & N. Dayawansa (2018). Habitat preference and den characterization of Indian Pangolin (*Manis crassicaudata*) in a tropical lowland forested landscape of southwest Sri Lanka. *PLoS ONE* 13(11): e0206082. <https://doi.org/10.1371/journal.pone.0206082>
- Mohapatra, R.K., S. Panda, M.V. Nair, L.N. Acharjyo & D.W.S. Challender (2015). A note on the illegal trade and use of pangolin body parts in India. *TRAFFIC Bulletin* 27(1): 33–40.
- Lupo, K.D. & D.N. Schmitt (2005). Small prey hunting technology and zooarchaeological measures of taxonomic diversity and abundance: Eehnoarchaeological evidence from central African forest foragers. *Journal of Anthropological Archaeology* 24(4): 335–353. <https://doi.org/10.1016/j.jaa.2005.02.002>
- Mahmood, T., K. Jabeen, I. Hussain & A.R. Kayani (2013). Plant Species Association, Burrow Characteristics and the Diet of the Indian

- Pangolin, *Manis crassicaudata*, in the Potohar Plateau, Pakistan. *Pakistan Journal of Zoology* 45(6): 1533–1539.
- Mahmood, T., D. Challender, A. Khatiwada, S. Andleeb, P. Perera, S. Trageser, A. Ghose & R. Mohapatra (2019). *Manis crassicaudata*. The IUCN Red List of Threatened Species 2019: e.T12761A123583998. <https://doi.org/10.2305/IUCN.UK.2019-3.RLTS.T12761A123583998.en>. Accessed on 16 February 2024.
- Mahmood, T., R.K. Mohapatra, P. Perera, N. Irshad, F. Akrim, S. Andleeb, M. Waseem, S. Sharma & S. Panda (2019). Indian Pangolin *Manis crassicaudata* (Geoffroy, 1803), pp. 71–88. In: Challender, D.W.S., H.C. Nash & C. Waterman. *Pangolins: Science, Society and Conservation*. Academic Press, Elsevier, London, United Kingdom, 658 pp.
- Mohapatra, R.K. & S. Panda (2014). Husbandry, behaviour and conservation breeding of Indian Pangolin. *Folia Zoologica* 63(2): 73–80. <https://doi.org/10.25225/fozo.v63.i2.a4.2014>
- Prater S.H. (ed.) (2005). *The Book of Indian Animals*. Bombay Natural History Society, Oxford University Press, Mumbai, India, 324 pp.
- Saltz, D. & P.U. Alkon (1989). On the spatial behaviour of Indian Crested Porcupines (*Hystrix indica*). *Journal of Zoology* 217(2): 255–266. <https://doi.org/10.1111/j.1469-7998.1989.tb02486.x>
- Samanta, S., S. Mahato & A. Mukherjee (2021). Documentation of the globally threatened Indian Pangolin and its threats from Ajodhya Hills, Purulia, West Bengal, India. *Zoo's Print* 36(12): 65–66.
- Shepherd C.R., E. Connelly, L. Hywood & P. Cassey (2017). Taking a stand against illegal wildlife trade: the Zimbabwean approach to Pangolin conservation. *Oryx* 51: 280–285. <https://doi.org/10.1017/S0030605316000119>
- Waseem, M., B. Khan, T. Mahmood, H. S. Hussain, R. Aziz, F. Akrim, T. Ahmad, R. Nazir, S. Hameed & M. N. Awan (2020). Occupancy, habitat suitability and habitat preference of endangered Indian Pangolin (*Manis crassicaudata*) in Potohar Plateau and Azad Jammu and Kashmir, Pakistan. *Global Ecology and Conservation* 23: e01135. <https://doi.org/10.1016/j.gecco.2020.e01135>
- Willcox, D., H.C. Nash, S. Trageser, H.J. Kim, L. Hywood, E. Connelly, G. Ichu, J.K. Nyumu, C.L.M. Moumbolou, D.J. Ingram & D.W.S. Challender (2019). Evaluating methods for detecting and monitoring pangolin (Pholidata: Manidae) populations. *Global Ecology and Conservation* 17: e00539. <https://doi.org/10.1016/j.gecco.2019.e00539>
- Xu, L., J. Guan, W. Lau & Y. Xiao (2016). An overview of pangolin trade in China. *TRAFFIC* September 2016: 1–10.

Quadrat Analysis Data

The Favoured Group

Name of tree	<i>Diospyros melanoxylon</i>	<i>Aegle marmelos</i>	<i>Neolamarckia cadamba</i>	<i>Dalbergia sissoo</i>
No. of trees of each type	33	25	32	21
	34	22	30	22
	32	23	29	23
	27	19	27	25
	25	18	25	28
	27	19	25	26
	35	29	21	22
	32	27	23	23
	31	28	23	22
	28	21	35	28
	26	21	33	27
	28	21	36	28
	31	18	22	23
	30	17	19	23
	33	17	20	23
	26	20	22	19
	25	20	21	19
	26	21	22	20
Mean	29.389	21.444	25.833	23.444
Standard deviation	3.310	3.650	5.393	2.955
SEM	0.780	0.860	1.271	0.696

Colour coding for Quadrat data collected at the six focal sites (in order):

- Three technical replicates from Focal site 1
- Three technical replicates from Focal site 2
- Three technical replicates from Focal site 3
- Three technical replicates from Focal site 4
- Three technical replicates from Focal site 5
- Three technical replicates from Focal site 6

The Unfavoured Group

Name of tree	<i>Albizia procera</i>	<i>Ziziphus mauritiana</i>	<i>Ficus benghalensis</i>	<i>Butea monosperma</i>
No. of trees of each type	12	15	2	10
	11	14	2	8
	12	15	1	9
	11	21	1	8
	12	19	1	8
	11	18	1	7
	13	12	3	7
	12	10	2	8
	10	13	2	7
	11	14	2	13
	13	13	3	11
	12	15	2	10
	12	13	0	8
	15	15	0	8
	12	14	0	8
	10	15	3	10
	13	16	3	12
	11	18	3	12
Mean	11.833	15.000	1.722	9.111
Standard deviation	1.200	2.657	1.074	1.875
SEM	0.283	0.626	0.253	0.442

Colour coding for Quadrature data collected at the six focal sites (in order):

-  Three technical replicates from Focal site 1
-  Three technical replicates from Focal site 2
-  Three technical replicates from Focal site 3
-  Three technical replicates from Focal site 4
-  Three technical replicates from Focal site 5
-  Three technical replicates from Focal site 6

R Code Sheet for Statistical Analysis of Quadrate data

R version 4.3.0

[Workspace loaded from ~/. RData]

```
> library(readxl)
> Pangolin_Porcupine <- read_excel ("Pangolin-Porcupine.xlsx",
+   sheet = "Favoured")
> View (Pangolin_Porcupine)
> shapiro.test (Pangolin_Porcupine$Number)
```

Shapiro-wilk normality test

```
data: Pangolin_Porcupine$Number
W = 0.95757, p-value = 0.01615
> LOGFAV=log (Pangolin_Porcupine$Number)
> shapiro.test (LOGFAV)
```

Shapiro-wilk normality test

```
data: LOGFAV
W = 0.97228, p-value = 0.1125
```

The Favoured group's dataset was log transformed to make the dataset parametric or normally distributed (Shapiro-Wilk normality test, $P>0.05$).

```
> library(readxl)
> Pangolin_Porcupine <- read_excel ("Pangolin-Porcupine.xlsx",
+   sheet = "Unfavoured")
> View (Pangolin_Porcupine)
> shapiro.test (Pangolin_Porcupine$Number)
```

Shapiro-wilk normality test

```
data: Pangolin_Porcupine$Number
W = 0.93847, p-value = 0.001587
> LOGVAL=log (Pangolin_Porcupine$Number)
> shapiro.test (LOGVAL)
```

Shapiro-wilk normality test

```
data: LOGVAL
W = 0.79605, p-value = 2.227e-08
> LOGVAL1<-log (Pangolin_Porcupine$`log (Number)+1`)
> shapiro.test (LOGVAL1)
```

Shapiro-wilk normality test

```
data: LOGVAL1
W = 0.70663, p-value = 1.902e-10
```

The Unfavoured group's dataset was non-parametric i.e., not normally distributed (Shapiro-Wilk normality test, $P<0.05$). Two types of log transformations were performed to normalize data distribution but couldn't be done.

```
> library(readxl)
> Pangolin_Porcupine <- read_excel ("Pangolin-Porcupine.xlsx",
+   sheet = "Combined")
> View (Pangolin_Porcupine)
> wilcox.test (Pangolin_Porcupine$Number)
```

Wilcoxon signed rank test with continuity correction

```
data: Pangolin_Porcupine$Number
V = 10011, p-value < 2.2e-16
alternative hypothesis: true location is not equal to 0.
```

Non-parametric test (Wilcoxon signed-ranks test, $P<0.05$) performed between the Favoured group and Unfavoured group, here named "Combined" group.



Supplemental Image 1 (A–D). Termite mounds found in study area. In addition to the six focal sites, termite mounds were found at various other locations within the study area, indicating the presence of the Indian Pangolin. © Debosmita Sikdar.



Supplemental Image 2. Picture of Study area. A view of the Gajaburu hills in Purulia District, West Bengal, India, where the Study was conducted. © Debosmita Sikdar.



Supplemental Image 3. Picture of Camera trap. The picture shows the type of Camera traps that were used in the study for monitoring the activities of the Indian Pangolin and the Indian Crested Porcupine. © Debosmita Sikdar.

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. Monsoon Jyoti Gogoi, Assam University, Silchar, Assam, India
Dr. Heo Chong Chin, Universiti Teknologi MARA (UiTM), Selangor, Malaysia
Dr. R.J. Shiel, University of Adelaide, SA 5005, Australia
Dr. Siddharth Kulkarni, The George Washington University, Washington, USA
Dr. Priyadarsanan Dharma Rajan, ATREE, Bengaluru, India
Dr. Phil Alderslade, CSIRO Marine And Atmospheric Research, Hobart, Australia
Dr. John E.N. Veron, Coral Reef Research, Townsville, Australia
Dr. Daniel Whitmore, State Museum of Natural History Stuttgart, Rosenstein, Germany.
Dr. Yu-Feng Hsu, National Taiwan Normal University, Taipei City, Taiwan
Dr. Keith V. Wolfe, Antioch, California, USA
Dr. Siddharth Kulkarni, The Hormiga Lab, The George Washington University, Washington, D.C., USA
Dr. Tomas Ditrich, Faculty of Education, University of South Bohemia in Ceske Budejovice, Czech Republic
Dr. Mihaly Foldvari, Natural History Museum, University of Oslo, Norway
Dr. V.P. 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. Chandrashekhar U. Rivonker, Goa University, Taleigao Plateau, Goa. India
Dr. S.R. Ganesh, Chennai Snake Park, Chennai, Tamil Nadu, India
Dr. Himansu Sekhar Das, Terrestrial & Marine Biodiversity, Abu Dhabi, UAE

Birds

Dr. Hem Sagar Baral, Charles Sturt University, NSW Australia
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, SAGON, Coimbatore, Tamil Nadu, India
Dr. Rajiv S. Kalsi, M.L.N. College, Yamuna Nagar, Haryana, India
Dr. V. Santharam, Rishi Valley Education Centre, Chittoor Dt., Andhra Pradesh, India
Dr. S. Balachandran, Bombay Natural History Society, Mumbai, India
Mr. J. Praveen, Bengaluru, India
Dr. C. Srinivasulu, Osmania University, Hyderabad, India
Dr. K.S. Gopi Sundar, International Crane Foundation, Baraboo, USA
Dr. Gombobaatar Sunde, Professor of Ornithology, Ulaanbaatar, Mongolia
Prof. Reuven Yosef, International Birding & Research Centre, Eilat, Israel
Dr. Taej Mundkur, Wetlands International, Wageningen, The Netherlands
Dr. Carol Inskipp, Bishop Auckland Co., Durham, UK
Dr. Tim Inskipp, Bishop Auckland Co., Durham, UK
Dr. V. Gokula, National College, Tiruchirappalli, Tamil Nadu, India
Dr. Arkady Lelej, Russian Academy of Sciences, Vladivostok, Russia
Dr. Simon Dowell, Science Director, Chester Zoo, UK
Dr. Mário Gabriel Santiago dos Santos, Universidade de Trás-os-Montes e Alto Douro, Quinta de Prados, Vila Real, Portugal
Dr. Grant Connette, Smithsonian Institution, Royal, VA, USA
Dr. 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, SAGON, 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, SAGON, Anaikatty P.O., Coimbatore, Tamil Nadu, India
Dr. Nishith Dharaiya, HNG University, Patan, Gujarat, India
Dr. Spartaco Gippoliti, Socio Onorario Società Italiana per la Storia della Fauna "Giuseppe Altobello", Rome, Italy
Dr. Justus Joshua, Green Future Foundation, Tiruchirappalli, Tamil Nadu, India
Dr. H. Raghuram, The American College, Madurai, Tamil Nadu, India
Dr. Paul Bates, Harison Institute, Kent, UK
Dr. Jim Sanderson, Small Wild Cat Conservation Foundation, Hartford, USA
Dr. Dan Challender, University of Kent, Canterbury, UK
Dr. David Mallon, Manchester Metropolitan University, Derbyshire, UK
Dr. Brian L. Cypher, California State University-Stanislaus, Bakersfield, CA
Dr. S.S. Talmale, Zoological Survey of India, Pune, Maharashtra, India
Prof. Karan Bahadur Shah, Budhanilakantha Municipality, Kathmandu, Nepal
Dr. Susan Cheyne, Borneo Nature Foundation International, Palangkaraja, Indonesia
Dr. Hemanta Kafley, Wildlife Sciences, Tarleton State University, Texas, USA

Other Disciplines

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

Reviewers 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

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



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)

February 2024 | Vol. 16 | No. 2 | Pages: 24615–24818

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

DOI: 10.11609/jott.2024.16.2.24615-24818

www.threatenedtaxa.org

Articles

Unearthing calf burials among Asian Elephants *Elephas maximus* Linnaeus, 1758 (Mammalia: Proboscidea: Elephantidae) in northern Bengal, India

– Parveen Kaswan & Akashdeep Roy, Pp. 24615–24629

Coexistence of Indian Pangolin *Manis crassicaudata* (Geoffroy, 1803) (Mammalia: Pholidota: Manidae) and Indian Crested Porcupine *Hystrix indica* (Kerr, 1792) (Mammalia: Rodentia: Hystricidae) in Purulia District, West Bengal, India

– Debosmita Sikdar, Shwetadri Bhandari & Sanjay Paira, Pp. 24630–24645

Avifaunal assemblage patterns in Bharathapuzha River Basin, Kerala, India

– Pazhayattuparambil Narayanan Anoop Raj, Avadhoot Dilip Velankar & Padmanabhan Pramod, Pp. 24646–24657

Desmids of Brahmaputra valley, a major southern Asian river basin

– Soumin Nath & Partha Pratim Baruah, Pp. 24658–24693

Communications

Distribution status and roost characteristics of Indian Flying Fox *Pteropus medius* Temminck, 1825 (Mammalia: Chiroptera: Pteropodidae) in Kurukshetra district, Haryana, India

– Ritu Devi & Parmesh Kumar, Pp. 24694–24706

Avifauna of four protected areas of Terai-Arc Landscape, India: significant records and a checklist of species

– Shariq Safi, Tanveer Ahmed, Junid Nazeer Shah, Meraj Anwar & Kamlesh K. Maurya, Pp. 24707–24729

Monitoring observations of the southernmost breeding population of Long-billed Vultures *Gyps indicus* (Scopoli, 1786) (Aves: Accipitriformes: Accipitridae) in the Nilgiri Biosphere Reserve, India

– S. Manigandan, H. Byju & P. Kannan, Pp. 24730–24736

Observations on Indian Skimmer *Rynchops albicollis* Swainson, 1838 (Aves: Charadriiformes: Laridae) breeding colonies in Middle Ganges stretch, India

Kumar Ankit, Mujahid Ahamad, Vivek Ranjan, Sanjay Kumar, Syed Ainul Hussain & Govindan Veeraswami Gopi, Pp. 24737–24745

Avifaunal diversity in urban greenspaces within Cotabato city, Mindanao Island, Philippines

– Joan Rhea Mae L. Baes, Peter Jan D. de Vera, John Paul A. Catipay, Marian Dara T. Tagoon & Elsa May Delima-Baron, Pp. 24746–24751

Waterbird count at Narathali waterbody, Buxa Tiger Reserve in northern Bengal for a decade (2009–2019) with a note on raptors

– Sachin Ranade & Soumya Sundar Chakraborty, Pp. 24752–24759

First confirmed reproduction by a translocated female Siamese Crocodile *Crocodylus siamensis* (Crocodylidae: Crocodilia) with observations of nest attendance and nest-associated fauna

– Steven G. Platt, Sounantha Boutxakittilath, Oudomxay Thongsavath, Samuel C. Leslie, Lonnie D. McCaskill, Randeep Singh & Thomas R. Rainwater, Pp. 24760–24768

Erode Ground Gecko *Cyrtodactylus speciosus* (Beddome, 1870) (Squamata: Gekkonidae) from peri-urban common-lands of Coimbatore, India, with comments on habitat associations

– S.R. Ganesh, N.A. Swaathi & Usha Ravindra, Pp. 24769–24774

Assessment of diversity of Odonata fauna in selected sites of Purba Bardhaman district, West Bengal, India

– Sulagna Mukherjee & Rabindranath Mandal, Pp. 24775–24785

A preliminary assessment of butterfly diversity from Mekhliganj town, Cooch Behar District, West Bengal, India

– Abhirup Saha, Prapti Das & Dhiraj Saha, Pp. 24786–24794

Utilization of *Afzelia africana* Sm. ex Pers. (Magnoliopsida: Fabales: Fabaceae) in Nigeria and its implications for conservation

– Samuel Oloruntoba Bamigboye, Muhali Olaide Jimoh, Falilat Abeni Lawal, Zainab Temitope Osiyemi, Charles Petrus Laubscher & Learnmore Kambizi, Pp. 24795–24803

Short Communications

Gastrointestinal parasites of the Indian Flying Fox *Pteropus medius* in Nagpur City: a seasonal study through faecal sample analysis

– Ruchika R. Sangale & Priya Gawande, Pp. 24804–24806

***Plagiochila javanica* (Sw.) Nees & Mont. (Marchantiophyta: Plagiochilaceae) rediscovered from the Western Ghats after 180 years**

– M.S. Sajitha, C.N. Manju, B. Mufeed, K.P. Rajesh & K.K. Rawat, Pp. 24807–24811

A new record of genus *Synedrus* Graham, 1956 with description of male of *Synedrus kasparyani* Tselikh, 2013 from India

– Mubashir Rashid & Arvind Kumar, Pp. 24812–24815

Note

***Hunteria zeylanica* (Retz.) Gardner ex Thwaites (Magnoliopsida: Gentianales: Apocyanaceae)—new addition and first genus record to the flora of Karnataka**

– G. Ramachandra Rao, Pp. 24816–24818

Publisher & Host



Threatened Taxa